Review on Driver`s Characteristics for Parking

[1]Nitin Kumar Shukla, [2]Tanu Chaturvedi
[1]M.E. Student, [2]Assistant Professor,
[1]Transportation Engineering Department,
[1]Samrat Ashok Technological Institute, Vidisha, India.

Abstract: As population increases which increases the number of vehicles and people heavily depends upon the transportation system for moving one place to another. The number of vehicle increases directly affects the parking area and capacity. Various problems arise related to car parking which is a major concern in the transportation infrastructure development. As there are many studies done concerning parking related problems, this study also has been conducted considering various parkers characteristics which will somehow overcome the parking problems. The general study is conducted while considering a tourist place in India. Different factors are considered for omitting the parking problems with the help of different surveys. This study will be helpful for every planner by considering these factors for getting rid out of these parking problems.

Index Terms **–Transportation Engineering, Parking Demand, Parking Problems, Parker`s Characteristics.**

I. INTRODUCTION

As we all know that India is a developing country in the world. India covers an area of 3.3 million square kilometers with about 182 million populations as it consists of 17.35% of total world`s population with second position in the world. India is also seventh largest country in the world. Since, India is a developing country it is very important as a country a well-planned and systematic approach is needed for country`s infrastructure development. For every country or city, there should be proper domestic, industrial, commercial and economic growth in development of any country. The transportation system also plays a major role in urban or rural development of the country. It is capable of holding 90 percent of traffic passengers in India. For the commercial areas, the parking problem are of large in number and difficult to tackle. The parking problems not only affects the parkers; it also affects the other people who are travelling along the parking area with or without the vehicle. As, if the vehicle is not properly parked then it will affect the driver firstly after that whoever wants to go from that way, they will also feel some discomfort able to move their vehicle or them itself. So, the transport infrastructure is of utmost importance. Such land uses draw traffic from every corner of the state. The existing parking conditions have deteriorated, as the number of private cars has increased and people in very large numbers have opted to travel by private car. Personal mobility such as motorbikes and cars are primary mode of transport by road in major cities. For example, a driver may leave parking lot due to the absence of parking details despite knowing that a space may soon become accessible. It is also common to see how a vacant space can be found during peak hours, although there are large number of spaces available throughout the day. Therefore, the collection of parking information and incentives are essential for everybody to guide the demand for parking in a more intelligent way to allow the best use of parking supply. If we forgot about the planning and designing of parking infrastructure, then there are lots of issues arises related to road infrastructure such as road congestions, traffic violations, road accidents and injuries, etc. Parking plays a vital role in developing best transport infrastructure so it is very important for every transportation engineer to know the basic and critical parking related problems. Drivers always prefer that parking space which is secure and safe for their vehicle.

II. PARKING STUDIES & LITERATURE

In this modern era, each and every family wants to own their personal vehicle but if any person who owns a vehicle needs space for parking of their vehicle. When the number of vehicle increases, demand for parking spaces also increases. (Behrendt, 1940) suggested that issues associated with parking were the product of people choosing to park just outside the door of the destination in his parking related papers. To minimize the walking distance, every car owner would like to park the car as close as possible to their destination. The increase in demand for transport for transport has shifted the issue to the challenge of finding a vacant parking spot at all. It means that this results in high demand for parking space in areas of the central business district and other areas where the activities are concerned. (Shoup, 2006) has shown that even a small amount of time to search a parking space will generate a considerable amount of traffic. The demand in the parking area/lots are closely connected to each other, as well as to parking space, the presence of alternate modes of transportation in the nearby and possibility of free on street parking. Owing to the high growth rate of vehicles, parking has become an integrated building and roadways. It therefore, creates a requirement while planning each infrastructure. Car parking is a matter of priority at both the local as well as strategic level of planning as per the (Young, Thompson, & Taylor, 1991) analysis and the study. It is thus one of the key concerns during the planning and design of any infrastructure project. When ignored, it leads to traffic congestion and violations, incidents and injuries, waste of time and energy. The main concern for designing parking modelling is to test applications and policies that would be disruptive and expensive in real life. Since transport is closely related to Human Behaviour, a relatively large part of the transport modelling process is defined by the sensitive decisions made by decision-makers. The decisions were taken on a temporary basis when policy was made to regulate the traffic in parking.

2.1 Parking Problems

According to (Feitelson & Rotem, 2004), Parking is a transport aspect that causes high impacts such as congestions, space occupancy, reduced safety and others. According to various studies such as (Arnold Jr & Gibbons, 1996; Amelie Y Davis, Pijanowski, Robinson, & Engel, 2010; Feitelson & Rotem, 2004; Ricker, 1948; Shoup, 2006), Aspects such as the use of public or private space for parking amenities, protection and the accessibility of disabled users are some of the concerns addressed for parking and are briefly discussed here. As an example (Akbari, Rose, & Taha, 2003), found that parking at Sacramento could touch 57% of commercial areas. The surface can be viewed as closed areas that cannot be used for other purposes for example- as recreation affecting urban growth (Feitelson & Rotem, 2004). (Shoup, 2006) performed comprehensive research on parking cruising and presented a clear example: in a city with 470 parking spaces and a turnover of 17 cars per day per parking space which

contributes to about 8000 cars cruising every day. Considering the average cruising time in this area is 3.3 minutes, the time spent is 440 hours per day on cruising. (Shoup, 2006) has also observed that average cruising for parking time in the United States varied from 3.3 minutes to 14 minutes and the average share of cruising for traffic was equivalent to 30% of the total traffic. Although the preceding issues have been addressed to this extent, mainly in the United States of America, they are not far from Europe. However, there is little literature, to the best of our knowledge, on parking issues in Europe and indeed few is updated. (Van Ommeren, Wentink, & Rietveld, 2012) has recently conducted a research on cruising in the Netherlands on the effects of age, sex, income, number of passengers and others. Even though the assessment of the impact of cruising on car parks may vary from city to city, it is verified by many researchers like (Arnott & Inci, 2006; Mouskos, Tvantzis, Bernstein, & Sansil, 2000) with the concept behind its significance to be simple i.e. cars that stay on the network, cruise in circles, interfere with the traffic. In conclusion, rising demand for motorized transport parking has become an important problem requiring attention. (Parmar, Das, & Azad, 2019) that the driver opts first to use the on-street parking to park the vehicle as close as possible to the destination.

2.2 Solutions to Parking Problems

Various researchers have proposed different types of solutions to parking problems, and those are discussed briefly in this section. The two basic solutions process for mitigating effects in parking are policy with a focus on parking pricing policies and information systems. This was the one to be analysed mainly in literature (Arnott & Inci, 2006; Arnott & Rowse, 1999; Amelie Y Davis et al., 2010; Amélie Y Davis, Pijanowski, Robinson, & Kidwell, 2010; Gillen, 1978) because of the immediate effect of parking policy. Parking Pricing, however has limits and raise issues of equity, rights and spillover effects. Other policies that are generally implemented concern the creation of parking areas in city centers with well-defined users for every class. Parking Guidance and Information systems (PGI) is the main form of information systems for parking. PGI systems have been built and deployed in a variety of cities providing through Variable Message Signs (VMS) and guiding drivers to parking lots with accessible parking spaces. However, many systems framework have been suggested that PGI system has problems such as switching occupancy (multiple-cars chasing-single-space) anomalies that have not yet been solved as per (Wang & He, 2011). In general, people were not aware of the system and there is a clear indication that system users are not familiar with their behaviour. The improvement in the average travel time for all drivers on the network has been estimated to be between 0.1% and 1%. The reason PGI`s don`t value a high level of acceptance is the shortcomings that cannot be easily overcome as claimed by (Geng & Cassandras, 2012). Starting with the direction of the VMS and the relative traffic, there could be a strong probability of not having a suitable parking space at the direction to which it is driven, even if suggested. In other words, the system could be considered unreliable by motorists. In addition, PGI`s that generate more undistributed congestion created by the traffic going to the indicated accessible parking spots by means of links indicated by the traffic signals. As per latest era of the parking technology is emerging under the name of Intelligent Parking Services (IPS), integrating personalized cooperative systems and utilizing parking space reservations. IPS system operate by tracking the direction and destination of the driver in order to provide customized information by, for example, locating and reserving a parking spot, providing guidance on routes and simply simplifying the parking process claimed by various researchers (Geng & Cassandras, 2012; Jonkers, Van Noort, & Van Der Veen, 2011; Teodorović & Lučić, 2006). The findings were considered to be very positive, with (Geng & Cassandras, 2012) suggesting that the transit times of the users were reduced to half under intense traffic with the addition of on-street parking for the implementation of the smart parking framework for a portion of the Boston University. (Thompson & Bonsall, 1997) raised a scenario using IPS where the average reduction in travel times in the network was 22 percent and in the inner city was 49 percent.

2.3 Studies on Parking Modelling

There are many forms of parking related models for various reasons, such as the design of parking structure, the layout of parking exits, or the depiction of interactions between users and parking. According to (Young et al., 1991), the easiest and most common way to include parking in the transport model is to include parking costs in the generalized cost of travel and use it in the well-known four-step transport model. The aim of this section is to review models for the representation of interactions between users and parking with a focus on the choice of parking and the demand for parking. According to various researchers (Feeney, 1989; Martens & Benenson, 2008; van der Waerden, Timmermans, & Borgers, 2002; Young et al., 1991), after several decades of parking research, literature provides studies and overviews that categorize and hierarchize the parking modeling process. (Martens & Benenson, 2008) suggests that parking is divided into spatially implied and spatially explicit models of parking. Generally speaking, spatially implicit models are static and focus on the choice of destination parking for travelers, while spatially explicit computing models focus on parking search processes and more differentiated choice. From the microscopic to the macroscopic, four levels can be differentiated in a way that is the level of the parking lot, the level of the parking area, the level of the sub-region and the urban level. These models communicate with a model representing the links between different levels claimed by (Young, 2008).

2.3.1 Parking Choice Behaviour Model

(Florian & Los, 1980) has developed a model based on entropy maximization methodology that can measure the effect of changes in the parking policies such as parking space allocation, addition or removal of parking lots, increase in parking fees, on parking lot choice. (Asakura & Kashiwadani, 1994) identified the impact of the availability of parking information system on the driver choosing behaviour for parking space. (Hunt & Teply, 1993) developed a Nested Logit Model by disclosing data from the preference survey near a major portion of the CBD region. They found that people`s behaviour in choosing the location of the on-street or off-street or employer arranged parking in CBD is influenced not only by the cost and distance to the final destination, but also by other factors such as the location of the trip, the nature of the parking surface and the willingness of parkers to spend more searching time or waiting for the parking spaces. Multinomial logit (MNL) based on a disaggregated choice model that can distinguish the difference in the driver`s preference of parking activity both with and without room availability details provided the driver`s previous knowledge of parking lot, such as parking cost, walking distance and capacity details, when the driver is seen to be successful variables. The study found that the drivers with the missing knowledge appear to pay less attention to walking distance and safety and more to the parking fees and other similar considerations (Ruisong, Meiping, & Xiaoguang, 2009). The authors also developed a logit model, taking into account the characteristics of the traveler and the location of the parking spaces. The multi-level parking had been suggested to develop in some study areas. (Whitlock, 1973) has developed a parking lot distribution model focused on linear programming which decides the option of a parking lot with the optimum benefit and minimal transportation costs. (Guo, Huang, Zhuang, & Sadek, 2013) compared the two models of choice- a static game-theoretical model which assumes that all drivers make decisions simultaneously with the perfect knowledge of all characteristics of parking without

taking into the account the different psychological characteristics of drivers and a dynamic neoadditive capacity model which takes into account the psychological characteristics of individual drivers under uncertainty. They concluded that the latter has high accuracy to replicate and predict the parking option actions of the driver, which in turn tends to suggest that the psychological characteristics of the driver, their positive and negative attitudes plays an important role in decision making phase of the parking. (Chen, Hu, & Chang, 2011) analyzed people`s choice behaviour for surface parking lot considering the fuzzy decision-making process of multiple attributes for optimal choice of parking space. They showed in modal validation that distance to parking space, walking distance, lane status to parking spaces and status of accessible parking spaces are characteristics that affects the driver`s choice. One of the drawbacks of the preceding models is that all drivers follow the same parking space choice approach. This developed model has been validated through the parking case study on the university campus, which may have significant differences in parking behaviour from other parking environments. In addition, (Ottomanelli, Dell'Orco, & Sassanelli, 2011) suggested the model to research the parking behaviour. They have used the Possibility Theory to reflect the driver`s insufficient knowledge of parking and transport system status with the incorporation of parking pricing structure, compliance policy for illegal parking, distance from the parking area to the final destination and congestion level as an element that influencing all the alternative options. As a result, they claimed that the model is used to manage the change in the numerical parameters in order to determine the change in the behavior of the user by selecting a parking spot. (Waraich & Axhausen, 2012) developed a model focused on the choice of parking space and used an agent based model to analyze the individual choices of behavior. They have developed a utility function for the parking facility to assign the utility or preference score to each variable that a person will consider while selecting a specific parking space from a given set of choices. The model was evaluated using the Multi-Agent Transportation Simulation Toolkit (MATSim) system with the inclusion of an evolutionary algorithm to include parking attributes that affect the decision making. (Ni & Sun, 2017) also used an agent based modelling methodology to determine the effect of the Parking Reservation System (PRS) on parking behaviour. In general, they considered two types of vehicles- smart vehicles with PRS facilities and standard vehicles that manually check for vacant space. The author has implemented the agent based simulation considering all the parking related variables as an individual agent to test the efficiency of the scenarios with the different penetration rates. The penetration rate is the percentage of smart vehicles that are able to make parking reservation decisions. The results of the study show that the average travel time increases as the penetration rate for regular vehicle improves. (Sattayhatewa & Smith Jr, 2003) developed the probability model of preference based on logit function to understand the drivers preference of parking actions for special events. They have developed a parking lot destination choice and a network assignment model to simulate the behaviour of the parkers and its impact on the traffic. They consider walking time to the destination and driving costs as an important parameter for the targeted parking lot choice. Because mixed land use construction has commercial activities within residential building areas, there is a high demand for parking space that contributes to indiscriminate parking across the commercial area of the residential building during work time. Researchers (Han, Huang, Wu, & Yang, 2018) revealed a policy on parking sharing for mixed residential and commercial land used to satisfy the demand for parking with available resources. (Han et al., 2018) proposed a model of parking location choice for mixed land use, considering a common parking policy for visitor parking spaces. They also developed the MNL model taking into account age, gender, parking time, search time, number of empty spaces available, total number of parking spaces provided and stress conditions in other parking lots and validated using the CAD program for transportation systems. In recent studies, (Antolín, Ibeas, Alonso, & dell'Olio, 2018) analyzed the parking behaviour considering the uncertainty of the driver and calculated the mixed logit model to simulate the actions of the commuter when selecting a parking alternative. They have considered the Free On-Street Parking (FOSP), Paid On-Street Parking (POSP), Paid Underground Parking (PUP) and Park & Ride facilities in the Santander City.

III. Conclusions

According to various studies there are various parker`s characteristics which are capable of overcoming the parking problems. The studies show that the parker`s characteristics plays an important role in the parking. The driver who wants to park their vehicle at their destination wants safe and secure parking space so as to secure their vehicle. The parkers characteristics are defined as those characteristics which are arising during the parking of the vehicle in the form of personal characteristics, travel characteristics, social characteristics, economical characteristics, etc. At the end, it is seen that parker`s characteristics should always be considered in mind while planning, design and assessing the parking infrastructure.

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