PARKING MANAGEMENT IN AN URBAN AREA

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ABSTRACT

The number of vehicles is increasing at an alarming rate in the urban areas. The commercialization of the area is also happening at a fast rate. The investment on roads and for parking facilities have not kept in pace with these growing traffic leading to congestion and accidents. The propensity to own private vehicles and the necessity for their use has generated huge parking demand in metropolitan cities. Almost all the metropolitan cities are experiencing increased problems related to parking. With the rapid increase of cars the need to find available parking space in the most efficient manner, to avoid traffic congestion in a parking area, is becoming a necessity in 'car park management'.

Many cities in the developing world are rapidly growing and the economic patterns of the people living in these cities in changing. With these changes there is a need for these cities to stay up to the mark in providing the mobility facilities or in other words meet the needs of mobility for the citizens. Often city officials presume that the providing of more parking spaces for the citizens means meeting the mobility needs. On the contrary, every car that is on the road needs a place to be parked. It is a key issue in almost all urban areas.

One of the problems created by road traffic is 'parking'. Not only do vehicles require street space to move about, but also they do require space to park where the occupants can be loaded and unloaded. The period over which a car is parked is very great compared with the time it is in motion. The size of average parking is 14m^2. It is roughly estimated that out of 8760 hours in a year, the car runs on an average for only 400 hours, leaving 8360 hours when it is parked. Every car owner wish to park their car as closely as possible to his destination so as to minimize walking.

Cars take up space when they are moving but for an average of 23 hours of the day they are parked, and if they were to be used for all journeys then they would need a parking space at both ends of every trip – so many spaces are required for every car. A parked car takes up around 8 square meters when parked and often the same again in maneuvering space – a huge amount in dense urban areas where land is expensive. Often, cars get more space to park than humans have to live in! The above mentioned reason justifies the need for having a parking management system.

The study has focused on identifying the parking problems in the study area and collected data from the surveys conducted and analyzed. The results of the study with recommendations are presented.

INTRODUCTION

Transportation is the key infrastructure of a country. A country's economy status depends upon how well the country is served by its roads, railways, air ports, ports, pipelines and shipping. The rate at which a country's economy grows is very closely linked to the rate at which the transport sector grows. As road transport gives personal mobility to persons, the vehicle ownership rate has been increasing at a fast rate round the world. Due to increase in car ownership, the problem of parking is becoming more and more acute day by day.

There is significant and tremendous increase in the demand of parking spaces due to increase of road traffic during the last one decade in small cities, leading to congestion of On-street spaces in official neighborhoods may give rise to inappropriate parking area in office and

shopping mall complex during the peak time of official transactions. The demand also leads to economic, social and environmental losses and with increase in population the problem becomes more critical. As such parking spaces optimization and control has become a real challenge for city transport planners and traffic authority.

Parking is one of the major problems that are created by the increasing vehicle traffic. It has an impact on transport development. The availability of less space in urban areas has increased demand for parking space especially in central business area. This affects the mode choice also. This has a great economical impact.

Need For Parking:

Vehicles parked at the kerbs in urban areas are responsible for several accidents by parking or unparking. Angle parking is more unsafe than parallel parking. Road way capacity can be increased by prohibiting or restricting kerb parking. Even a few parked vehicles along a road effectively reducing its ability to carry the traffic flow. The space for kerb parking should be used as efficiently as possible. Before imposing the parking control, study must be undertaken of the parking resources available and the present demand. Most of the road users like to park on the kerb rather than using the off street parking spaces. The traffic engineering has to weigh the balance of provision of long-term spaces to short-term spaces, the balance of on street spaces to off-street. He has to consider to the provision and need of ground -level, underground or multistory parking facilities, and satisfy the drivers, shopkeepers, commercial vehicles, public transport operators etc.,

Purposes Of Parking Study:

The purpose of a parking study is to develop a parking programmer which meets the requirements of an area. For a parking study, it is necessary to have the following information:

- The supply and type of parking facilities, both on-street and off-street.
- How and for what purposes parking facilities are used including parking duration and illegal parking.
- The demand for parking space.
- The characteristics of parking demand.
- The location of parking generators.
- Legal, financial and administrative factors associated with parking situation, and the adequacy of the existing enforcement measures.

Proper design of parking space is very important for good transporting system. If there will be lack of parking space and facility then it will be a chaotic condition for everyone. But designing of any parking space is not a easy job. It seeks a lot of parameters which we need to know, we need to find out with the help of simple data by applying some technique.

Parking is broadly classified into On-street and Off-street parking. Off-street parking is passive in operation and mostly used for work trips or for long duration trips with more than 2 to 6 hours and even for more than 12 hours duration. They are parked mostly in garages or multi storied parking lots. On an average, Off-street parking requires 300 sq. ft area per car.

a) **Surface car parking**:

Surface car parks properly located and developed on a piece of vacant line or surrounding an office complex or super market is very popular with motorist. Great care is needed in their design and operation. The overall aesthetics of the area should receive due attention. A stall size of 2.5m x 5m is probably adequate for Indian conditions, predominated by small size cars, where as four American conditions 2.6m x 5.5m is recommended. A variety of layouts is possible depending upon the area. If the surface park is to be operated with a full charging system, there should be arrangement for collecting the money. This can be done either annually by stationing an attendant at the entrance who sells the parking tickets.

Illustration of Surface Car parking

b) **Multi-storied car parking**:

Multi-storied parking garages are restored to when the floor space available for the parking garage is less and is very costly. It is possible to construct multistoried garages to park a large number of cars at a time. It is necessary to provide the inter floor travel facility for the vehicles, such as elevators, ramps, etc.

Multistoried car parks are designed for a capacity of about 400 to 500 cars. It involves larger capacity lands to increase the time for unparking a car. Some of the desirable standards for designing of the multistoried car parks are:

i) Gradient of the ramp: 1 in 10 generally and 1 in 8 for very short ramps
ii) Parking stall dimensions: 2.5m x 5m
iii) Clear height between floors: 2.1m
iv) Inside radius of curves: 7m
v) Width of traffic lane on ramps and entrances: 3.75m
vi) Gradient of slopping floors: not steeper than 1 in 20
vii) Loading standards: 400 kg/m^2

The arrangement of floors and the access ramps needs careful design. Ramps are preferably made on way. In case of planning a 'two way' system, they should be suitably level floors and direct floor to floor ramps. Another arrangement is with parking floors themselves continuously sloping to gain access from the level to other horizontal floors with separate helical entrance and exit ramps have been found to be efficient. The car parking floors, the ramps, the entrance and the exit should be well illuminated.

Illustration of Multi-storied car Parking

c) **Roof Parking**:

A very popular method of solving the parking problems adopted in many cities is to park the vehicles on roof tops. Access ramps or mechanical lifts provide the necessary access to roofs. It is the parking which is provided on the roof of building, and this type of parking is provided by joining or connecting the roofs of several buildings of same height and providing separate entry and exit to give safe, easy and efficient access to roof.

Illustration of Roof parking

d) **Mechanical parking :** Mechanical Parking encompasses a wide range of options all designed to increase parking density and cut costs over traditional parking methods. The solutions start at simple stackers, where the bottom car must be moved to get to the top car (dependent access) and go up to fully automatic machines where cars can be stored and retrieved from a single point of access. There are 5 mechanical parking typologies: dependent access stackers, independent access stackers, puzzle lifts, pallets and fully automatic parking machines.

Illustration of Mechanical Parking

e) **Underground parking facility**:

In this type of parking the space is constructed to parking under the ground, this is quite expensive construction. Actually in study area there is underground parking facility in some sub-area as in parking subarea-5, but not in use. So, to overcome the problem of shortage of parking space as per demand this kind of space should be properly maintained and optimized to its use. All the i.e. parking garages, roof parking and underground parking facilities must be provided with APMS system. So that the user can easily get information regarding status of parking area.

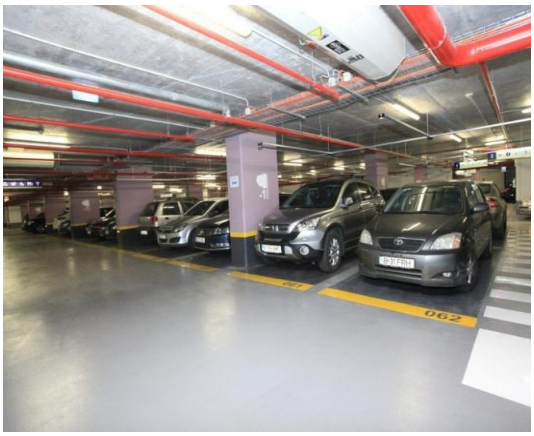

Fig.1.11. Illustration of Under-ground car Parking

Automated Parking System (APS):

An **Automated Parking System or APS** is a mechanical system that moves cars from the entry to an available parking space. It uses multiple levels and stacks cars vertically to use as less land as possible to park as many cars as possible. It's entirely automatic and doesn't require any staff. Automated Parking Systems are sometimes also called:

- Mechanical Parking System
- Robotic Parking System
- Rotary Parking System
- Automatic Parking
- Stacker Parking
- Etc.

Automatic parking systems are very **space efficient**. You can simply stack all the cars plus the parking space doesn't have to be as wide as in a conventional parking lot. You can stack more cars in a compact space, because cars are moved by platforms and lifts. The system doesn't need as much space to park as a human does. There's no need for ramps, pedestrian areas etc.

Semi-Automated Parking System:

A **Semi-Automated Parking System** uses a mechanical system to move cars to their parking space, only it needs a human action to work, either by the driver or an attendant. This action can be as simple as pushing a button.

AN ANALYSIS OF PARKING - LITERATURE SURVEY

AN ANALYSIS OF THE SPATIAL DISTRIBUTION OF PARKING SUPPLY POLICY AND DEMAND:

Young, Beaton, Satgunarajah (department of civil engineering, Monash university, Victoria, Australia, 2010) studied the spatial distribution of parking of Melbourne City. Parking facility is one of the important transport facility in urban area specially the central districts having high retail activity & employment opportunities. Parking policies & pricing impacts the entire city transportation & land use. Transport planner & Land use planner look for parking places differently. Spatial integration of parking, land use & transport facility is ignored. Parking influences the spatial distribution of transport use & viability of development. Parking should be considered as at metropolitan level than to consider for a particular region.

BEHAVIORAL CHARACTERISTICS OF CAR PARKING DEMAND(A CASE STUDY OF KOLKATA):

Generalized parking rates are assumed for estimating the parking demand & other parameters are ignored. Chakrabarty & Mazumdar (Institute of town planner, India journal 7-4, of December 2010) in this paper took into consideration various behavioral characteristics of parking demand for various trips, location & with various urban areas. Various factors influencing the parking demand & also their influence on each other was tried to find out.

ANALYSIS ON PARKING DEMAND OF THE COMMERCIAL BUILDINGS CONSIDERING THE PUBLIC TRANSPORT ACCESSIBILITY:

Qin, Xiao, Gan, Pan (nature and science. 2010; 8(3): 63-68), [ISSN: 1545-0740] analyzed the parking demand of shopping centre & markets from the data obtained by conducting parking demand survey at various locations of Beijing. Relationship between parking demand & transport accessibility was analyzed. Parking demand decreases with good & efficient transport facility. Parking demand rate with different public transport accessibility was determined & a parking demand model with different accessibility was provided.

ATTITUDES AND BEHAVIORAL RESPONSES TO PARKING MEASURES:

Warden, Borgers, TImmermans (Urban planning group, Eindhoven University of technology, March 2006) studied attitude & behavioral responses of car drivers to planned parking measures at campus of the Eindhoven University of Technology, the Netherlands. In an on-street questionnaire, car drivers were asked their opinion about restricting access to the campus area for cars of non university car drivers through (i) a barrier, (ii) proper identification when entering the campus area, and (iii) payment. The response of more than 700 car drivers was used in multinomial logit analysis. Most drivers wanted to continue into the University campus by car. Half of the car driver responded they would change their mode of transport or park car outside the campus if they have to pay parking fee.

CHARACTERIZING PARKING SPACES USING SURVEY DATA:

Parking spaces are strategic commodities of modern day transport facility. Few dataset allows precisely measuring the use of spaces in terms of population, segments, activity types & duration. Morency & Trepainer (Interuniversity Research centre on enterprise networks, logistics and transportation (CIRRELT) 2008) proposed empirical measures & methods regarding the use of parking space in a strategic urban area. Large survey was conducted representing 5% of the population of Montreal. Car driver heading towards the area enquired regarding the type of parking space. Parking spaces were classified according to their jurisdiction (private/public), location (indoor/on the street/outdoor) and rates (free/fee charging/subsidized by the employer). Using these data, statistics describing the use of these spaces are developed. On the one hand, people benefiting from the various types of parking spaces are described in terms of residence location, demographic attributes and type of activity. On the other hand, parking accumulation profiles are developed and summarized by key indicators.

PARKING SITE SELECTION MANAGEMENT USING FUZZY LOGIC AND MULTI CRITERIA DECISION MAKING:

Population growth, sprawling of cities and increasing of vehicles result in heavy traffic and prolonged city trips. Utilizing public parking's regarded as an effective approach to abate traffic load in city centers, in that spaces designated for vehicles parking along the roads would be freed, and consequently the usable space of the roads would increase, which in turn would contribute to the smooth flow of traffic. Farzanmanesh, Ghaziasgari and Abdullah(Department of

environmental sciences, university Putra Malaysia2008) described an ideal method for parking site selection by the use of GIS, fuzzy logic and weighting criteria to determine proper parking sites. Suitable place for parking is selected for one of the high traffic regions of Esfahan city in Iran.

IMPACT OF ON-STREET PARKING ON ROAD PARQAMETERS AND TRAFFIC FLOWS:

Ramachandra reddy(2008) in his PhD thesis explained the various effects of On-street parking on traffic flows, capacities and speeds and suggested methods of developing On- street parking.

STUDY AREA DESCRIPTION AND DATA COLLECTION

Study Area Description:

National Highway 9 (NH 9) is a major National Highway in central India, stretching 841 km (523 mi) from Pune in Maharashtra through the states of Karnataka and Telangana to Machilipatnam in Andhra Pradesh.

The study area in the present study is a corridor from NH-65 (old NH-9) located at Kothapet 'T' junction to T.V. tower area in Hyderabad city. The stretch is of 2.7 kms long. It is both commercial as well as residential area. It is a 6 lane National Highway. It has two T-junctions and one 'Y' junction namely at Kothapet, Moosarambagh and Gaddi Annaram. It has been observed that all the intersections mentioned above are overloaded with heavy traffic flow moving along the corridor. All intersections are provided with traffic signals which are operated manually.

The following table gives the details of the study corridor:

Details of the Study Corridor

S.No.	Name of the junction	Length (m)
1.	Kothapet to Chaitanyapuri	800 m
2.	Chaitanyapuri to Dilsukhnagar	800 m
3.	Dilsukhnagar to Moosarambagh	1100 m

The Padmavamshi Handloom and Textiles Market is located in the Kothapet area near the HUDA Complex and there is also a 'Fruit market' which comes into our corridor area. Because of the presence of goddess temple in the middle of the National Highway, the ongoing vehicular traffic speeds are getting reduced.

Due to L&T Metro Rail construction work in progress, the road is reduced into 4 lane road at some points. The service road at the Fruit Market is very busy with the trucks loaded with Fruits at early morning hours, but some fruit vendors have occupied unauthorized about half of the service roads causing obstruction to the ongoing local traffic and leaving no space for customers vehicles for parking purpose.

Dilsukhnagar is one of the largest commercial and residential centers in Hyderabad. It was once part of the Municipal Corporation of Hyderabad, but later merged with the Greater Hyderabad Municipal Corporation. It is occupied by many shopping complexes like R.S. Brothers, Chandana Brothers etc., Study

circles, and many theatres like Rajadhani, Venkatadri etc., Offices and Banks.

Sai Baba Temple which is located in Diluskhnagar is very famous and it is ever busy with the ongoing devotees coming to the temple.

The Bus Stand present in the Dilsukhnagar area is the biggest Bus stop with presence of various kinds of buses like District buses, Sub urban buses and also the Urban buses.

Malakpet is one of the old areas of Hyderabad, India. Named after Malik Yakoob, a servant of Abdulah Qutub Shah Golconda King where he resided had a market, hence the name Malakpet. This suburb is further divided into two parts, Old Malakpet and New Malakpet. In this area the traffic is minimal compared to that of Dilsukhnagar area, and there are no much parked vehicles on the road side.

Presence of Bus-bays and Bus stops in study area:

Presence of Auto stands:

There are no authorized auto stands present in our corridor area. Due to the loading and un-loading of passengers on the road side itself it is causing obstruction to the on-going traffic flow.

Number of auto stands:

1. Steering auto stand at Kothapet
2. Dilsukhnagar

Types of Parking Survey: The following are the types of parking surveys usually conducted:

1. Parking space inventory.
2. Parking usage survey by petrol.
   - In-out survey method
   - License plate method of survey
   - Fixed period sampling method
3. Questionnaire type parking usage survey.
4. Cordon count.

1. Parking Space Inventory: The first step in a parking survey is to collect data and amount, type and location of space actually or potentially available for parking in an area. The area to be surveyed should first delineate. The Central Business District [CBD] is usually the area where the parking survey is needed. The area surrounding the CBD where the parking spills over should be included in the survey. The survey area is then subdivided on a street by street basis and the sub-divisions marked on the map. Sketch plans of the streets are then prepared in advance. The data on parking facilities should be recorded on the sketch using suitable symbols.

The items to be recorded include the following:

Frequency of patrol: A frequency of half an hour is considered to be satisfactory for On Street Parking while a frequency of 1 hour could be used Off Street Parking.

Method of Observation: Usually patrols are by foot, but where vehicles are not parked, too close to one another a moving car may be also used. As an aid a tape recorded may also be used to record the registration numbers of vehicles.

Timing of the survey: The survey should be done on a typical weekday free from factors likely to result in non representative characteristics.

Equipment and form of recording: Each observer will be equipped with a watch, pencil, supply of forms, a map of the street and a form.

SURVEYS CONDUCTED

In accordance with the standard surveys explained above, Surveys are conducted in the study area from Kothapet to T. V. tower.The following are the details.

Location: Kothapet To T. V. Tower
Type of parking: On-street Parking
Survey technique adopted: In and Out Survey
Length : 2.7 kilometer
Date: 8th April 2015, Wednesday
Time: 8 A.M- 12 P.M
Number of time slots: 4 (1 hour duration)
Number of observers: 4
Type of vehicles surveyed: 3(Four wheeler, 3Wheeler, 2Wheeler).
Type of survey conducted: In-out survey was conducted for a parking area at 4 places. The number of vehicles coming in and out of the parking lot for a time interval of 1 hour is as shown in the table and the accumulation and parking loads are presented in Table for 2 wheelers.

In-Out Parking Survey Data At Saibaba Temple (2 wheelers)

Time	In	Out	Net Parked Vehicles
8:00 A. M. 5	3	2	1
10	2	4	1
15	4	2	7
20	5	4	10
25	7	3	19
30	8	2	27
35	2	7	24
40	4	2	33
45	6	4	37
50	4	1	44
9:00 A. M. 60	2	5	45

Accumulation and Parking loads At Saibaba Temple (2 wheelers)

Time	**In**	**Out**	**Accumulation**	**Occupancy**	**Parking load**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
8:00 A. M. 5	3	2	26	65	130
10	2	4	24	60	120
15	4	2	26	65	130
20	5	4	27	67.5	135
25	7	3	31	77.5	155
30	8	2	37	92.5	185
35	2	7	32	80	160
40	4	2	34	85	170
45	6	4	36	90	180
50	4	1	39	97.5	195

55	3	3	39	97.5	195
9:00 A. M 60	2	5	36	90	180
Total					1935

- Accumulation can be found out as initial count plus number of vehicles that entered the parking lot till that time minus the number of vehicles that just exited for that particular time interval. For the first time interval of 5 minutes, accumulation can be found out as 25+3-2 = 26. It is being tabulated in column 4.
- Occupancy or parking index is given by equation for the first time interval of five minutes, $Parking\ index = \frac{26}{40} \times 100$ = 65%. The occupancy for the remaining time slot is similarly calculated and is tabulated in column 5. Average occupancy is the average of the occupancy values for each time interval. Thus it is the average of all values given in column 5 and the value is 80.63%.
- Parking load is tabulated in column 6. It is obtained by multiplying accumulation with the time interval. For the first time interval, parking load = 26 x 5 = 130 vehicle minutes.
- Total parking load is the summation of all the values in column 5 which is equal to 1935 vehicle minutes or 32.25 vehicle hours.

The data on In and Out survey at Saibaba Temple for 3 wheelers is presented in table below and

In-Out Parking Survey Data At Saibaba Temple (3 wheelers)

Time	In	Out	Net Parked Vehicles
8:00 A. M. 5	1	0	1
10	1	1	1
15	3	0	5
20	1	2	4
25	1	0	7
30	0	1	6
35	2	3	6
40	1	2	8
45	0	1	9
50	2	1	11
55	3	0	15
9:00 A. M. 60	0	1	14

Accumulation and Parking loads At Saibaba Temple (3 wheelers)

Time	In	Out	Accumulation	Occupancy	Parking load
(1)	(2)	(3)	(4)	(5)	(6)
8:00 A. M. 5	1	0	26	65	130
10	1	1	25	62	125
15	3	0	28	70	140
20	1	2	24	60	120
25	1	0	26	65	130
30	0	1	24	60	120
35	2	1	26	65	130
40	1	2	24	60	120
45	2	1	26	65	130
50	2	1	26	65	130
55	3	0	28	70	140
9:00 A. M 60	0	1	24	60	120
Total					1535

The data on In and Out survey at Saibaba Temple for 4 wheelers is presented in above table

ANALYSIS AND RESULT

Analysis of Parking Data:

Before taking any measures for the betterment of conditions, data regarding availability of parking space, extent of its usage and parking demand is essential. It is also required to estimate the parking fares also. Parking surveys are intended to provide all these information. Since the duration of parking varies with different vehicles, several statistics are used to access the parking need. The following parking statistics are normally important.

1. **Parking accumulation**: It is defined as the number of vehicles parked at a given instant of time. Normally this is expressed by accumulation curve. Accumulation curve is the graph obtained by plotting the number of bays occupied with respect to time.

2. **Parking volume**: Parking volume is the total number of vehicles parked at a given duration of time. This does not account for repetition of vehicles. The actual volume of vehicles entered in the area is recorded.

3. **Parking load** : Parking load gives the area under the accumulation curve. It can also be obtained by simply multiplying the number of vehicles occupying the parking area at each time interval with the time interval. It is expressed as vehicle hours.

4. **Average parking duration**: It is the ratio of total vehicle hours to the number of vehicles parked. parking duration = parking load parking volume

5. **Parking turnover**: It is the ratio of number of vehicles parked in a duration to the number of parking bays available. This can be expressed as number of vehicles per

bay per time duration. parking turnover = parking volume no. of bays available

6. **Parking index**: Parking index is also called occupancy or efficiency. It is defined as the ratio of number of bays occupied in a time duration to the total space available. It gives an aggregate measure of how effectively the parking space is utilized. Parking index can be found out as follows

Parking index = Parking load parking capacity × 100

7. **Parking duration:** The average time spent in a parking space

Number of vehicles that can park in a given area

$$= \frac{(Number\ of\ spaces)(Period\ coverd\ in\ hours)}{Average\ parking\ duration\ (hours\ per\ vehicle)}\ x\ 0.85\ to\ 0.95$$

Parking Data Analysis:

Due to the ever increasing vehicle population, there has been a concomitant increase in demand for vehicular parking. The supply of parking spaces has not kept pace with this increase in parking demand. The lack of proper and adequate parking spaces, vehicles are parked on the road side haphazardly and thereby reducing effective width of carriageway, decreasing capacity of the road and increasing road congestion. Keeping this in mind and to know the present parking situation in HMA, HMDA mandated to conduct systematic studies at selected sites to assess the parking demand.

Parking lot:

A parking lot is an **area that is assigned for parking**. Normally, the parking spaces are marked on the ground with white or yellow lines that form squares that each fit one car. Parking lots are common near shops, bars, restaurants and other facilities that require parking. There are parking lots that are open throughout the year, but there are also improvised parking lots that are specially assigned for an event. For example, when there is a music festival that only happens once a year people can decide to open a nearby meadow to provide parking spaces for the visitors of that particular music festival.

Traffic studies and Parameters involved:

To conduct any traffic study some parameters are common and based on specific need or condition, a few additional parameters are also being considered. A few of such observations are listed below:

The list of common parameters used for different study purposes:

- Speed and average speed
- Traffic volume
- Road width
- Road capacity
- Land use
- Width and length of existing On-street parking.

Other parameters used for specific purpose of study:

- Parallel or Angular parking
- Off street parking performance, demand and percentage of utility
- Road surface and road edge characteristics
- Gradient of the road
- Road curves
- Existence of bus stops on the roads
- Pedestrian interference
- Shoulder width and conditions
- Access roads
- Through traffic etc;

Proposed Approach:

To study and measure the magnitude of impact of On-street parking on speed variation of the traffic flow, it is proposed to make use of following parameters to examine the interrelationship among them, which may lead to measure the speed variation in traffic flow due to On-street parking.

- Traffic volume
- Road width
- Land use particulars
- Parking width
- Parking length
- Speed of the vehicles before On-street parking and after On-street parking.

Road width - Variation Effect:

Road width is considered to be the distance between curb to curb. The ratio of parking width(P_w) and road width(r_w) affects traffic flow speeds, due to the provision of On-street parking facility on any road. As the rate of p_w /r_w increases the speed of the traffic is likely reduced.

Reduction of road width due to parking:

On-street parking occupies some portion of road width along the curb i.e, a portion of road width equivalent to On-street parking width is reduced.

Parking Width:

The width of the space marked for car parking is known as parking width. Generally minimum of 6 feet or maximum of 8 feet is allocated as suggested in transportation and traffic engineering hand book.

Sufficiency Of Parking Facility:

The Parking sufficiency reports for some of the cities are given below:

CBD Parking Spaces in Relation to CBD Areas and Metropolitan Area Population

City	Metropolitan Area Population	CBD Areas		CBD Parking spaces Provided			Parking Space Ratios		
		Acres	Hectares	On-street	Off-street	Total	Spaces for 1000 pop.	Spaces for Acre	Spaces for Hectare
Adelaide (Aust.)	746,000	455	184	6,003	8,074	14,077	18.9	30.9	76.5
Perth (Aust.)	470,000	1,485	600	8,103	19,400	27,503	58.5	18.5	45.8
Essen (Ger.)	727,000	89	36	2,122	4,941	7,063	9.7	79.4	196.4
Frankfurt (Ger.)	693,000	631	255	11,783	28,500	40,283	58.1	63.8	157.9
Hamburg	1,860,000	594	240	4,272	10,116	14,388	7.7	24.2	60.0

(Ger.)									
Rome(It.)	2,489,000	4,950	2,000	25,252	9,582	34,834	14.0	7.0	17.4
Madrid (Sp.)	2,700,000	547	221	8,250	12,500	20,750	7.7	38.0	94.0

(Source: Compiled from " Schemes for the provision of parking spaces in town centers, " Theme 6, Eighth International Study week in Traffic Engineering OTA, London, England 1996. (ITE Handbook).)

Percentage of Parkers Classified By Facility and Trip Purpose

Pop. Group of Urbanized area	Kerb					Off-street					Garage				
	Shopping	Personal Business	Work	Other	Total kerb	Shopping	Personal Business	Work	Other	Total lot	Shopping	Personal Business	Work	Other	Total garage
10,000-25,000	30	22	11	16	79	8	1	10	2	21	0	0	0	0	0
25,000-50,000	22	30	8	14	74	5	5	13	3	26	0	0	0	0	0
50,000-1,00,000	19	24	7	18	68	5	7	12	7	31	0	0	1	0	1
1,00,000-2,50,000	11	24	6	11	52	9	9	17	7	42	1	1	3	1	6
2,50,000-5,00,000	10	23	8	13	54	6	7	18	3	34	3	3	4	2	12
5,00,000-10,00,000	3	12	9	9	33	5	8	23	3	39	5	5	15	3	28

Over 10,00 ,000	**3**	**15**	**4**	**8**	**30**	**4**	**13**	**29**	**8**	**54**	**3**	**2**	**8**	**3**	**16**

(Source: Parking Principles).

Analyses from survey data in the study area are selected:

1) From Surveys:

Four locations from the project site corridor are selected. They are :

i. **PVT Market**: There is a cellar parking for PVT market, but only for office persons. As the is no access for outside vehicle commuters, the vehicles are parked along the road side. In the same lane there is no service road up to shalini theatre.

Parked Vehicles At PVT Market

ii. Fruit Market: Due to the fruit vendors the service road is being occupied and as there is fruit market there will be more vehicular traffic in this service road but the service road is occupied more than half by the fruit carts, autos and trolleys. and also due to L & T construction half of the service road is occupied by the work progress.

Fruit Vendors At Fruit Market

iii. Saibaba Temple: As Dilsukhnagar is the most commercial area, it has more offices, commercial buildings and shopping complexes there is a huge traffic flow in this area. As a result service roads are also being occupied by the parked vehicles. It is also observed that many commercial complexes are not having adequate parking lots in their buildings. Due to the lack of parking spaces the service roads are being occupied.

Parked vehicles In front of Saibaba Temple

iv. **Dilsukhnagar Bus Stand**: As there is no separate parking lots for autos they are leaving the passengers on the side of the road, due to this the on-going traffic is affected. And also due to less parking space for buses they are parked on the side of the road. The auto stands which are present in the dilsukhnagar bus stand are also un-authorized.

In-spite of towing zone present at bus stand the vehicles are parked at the towing zone.

Parked Vehicles At Dilsukhnagar Bus stand

From the Arrival and Departure data, Parking accumulation and accumulation factors are worked out and presented in Table for 2 wheelers, 3 wheelers and 4 wheelers at Saibaba temple.

CONCLUSIONS AND RECOMMENDATIONS

Summary:

settlements particularly in larger ones, has strained urban services and severely affected all types of urban environment viz. physical, social, economic and aesthetic, in these pressure on urban infrastructure facilities and services, thereby affecting the quality of life in our urban settlements to a great extent. In order to achieve healthy living conditions in our urban areas, it is necessary to resort to innovative and efficient systems of urban transportation planning, challenges and policy initiatives, which have to play an important role not only in fighting the urban growth, but to accept it as an inevitable outcome of economic change and to prevent or minimize many negative effects of urban

The heavy concentration of population and consequently increasing activities in urban settlements. It is experienced in the world over that, this sort of rapid urbanization has resulted in tremendous growth, such as traffic problems, slums and environmental degradation etc.

Conclusions:

Parking takes considerable street space leading to the lowering of the road capacity. Hence, speed will be reduced, Journey time and delay will also subsequently increase. The operational cost of the vehicle increases leading great economical loss to the community. According to the parking study on existing traffic condition on the road network it is must and required to remove

onstreet parking system for efficient transportation system. Careless maneuvering of parking and un-parking leads to accidents which are referred to as accidents. Common type of parking accidents occur while driving out a car from the parked area, careless opening of doors of parked cars, and while bringing in the vehicle to the parking lot for parking. They also cause pollution to the environment because stopping and starting of vehicle while parking and un-parking results are noise and fumes To reduce the parking of vehicles we can implement the following:

- The Two wheelers were found to ccupy more spaces in all the locations of the study area.
- Commercial centers need more parking space than that for offices with the same working space and with no sufficient parking area provided; the vehicles are parked on kerb side, creating traffic congestion.
- For short term measures pay and park method may be done at peak hours to control and regulate the parking.

Parking enforcement officers:

People who work in **parking enforcement** are commonly known as parking attendants, parking enforcement officers, etc. At places with parking meters they're also known as meter attendants, parking inspectors or traffic wardens.

Parking enforcement officers make sure that **people follow the parking rules and regulations**. As a member of the traffic department, they are appointed to issue tickets for parking violations.

A parking ticket placed on the windshield of a car

Normally when a parking enforcement officer notices a parking violation, he prints a**ticket** and places a copy of the ticket on the windshield of the car for the owner to find. This way the car owner knows he can expect a fine. After writing the ticket, the parking enforcement officer files the ticket to the local authority and a few weeks later the driver receives the official fine by mail.

The above recommendations will help in providing adequate parking at the3 locations, relieve traffic congestion on the main road and providing relief to the vehicle users.

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