PARK AND RIDE INTEGRATION AND COMMUTER BEHAVIOR ANALYSIS ALONG THE ROUTE OF LAHORE BUS MASS TRANSIT SYSTEM

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ABSTRACT: The Punjab government recently developed a mass rapid transit system, Metro Bus, in the provincial capital Lahore. Integration of park and ride facilities with bus transit route and commuter (frequent traveler) behavior analysis along route of transit system was assessed. Current utilization characteristics of park and ride facilities and factors resulting in the underutilization of integrated parking facilities with Bus Transit System were described. Parking Duration/Efficiency, Commuter and Parking User surveys were conducted at park and ride facilities of selected Metro Bus stations. Despite a considerable parking demand, there were many metro bus stations where no park and ride facilities were provided. It was found that only 11% of the commuters used Cars and motorcycles to reach metro bus and 48 % did not use park and ride due to non-familiarity and non-availability of the parking facilities. It was revealed that 50 % of the parking users parked vehicles for less than five hours and 63% users showed dissatisfaction in relation to existing parking facility. It was recommended to integrate Metro Bus ticketing and surveillance system with park and ride system. It was suggested to provide parking facilities at demographically feasible locations like near Gajjumatta metro bus station and to publicize parking facilities along the Metro Bus route.

Keywords: Metro Bus, Commuters, Park and Ride, Mass Transit, Public Transport

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INTRODUCTION

Lahore is the provincial capital of the Punjab and the second largest city of Pakistan. In 1972, the city had a population of 2.17 million which now has reached to 9.75 million in 2014 with an increase of 350 per cent in four decades (Sajjad *et al*., 2015). It is considered to be an educational and historical treasure of the region (UTPS, 2008). The city population has been growing at a growth rate of about 3 % per annum. This rapid growth in population coupled with increasing vehicle ownership has resulted in insatiable travel demand (LUTMP, 2012). There are 2.17 million registered motorcycles and 0.87 million cars, jeep and wagons (PDS, 2014). These figures of private vehicle ownership depict that most of the people are not using public transportation which is creating vehicle boom in the city. In Lahore motorized transport carries social and economic costs, from simple traffic jams causing irritations and stress to its advance impacts on urban air quality as shown all modes including slow moving (Ali, 2013).

The provision of a better transport system in any city is considered an essential part of the development of the city. The Metro Bus green line System has been established from Shadhrah to Gajjumatta. It is 27 km long uninterrupted ride (Pakistan Development Perspective, 2015). It has 27 bus stations, 18 at grade stations and 9 bus stations are constructed on elevated section. The actual daily ridership for the Lahore Metro bus is 180,000 trips/day (Mir, 2014).

Park and ride facilities are important factors of all high-occupancy vehicle (HOV) programs. They serve as a collection point for individuals transferring to another vehicle containing at least one other person. Park and ride lots are generally designed to serve bus or rail transit, but also can be developed to facilitate carpooling, vanpooling, use of various types of shuttle services, and combinations of these high-occupancy vehicles (USEPA, 1992).

Park and ride attempts to combine the benefits of both Car and Public Transport use into an efficient and effective integrated transport system. Park and ride facilities have significant role in many developed countries like:

Rail based park and ride is well established and plays a major role for London travelling. Bus-based park and ride has been developed mainly over the last 20 years in a number of medium-sized cities and there has been a resurgence of interest in such policies over the last few years as reported by (Mike and Hamilton, 2007).

Park and ride lots are connecting links between private vehicles and mass transit system. At the same time, change of mode parking (park and ride) increases the demand for mass transit along established travel corridors, by increasing the service area of transit stations. Finally, change of mode parking (park and ride)

reduces the demand for parking in downtown areas, by diverting such demand to locations of lower land use density and lower land value (William and Samad, 1972).

Park and ride does result in an overall decrease in distances driven by private cars. There are factors like the transport strategy of the town or city and the catchment area of the centre which influence the extent to which park and ride affects private car users (Steff and Cooper, 1998).

Keeping in view the scope of the research, different aspects related to commuters, parking users and park and ride were covered for the analysis of existing parking trends along metro bus route.

MATERIALS AND METHODS

Three types of surveys were conducted including Parking Duration Survey, Commuter Survey and Parking User Survey. In parking duration surveys vehicles entry and exit timings along with vehicle classification were noted. Commuter and Parking User surveys were type of the intercept questionnaire surveys. Simple random sampling technique was adopted to estimate sample size for the commuter surveys keeping the confidence level of 95%, confidence interval of 5% and population size of 180,000. The calculated sample size for aforesaid population and specifications was 383 commuters. Instead of estimated sample size of 383, Four Hundred (400) commuters were included to get more precise results. Due to time and financial limitation, commuter surveys were conducted at two on-street and two off-street park and ride.

Similarly, parking user surveys were conducted from 114 park and ride users. These surveys were conducted at four different park and ride Shadhrah, Ichra, Qadafi and Model Towns. Almost all the parking users of aforesaid four park and ride were interviewed to cover maximum population.

The software used for the data entry and analysis was Microsoft Excel. The results of the study were discussed with officials of Punjab Metro Bus Authority (PMA), Lahore Transport Company (LTC) and Lahore Parking Company (LPC) to report suggestions in accordance with the outcomes of the surveys.

RESULTS AND DISCUSSIONS

Park and ride facilities had been provided near nine Metro Bus stations. Out of twenty seven (27) Metro Bus Stations, three (03) bus stations had park and Ride facilities on both sides and six (06) had park and Ride facilities on one side of the station only. In total, there were twelve (12) park and Ride facilities on both sides of the Metro Bus Route (table 1).

Some of the Park and Ride facilities were non-operational due to various reasons like construction and security. Moreover, these parking facilities were not solely used by the commuters intending to use Metro bus after parking their vehicle.

Table-1. Park and ride availability at Metro Bus Station

Gajjumatta to Shahdara							
		Up	Down			Up	Down
Sr. No.	Station Name	Park & Ride Status	Park & Ride Status	Sr. No.	Station Name	Park & Ride Status	Park & Ride Status
1	Gajjumatta	-	-	15	Canal	Non- Operational	
2	Dullu Khurd	-	-	16	Ichra	-	Yes
3	Yohanna Abad	-	-	17	Shama	-	-
4	Nishter	Yes	Yes	18	Qartaba Chowk	-	-
5	Attari	Yes	-	19	Janzgah	-	-
6	Kamhan	Non-Operational		20	MAO College	-	-
7	Chungi Amarsidhu	-	-	21	Civil Secretariat	-	-
8	Ghazi	-	-	22	Katchery	-	-
9	Qanchi	-	Yes	23	Bhatti Chowk	-	-
10	Ittefaq	Yes	-	24	Azadi Chowk	Non-Operational	
11	Naseerabad	Yes	Yes	25	Timber Market	-	-
12	Model Town	Yes	Yes	26	Niazi Chowk	-	-
13	Kalma Chowk	-	-	27	Shadhrah	-	Yes
14	Gadafi	-	Yes				

Apparently, these facilities were either underutilized or not used by the metro bus commuter. Parking utilization at Ichra park and ride (off-street) and Qaddafi (on-street) are presented in Fig-1 and Fig-2 respectively.

Fig-1. Ichra Park and Ride

Fig-2. Qaddafi Park and Ride

Parking Duration Surveys: These surveys were conducted from 6 AM to11 PM as per the operational timings of the parking facilities. The basic aim of surveys was to determine mode choice (type of vehicle used) and parking durations.

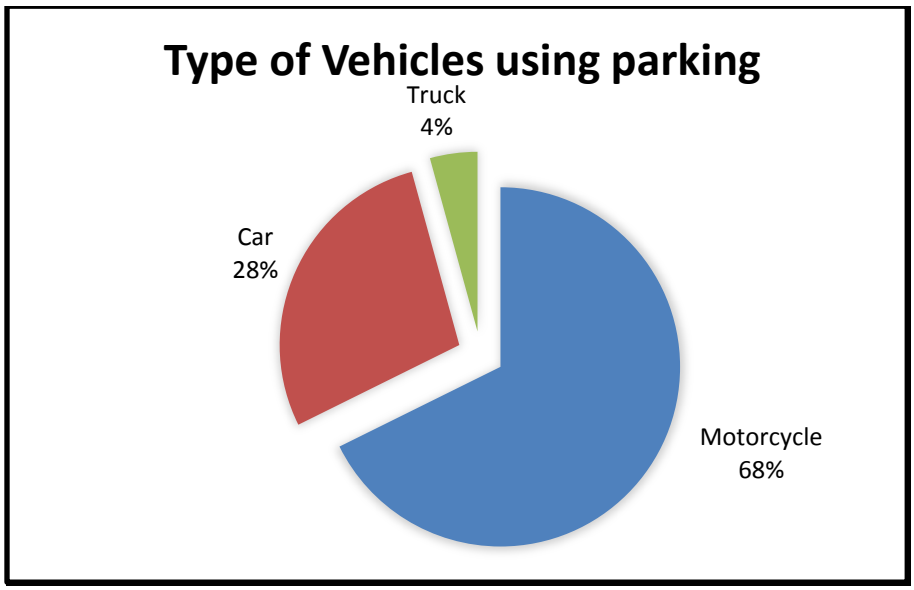

Fig-3. Mode Choice Analysis

The mode choice of most of the parking users was motorcycles (68%) followed by cars (28%) and trucks (4%). Average parking duration was almost six hours (Fig-4). It is apparent that 25% of parking users parked their vehicle for 3 to 5 hours.

Commuter Surveys: Commuter surveys were conducted to assess different attributes related to commuters like mode choice, trip purpose, opinion regarding existing parking facilities, distance from metro bus station, reasons of not using parking facilities and suggestions for improving existing parking management system.

Terminating stations of metro bus Shadhrah and Gajjumatta and Janazgah and Model Town stations were selected for commuter's survey. Mostly travelers reached Metro Bus by walking (31%). Only 12 % of the commuters used motorcycle and cars to reach metro bus stations. It showed that parking facilities were only developed for the 12 % population intending to use metro bus. Moreover, it highlighted the percentage of commuters (30%) using public transportation to reach MBS (Fig-5).

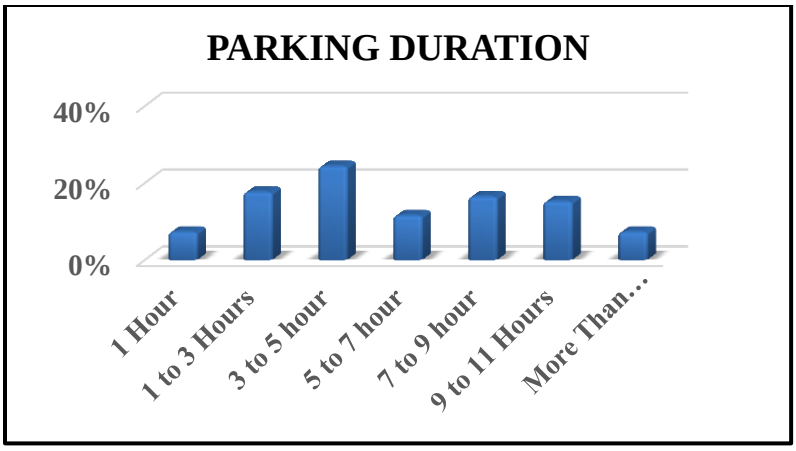

Fig-4. Parking Durations Analysis

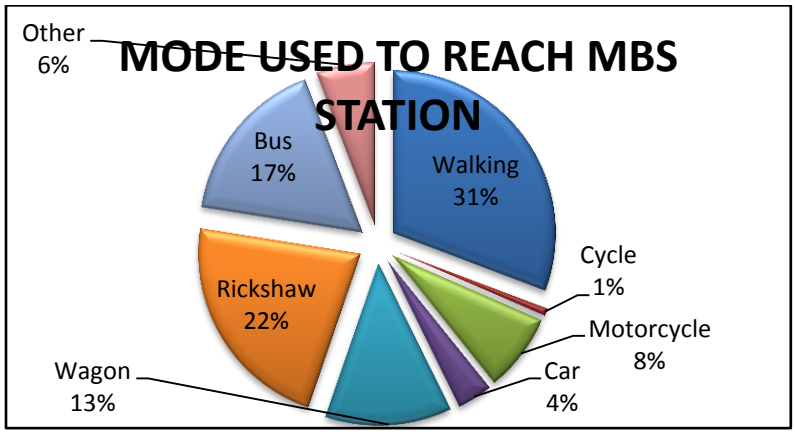

Fig-5. Commuter's Mode Choice Analysis.

Commuters were also asked to tell the reason of not using metro bus. The results of the question are shown in figure 6 via pie chart. Around 18 % commuters stated that no parking facility was available near their boarding MBS station. It was evident that 31 % of the commuters were not aware of the park and ride facilities

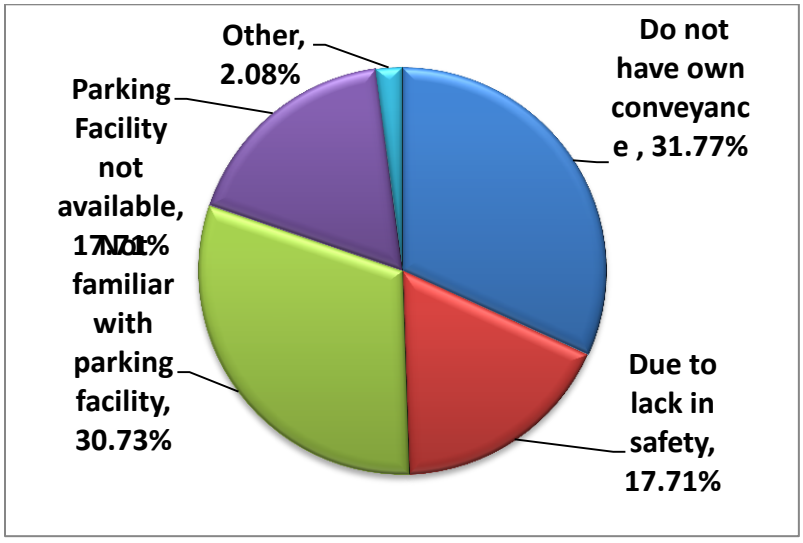

Fig-6. Reasons of not using Park and Ride

Parking User Surveys: Similarly like Commuter surveys, parking users surveys were conducted to gauge different characteristics of parking users like trip purpose, opinion regarding existing parking management system, frequency of parking usage, suggestions for improvements and views regarding distance between metro bus stations and parking facility.

According to the analysis of parking users' questionnaire survey, the mode choice of major chunk of parking users was motorcycle (67%) followed by cars (28%). Trucks were less in numbers and only parked at Ichra Park and Ride station out of surveyed stations. So, parking facilities should be designed primarily for motorcycles keeping in view the demographic conditions. Trip purpose of 37% parking users was job followed by others (Study etc), business and recreational. It was astonishing that 33% of parking users park their vehicles at park and ride stations on daily basis and 19% used to park 2-6 times in a week. Remaining 48% rarely parked their vehicles in parking facilities.

Sixty One (61%) parking users did not use metro bus after parking their vehicles. These were the people who were doing jobs in surrounding areas, shopkeepers, workers or visitors. Additionally, sixty three percent (63%) of the parking users expressed dissatisfaction on current parking management system and safety measures at parking facilities.

It was suggested by 39% parking users to increase safety of the parking facilities followed by the deployment of automatic ticketing system and fencing.

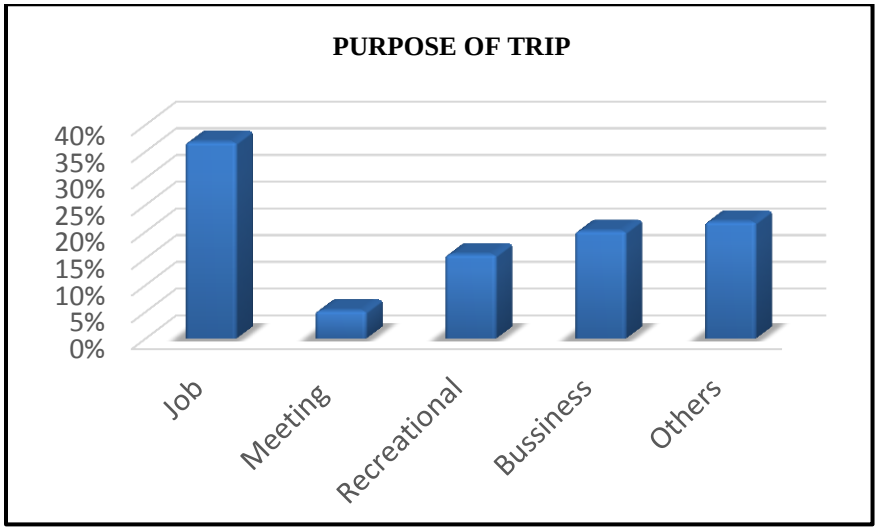

Fig-7. Parking Users Trip Purpose Analysis

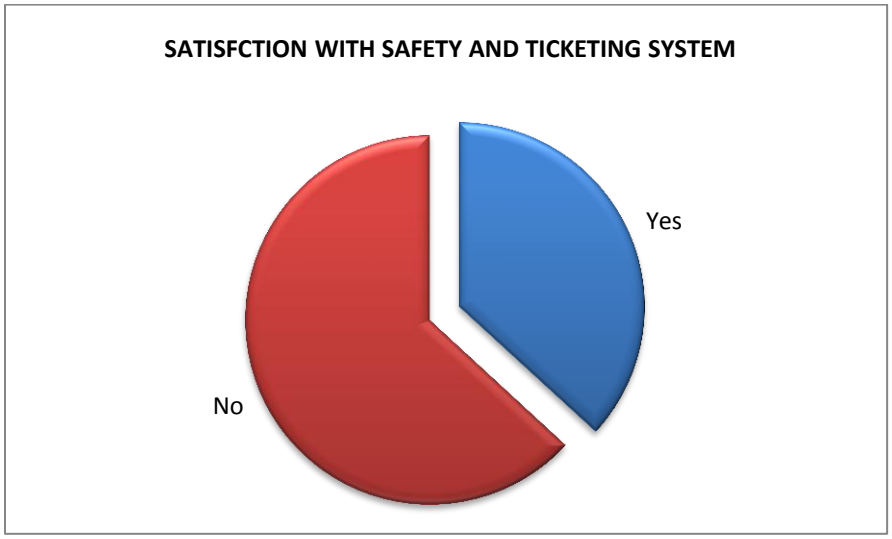

Fig-8. Opinion of parking users regarding existing Parking Facility

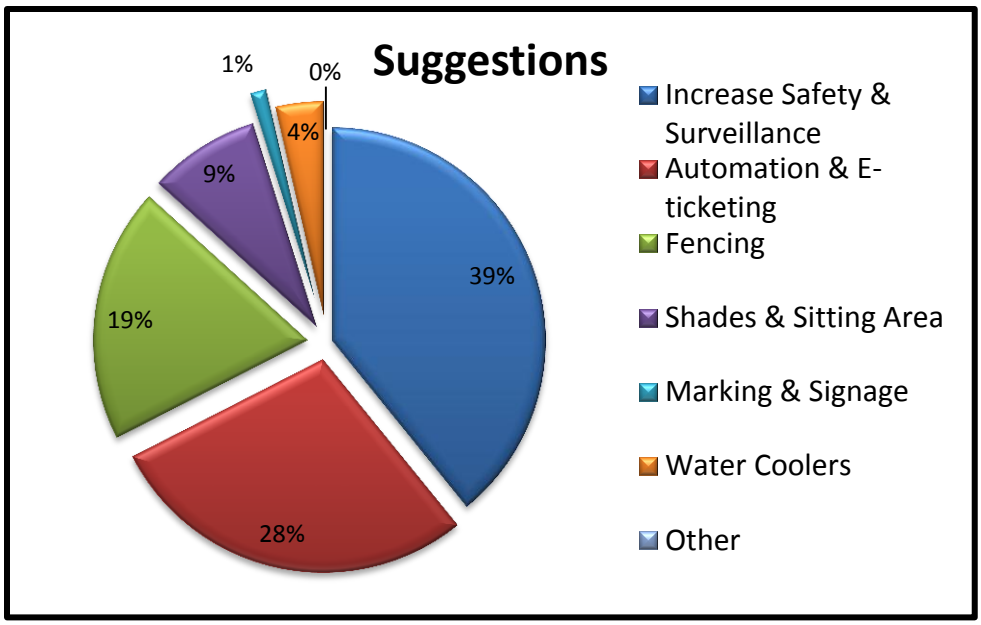

Fig-9. Suggestions for improving parking Facilities

Park and ride facilities were either not available or non-operational near eighteen (18) metro bus stations in areas of high population density in Lahore. This factor reduced public transport demand and consequently increased private vehicle trips and congestion. The findings are in line with the findings of Arup *et. al;* (2012) who reported that if bus based park and ride was not available or constrained there would be a significant switch among users to making their entire journey by car. Jon and White (2012) also reported that the basic idea behind park and ride was that private vehicles were used for the least congested part of the journey towards an urban area and then travelers transferred to public transport for the most congested final stages (destination points in urban areas) of their trip.

The average parking duration at park and ride facilities along MBS was 6 hours and only 22.56 % of the parking users parked their vehicles for more than 9 hours. The intensity of long term parking duration at park and ride facilities along metro bus was very less as compare to findings of Sharifah and Hamsa (2013) who reported that about 62% of the surface parking users parked for more than 9 hours at Putrajaya Sentral surface parking in Malaysia. This difference may be because of recent development of metro bus, low income level of people and less awareness.

It was evident from results that 69% of the commuters were aware of the park and ride facilities along MBS route. It is more than the familiarity level of 58% regarding park and ride facilities in Putrajaya, Malaysia (Shuhairy *et. al;* 2012). It was recommended to publicize park and ride facilities among general public, especially commuters, to enhance public transport demand along metro bus route. William and Samad (1972) also emphasized that most of the interaction terms that contained the transit service rating, the location rating or the parking fee rating affect the percent usage of parking facilities

There were no park and ride available near major trip originating areas like Gajjumatta, Janazga etc. All such locations should be assessed for development of park and ride facilities. The main characteristics of location of park and ride facilities were highlighted by Lorenzo *et. al;* (2014) who reported that park and ride location should be able to accommodate most of the demand. It should also be placed near the trip origins, residential area, and far from the trips destinations, employment areas. The travel times for users from home to the park and ride lot followed by transit to the destinations are not so far from their typical driving times from home to work. Park and ride location impact on driver behaviour was highlighted by Doina *et. al;* (2014) who reported that at peak times, drivers may preferred a station they could reach quicker and had sufficient provision of park and ride, even if it's not the 'closest'.

Non-availability of park and ride facilities near metro bus stations in high population density areas was adding in the urban air pollution of Lahore city. The findings are in line with the findings of Aziz and Ihsan (2008) who reported that Mass Transit System that can be put forth as solution to urban air pollution was contingent with right choice of system and its affiliation with motorized vehicles and nature of urban air pollution. The basic affiliation point of any mass transit system with motorized vehicles is through park and ride facility. Therefore, it is necessary to provide park and ride facilities at all feasible locations near metro bus stations.

Shuhairy *et. al;* (2012) recommended to transform a park and ride terminals to become a part of business area such as in KL (Kuala Lumpur) Central, can be attraction for users to use it as transit since they can also spend a time for having a meals or shopping before move to other points. In light of aforementioned recommendation, it was suggested to develop small business units at park and ride terminal to attract more commuters to enhance parking occupancy by metro bus commuters.

The existing operational system of the park and ride facilities was controlled by Lahore Parking Company (LPC). There was no integration of ticketing and surveillance system between park and rides and metro bus. All the parking facilities were underutilized and 61% of the park and ride users did not use metro bus after parking their vehicles. Moreover, around 18% of the commuters did not use park and rides due to lack in safety and 39% of the parking users suggested to enhance security and safety measures at park and ride facilities. Park and ride is a passive travel behavior which mainly caused by the poor traffic condition. Meanwhile, improving the service level of the park and ride facility and comfort for riding bus or railway will increase the utilization rate for park and ride (Huanmei *et. al;* 2012). In order to improve service level of park and ride facilities, it was suggested to integrate ticketing and surveillance system of metro bus stations. It was also recommended to provide combined subsidized monthly fare packages for metro bus and parking facilities.

Conclusions: The effectiveness level of park and ride along Lahore Bus Transit route was not adequate. Less public awareness, unplanned park and ride development, non-availability at some station, lack of safety and surveillance system and absence of integrated fare packages were significant factors of underutilization of park and ride by the commuter. Around 61% of the parking users were not using Metro Bus and 63% showed dissatisfaction on current parking management system. Integration of ticketing and surveillance system of Metro Bus stations and respective park and ride facility along with combination of subsidized fare packages will improve service level of the park and ride facilities. Park and ride awareness level among commuters must be increased by installation of parking availability sign boards at metro bus stations, distribution of pamphlets, advertisement on local media sources and development of parking information system.

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