

**Paradigm Shift Through Kinetic Parking Spaces
in Commercial / Essential Services Buildings
– An User Friendly Analysis**

By

SOFIA JANNET. J – (15PIR013)

A thesis submitted to

**Avinashilingam Institute of Home Science and Higher
Education for Women, Coimbatore – 641043**

Department of Resource Management

In partial fulfillment of the requirements for the award of the Degree of

**Master of Science in Interior Design & Resource
Management**

April – 2017

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**Signature of the Head of the
Department**

Signature of the Supervisor

CERTIFICATE

This is to certify that the dissertation titled **“PARADIGM SHIFT THROUGH KINETIC PARKING SPACES IN COMMERCIAL / ESSENTIAL SERVICES BUILDINGS – AN USER FRIENDLY ANALYSIS”** submitted to Avinashilingam Institute for Home Science and Higher Education for Women , Coimbatore – 641 043, in partial fulfillment of the requirements for the award of the degree of Master of Interior Design and Resource Management is a record of original research work done by Sofia Jannet.J – 15PIR013 during the period of the study in the Department of Resource management, Avinashilingam Institute for Home Science and Higher Education for Women , Coimbatore – 641 043, under my supervision and guidance, as not formed the basis for the award of any degree / Diploma Associateship / fellowship are similar title to any candidate of any other university.

Signature of the Guide

Signature of the Head of the Department

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INTRODUCTION

Customers are “users” of an agency’s facilities or services”

Stein and Sloane (2003)

Parking is the act of stopping and disengaging a vehicle and leaving it unoccupied. Parking on one or both sides of a road is often permitted, though sometimes with restrictions. Parking is considered as one of the essential elements while planning for any commercial space. In most of the cases the basement includes the car park area. Parking facilities can be in both – indoor and outdoor, public or private. Some buildings have parking facilities for use of the building users.

(<https://en.m.wikipedia.org/wiki/parking>).

Mandloi (2016) has defined **Parking space** as an enclosed or unenclosed, covered or open area sufficient in size to park vehicles. Parking spaces shall be served by a driveway connecting them with a street and permitting ingress and egress of vehicles.

Even as the development community embraces smart growth, complete streets and sustainable transportation principles, parking remains a necessary and important feature of those systems. Parking is the first and last impression of a destination for many users. Parking is said to be smarter when it offers enough safe, convenient parking, mixed uses with shared parking, consideration of pedestrian and bicycles, efficient design and minimum use of non-renewable resources (Pande and Wolshon, 2016)

Box 1

Leisure and consumption activity of people has opened up spaces for new forms of collective expression and creativity says, Bennett (2005).

According to Okulicz- Kozaryn (2015), cities attract people, because people strive for power and status. Big cities have long been centres of power-economic, political and any kind of power. People flock to cities arguably mostly in search of job opportunities and excitement plus all the

amenities. People are forced to be close to cities (jobs and amenities). Many smart people are more likely to move to cities especially to get education, jobs and in search of lifestyle.

Increase in the number of MNC's in the cities helps the people to improve their standard of living. They provide innovative and technological products in the market which enhances the quality of people and affects their shopping behaviour by providing job opportunities and high pay packages states, Bhatia and Ranjan(2016).

People who move home from one place to another tend also to be upwardly socially mobile. Indeed it is usually their ambition and drive that



Figure 1. Mobility of People

generated within them a desire to move – to discover new opportunities for work and for their life. Act of moving encourages people to become more adaptive and flexible. People want to live where opportunities abound. In a

highly competitive and global world, life's opportunities are clustered in successful urban areas states, Quirk(2011). Mobility has been a major reason adding fuel to such migration, which in its tide brings in changed life styles, ownership of automobiles and shopping behaviour.

Automobiles are synonymous with mobility and freedom. A car is driven, on an average, two to three hours per day, spending the remainder of its time parked. Car parking has become an important requirement for high rises. Buildings with inadequate parking find few **users**, contributing to the property's eroding value over the years. In cities, where **space is at a premium** and **car ownership is growing, automated car-parking systems** may be the best solution to meet parking needs. In conventional car parking, about 35 per cent of the area is consumed by providing access to parking spaces. Automated systems provide more car slots in the same space or,

alternately, release more space for better use with the same number of spaces offered by conventional parking. A range of automated car-parking systems are available to suit various customer needs. For planners and developers seeking solutions, automated systems provide a new perspective. Architects can provide new dimensions to car-parking services and aesthetically adapt it to the building's architecture. Builders and developers have reservations about the return on investment provided by traditional car parking. The cost of planning, construction and operation of automated parking is lower than that of conventional multilevel parking. In terms of cost, there is no real alternative to an automatic-parking system, where large numbers of cars are parked or high-traffic volume is encountered. In India, the market is new and still developing, with few systems in operation. In the absence of a regulatory safety body, quality and performance standards are based on company standards. In the absence of national standards, purchasers must accept the supplier country standards opine, Rajagopalan (2011).

The automobile has become indispensable to modern life like electricity and water. Cars also dominate the habit of shopping. Increasingly merchants also provide sufficient parking facility to attract customers as the life style of people has been changed a lot. Retailing has become totally reconfigured around automobile convenience. Parking remains a critical preoccupation in the nation's making and remaking of landscape and place. People need parking space where they work, shop, and play and at wherever car travel terminates. Retail activity in particular requires convenient parking spaces that can handle high turnover. In all categories of movement, the motor car is the transport mode, and the problem of where to park is a universal constant. Parking pervades one's lives to the extent that one is substantially dependent on cars for everyday mobility. It is a new approach – a clear focus on parking as a common place of everyday life state, Jakle and Sculle(2004).

Current Scenario in India

India is one of the fastest growing and resilient economies of the world having a booming automobile market. Relaxation in foreign trade policies and a developing indigenous automobile manufacturing sector has added to the ever proliferating automobile fleet in



Figure 2. Traffic in Commercial Area

urban India. The small city cars are affordable, attractive and have enticed the urban middle class who park free or at a nominal parking fee for majority of their trips. Parking is highly subsidized and parking fee is never a consideration in the mode choice of the motorists. All new developments provide ample, free off-street parking space or at nominal cost. The negative impact of parking activities on the traffic and transportation scenario in most of the metropolitan cities of India is reaching an alarming stage.



Figure 3. Crowded Roads

While it is quite normal for a country like India, passing through such a phase of economic development to have high aspirations and desires which positively influence people's parking preferences and behaviours (Chakrabarti and Mazumder, 2010).

Metropolitan cities cover merely two per cent of the world's surface but support 50 per cent of its population; that is what makes real-estate expensive in or near metros. It takes 375 sq. ft. to park one car, and most vehicles remain parked 95 per cent of the time! However, the real problem is not moving a vehicle but parking one. With land scarce and available at an exorbitant price, it has become imperative to make the best use of available

space. This has led to the birth of new parking solutions, and **mechanized multilevel car parking systems** are catching the imaginations of many. There is a tremendous market potential for parking systems, in India, and there are about 10,000 mechanized/automated parking spaces presently operating points, Kileda (2011).

Commercial parking can be in open lots, in stand-alone structures, or within the premises of buildings where it may be run in-house or by a professional parking operator. Privately-owned parking structures that stand alone, apart from other buildings, are a common feature of city centres (Barter, 2011).

Allocating prime private space to the automobile and using this feature to generate the overall design of a commercial facility serving other purposes was an alien concept. However convenient, car parking was seen as a waste of space and money by retailers and as unattractive blotches on the face of the city by the components of civic improvement says Longstreth, (2000).

Box 2

Appropriate amount of good quality car parking are an essential ingredient in forming a successful shopping centre. The quantity, quality, location and areas used for car parking are important design considerations. Customers will vote with their feet and use an alternative shopping venue if it has better and easier parking facilities. Problems not resolved in the design which result in queuing for a parking space, problem in relocating a car or long delays when exiting a car park are all sufficient to deter a customer from reusing a shopping centre and likely to affect its long term success. It is important to review the different qualities that are inherent to commercial building car parking and which differentiate this type of car parking from office or industrial parks opines, Coleman(2006).

In a bid to decongest the roads, the government may allow registration of vehicles only after production of parking space availability certificate to the authorities, said Union Minister Sri. Venkaiah Naidu.

(<http://indianexpress.com/article/india/parking-space-proof-may-be-mandatory-for-vehicle-registration-govt/>)

Box 3

Need for the study

- In recent years, an added factor is the change in lifestyles of the people to shop almost every day for day to day things and celebrations with more pomp than in earlier days. Use of cars for shopping has become quite a routine.
- Commercial centres are also on the increase and are expanding the shopping experiences they can offer to customers. Evidently they are forced to provide parking spaces to lure maximum customers. This has ended up in stiff competition and redefined rules/ regulations for construction.
- It is equally the case with those joints providing essential services (hospitals etc), entertainment, hotels, restaurants etc.
- In all these places, space allocation for public utility is a felt problem. Due to space constraints, car parking specifically has emerged as a major problem to be tackled tactfully by the joint owners, which should not only provide space, but ease in driving, parking, egress and ingress to the joints, fees levy, safety and above all avoiding traffic jam in the access roads.
- Hence studying existing conventional parking spaces and upcoming innovative kinetic (automated) parking and their acceptance by users was felt as indispensable.

Studies highlighting the limitations, significance and timely need of such ratifications in parking services are felt lacunae. Overriding these, details on awareness about trendy, innovative parking systems in the City had to be known. Being a driving consumer herself had provided the investigator ample circumstances to enjoy as well as feel the pinch of many a parking spaces. As comfortable and convenient parking space is also a 'Tangible resource' for any user motivated launch of this study, as the investigator is an ardent student in Resource Management and Consumerism. With this backdrop a micro level study on **“Paradigm Shift Through Kinetic Parking Spaces in Commercial / Essential Services Buildings – An User Friendly Analysis”** was launched in Coimbatore City to understand consumer behaviour with the following objectives.

Objectives of the Study

- *Understand the importance of parking facilities in commercial centers and other public buildings*
- *Locate significance given to parking lots in selected locale*
- *Decipher customer satisfaction with the provisions made*

Expanded Objectives

- *Analyze pointers for safe, convenient parking concepts*
- *Examine parking space availability in selected joints - commercial and essential services centers*
- *Infer viewpoints of providers and users on effective space planning for parking vehicles*
- *Delve on improvements to be made to optimize parking space usage*
- *Examine the feasibility and acceptability of innovative parking spaces provided - multi level, hydraulic etc*
- *Analyze the social cost benefits of such parking provisions.*

Hypotheses set

- 1. Conventional parking spaces would be rated high for basic amenities and convenience of users**
- 2. Automated systems may not be welcomed by customers as they may not meet upto their expectations**

It is hoped that the study would be an eye opener for those who are not aware of the recent developments in parking space provisions like automated parking and hydraulic systems at the same time drawing lines on improving existing conventional parking systems. Exhibit (1) gives an insight on the impetus this aspect has gained in recent years.

Coimbatore Railway Junction to get parking lots

NEWS REPORTER

Coimbatore: Rail passengers using the Coimbatore Junction will soon get more facilities. A new automated parking lot will be set up near the Junction. The project is being implemented by the Railways Ministry. The new parking lot will be set up near the Junction. The project is being implemented by the Railways Ministry. The new parking lot will be set up near the Junction. The project is being implemented by the Railways Ministry.



The pavement on the Dr. Balasundaram Road in the city has been turned into parking space by the two-wheeler and car users parking the pedestrians on to the road.

'மல்டி லெவல் பார்க்கிங்' திட்ட வரையடி சமர்ப்பிப்பு

சென்னை - மல்டி லெவல் பார்க்கிங் திட்ட வரையடி சமர்ப்பிப்பு செய்துள்ளதாக செய்தி. மல்டி லெவல் பார்க்கிங் திட்ட வரையடி சமர்ப்பிப்பு செய்துள்ளதாக செய்தி. மல்டி லெவல் பார்க்கிங் திட்ட வரையடி சமர்ப்பிப்பு செய்துள்ளதாக செய்தி. மல்டி லெவல் பார்க்கிங் திட்ட வரையடி சமர்ப்பிப்பு செய்துள்ளதாக செய்தி.

Valet parking, a necessary value-addition

NEWS REPORTER

Coimbatore: Valet parking is a necessary value-addition for hotels and restaurants. It provides a convenient service for guests, especially in busy areas. The service involves a valet driver who parks the car for the guest and returns the keys to them. This service is highly appreciated by guests and adds to the overall experience of staying at a hotel or dining at a restaurant.

Shut eateries without parking space: HC

SURESHKUMAR

NEWS REPORTER

Coimbatore: A major blow to the city restaurants and hotels, the Madras High Court has directed the government to shut down eateries which do not have adequate parking space. The court's decision is based on the fact that many eateries in the city do not have adequate parking facilities, which causes inconvenience to the public. The court has ordered the government to take steps to ensure that all eateries have adequate parking facilities.

Alternate parking system soon on D.B. Road

NEWS REPORTER

Coimbatore: An alternate parking system is being implemented on D.B. Road. The system involves the use of a central parking area where vehicles are parked and then transported to the destination by a shuttle service. This system is designed to reduce traffic congestion and provide a more efficient parking solution for the area.

பார்க்கிங் இடம் இருந்தால்தான் வாகனங்களுக்கு ஆர்டிஓ பதிவு

அமல்படுத்த மத்திய அரசு தீர்மானம்

மத்திய அரசு தீர்மானம் படி, பார்க்கிங் இடம் இருந்தால்தான் வாகனங்களுக்கு ஆர்டிஓ பதிவு செய்யப்படும். இது மத்திய அரசின் தீர்மானம். இது மத்திய அரசின் தீர்மானம். இது மத்திய அரசின் தீர்மானம்.

அபுரான்ட்மென்ட் கார்ப்பார்க்கிங் இனி எளிது

வந்தாச்சு ஹைட்ராலிக் லிப்ட்!

கொழும்பு: அபுரான்ட்மென்ட் கார்ப்பார்க்கிங் இனி எளிது. வந்தாச்சு ஹைட்ராலிக் லிப்ட்! இது மத்திய அரசின் தீர்மானம். இது மத்திய அரசின் தீர்மானம். இது மத்திய அரசின் தீர்மானம்.

மல்டி லெவல் பார்க்கிங்: பல்படி அடிக்குது

வழியெல்லாம் அடைச்சு நிக் குது கார்டு... வாகன நெரிசலில் தவிக்குது ஊர்

கொழும்பு: மல்டி லெவல் பார்க்கிங் திட்டம் பல்படி அடிக்குது. வழியெல்லாம் அடைச்சு நிக் குது கார்டு... வாகன நெரிசலில் தவிக்குது ஊர். இது மத்திய அரசின் தீர்மானம். இது மத்திய அரசின் தீர்மானம். இது மத்திய அரசின் தீர்மானம்.

Exhibit 1. Newspaper clippings

II. REVIEW OF LITERATURE

The review of literature pertaining to the study on “**Paradigm Shift Through Kinetic Parking Spaces in Commercial/Essential Services Buildings - An User Friendly Analysis**” is discussed under the following headings:

- A. **Concept of Commercial Buildings**
- B. **Public Utility Spaces - Parking Space Scenario**
- C. **Demand - Supply Balance**
- D. **Conventional Vs Innovative Parking Spaces**
- E. **Impacts of Parking Space Allocation**

A. **Concept of Commercial Buildings:**



Plate 1. Commercial Buildings

The term **Commercial building** refers to any building or part of building which is used as shops, market, for display and sale of merchandise either wholesale or retail, for transaction of business or keeping of accounts and records for similar purposes, professional service facilities, petrol pump, restaurants, lodges, nursing homes, banks, theatres, clubs run on commercial basis etc (Rangwala et al, 2014).

International Building Code has defined commercial buildings as buildings or portions of structures used for sales, business and professional or service transactions, including office buildings, eating, drinking and shopping establishment.

The International Energy conservation Code defines any building that is not a residential building with occupancy of three stories or less as commercial buildings (Jefferis and Smith, 2016).

Box 4

Successful shopping environments from small boutiques to large mixed-use projects are places where people want to be. People visit retail environments to go shopping, dine, recreate, socialize and to be entertained. They have transformed the cities and changed the way people interact with each other. The evolution of retailing has also transformed the way it is planned, and design civic infrastructure as well as commercial and cultural projects (Kliment, 2004). Each building has its own requirement. There are some common units required in all types of commercial buildings. Out of those units vehicle parking space is considered to be an important and essential unit of any public building. It may be in the basement or around the building. Total parking place required for a building whether commercial or official depends upon the number of employees in the buildings and the number of visitors at peak hours (Bhavikatti and Chitawadagi, 2014).

The concept of public space comes from the Greek word 'agora', which was generally considered as where citizens could make free speech, share intellectual opinions and enjoy convenience from market exchange (Mitchell, 1995).

B. Public Utility Spaces - Parking Space Scenario: People need places to hangout in cities, where everyone is welcomed that are entertaining, interesting, attractive, unique, inviting, fun and unusual. Public utility spaces should be the central focal points in the cities. They should be accessible to everyone by various public and private transit states, Martoni (2010). The term is used commonly to describe the corporate plazas, open spaces, shopping malls, and other such settings that are increasingly popular destinations for the public (Banerjee, 1994). Public space can be changed by public action, because it is owned by all. By using public spaces, people learn to live together. Spaces that satisfy people's needs, protect their rights, and offer them meaning will be attractive and are therefore economically successful. Public utility spaces should be responsive, democratic and also meaningful (Carr et al, 1992). A parking space or lot is also a public utility space.

Parking has become a conflicting and confusing situation for a number of people. Whether at a bus station, shopping centers or airports, problem with parking are an everyday occurrence (Banerjee Associates, 2003)



Exhibit 2. Public Utility Spaces

Parking on a prepared surface on grade and opened to the sky is a parking lot and also called as surface lot (Pande and Wolshon, 2016)

The sites for certain public buildings such as town hall, hospital, etc., should have ample and adequate parking space around them. Space under a building constructed on stilts or pillars are used as a parking space (Rangwala, et al, 1999).

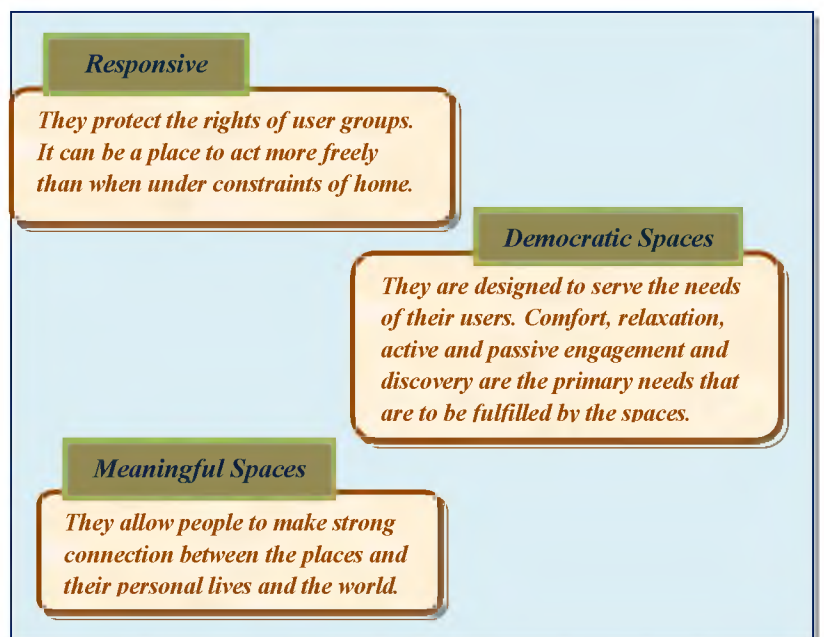


Exhibit 3. Spaces - Democratic, Meaningful and Responsive

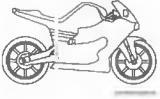

Additional parking provision can contribute to economic efficiency by reducing the need to search for parking space. It appears that a significant part of town centre traffic is made up of cars searching for available parking space. Lack of parking also acts as a control on car use and expansion may simply encourage additional car use. Off-street parking is therefore probably combined with on-street parking thereby reducing parking traffic; improving the environment and increasing safety. The cost of parking provision, time scale and land availability are likely to be significant constraints states Flaherty (2006).

C. Demand - Supply Balance: This aspect of the literature is reviewed under two headings:

1. Standards and Stipulations
2. Parking Demand Characteristics

1. Standards and Stipulations: Nowadays as the number of vehicle owners has increased hence, parking space requirement is high. Many buildings are provided with more than one basement for parking. In cinema halls, shopping malls, railway stations, airports etc., multi-storeyed parking are provided. Area required for different vehicles is as given in the Box 5. The side space between two cars is one to two metres (Bhavikatti and Chitawadagi, 2014).

Box 5. Area required for each Vehicle

Area Required for Each Vehicle	
Vehicle	Area (on m ² or sq.m)
	3.0 m ²
	20.0 m ²

Box 6. Space for one car

Use	Space required for one car
Shopping areas	For every 400 m ² of plinth area of shops
Offices	For every 600 m ² of plinth area of offices

There are some important considerations while planning for parking spaces in commercial buildings/areas. According to Seetharaman (2014) the

parking space required for shopping areas and offices located in central areas should provide for the specifications given in Box 6.

The minimum area required for parking cars shall be 24 m.

- In a library, suitable parking area though should be provided nearer should not be close to the reading area.
- While planning for hotels, the parking space should be in the cellar portion or around the building.
- Car parking area may be located a little bit away from the bus parking area (Bhavikatti and Chitawadagi, 2014).

While planning for a parking space some of the following points are to be noted:

- i. If the parking is not provided at street-level, the gradient of ramp leading to parking space should not exceed 14.3 per cent i.e. the vertical rise should not be more than one metre over a horizontal distance of seven metres.
- ii. It is necessary to put up a sign board indicating the location of parking spaces for different types of vehicles.
- iii. The off-street parking is not permitted in area within six metres from the perimeter of the building.
- iv. The parking layout should include adequate vehicular access to the street, drive ways and above the parking space.
- v. Clear headway of 2.4 m shall be provided on every access leading to parking space and at any point in parking space.

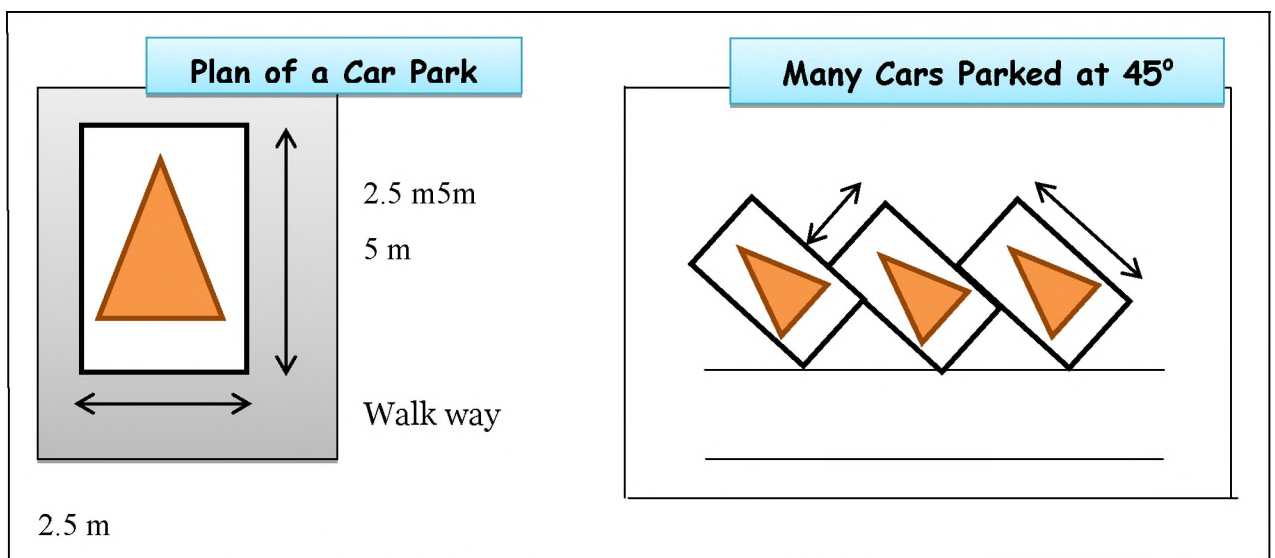


Figure 4. Plan of a car park and 45° car park

The standard for parking layout in a public building or commercial building to be followed is five to six cars for 95 sq.m of leasable area. The cars can be parked at an angle of 45° or also at 90° parallel to each other. Hedges and trees can be used to separate parking lots from the road. The minimum space required for car parking is 2.5 m x 5 m (Shoba, 2006).

The exemptions in off-street parking may be granted in deserving cases states Rangwala, et al, (2014) when:

- area of land in gamtal is less than 200 m².
- area of land in T.P (town planning) scheme is not less than 800 m².
- height of building is not exceeding 10 m; and
- in special buildings used as temple, mosque, prayer hall, etc.

Table shows the typical usual off-street parking required for various types of structures.

Table 1. Typical Off-street Parking for Vehicles

No	Type of use	Off-street parking
1	Cinema, theatre, public assembly halls, auditorium, stadium, etc.	1m ² per seat. 50% of total parking shall be reserved for cars.
2	Colleges and coaching classes.	70m ² for every 100 students
3	Commercial buildings including business office, bank, hotel, guest house, lodge, restaurant, institutional building, etc. and health facilities including hospitals and nursing homes, etc.	30% of maximum permissible F.S.I. (Floor Space Index) 50% of total parking space requirements shall be reserved for cars.
4	Community buildings such as community hall, recreational club, marriage hall, religious buildings, party plot, club house etc.	50% of building unit 50% of total parking space shall be reserved for cars.
5	Grain market, timber market, iron market, agricultural market and such other wholesale trade.	30% of maximum permissible F.S.I. 50% of total parking space shall be reserved for cars.
6	Industrial premises	10% of building unit. 50% of total parking space shall be reserved for cars.
7	Primary school	20m ² for every 100 students.
8	Residential flats or apartments	15% of maximum permissible F.S.I for dwelling units having built-up area above 80m, 50% of total parking space shall be reserved for cars and for dwelling units below 80m ² built-up area. 25% of total parking space shall be reserved for cars.
9	Secondary and higher secondary schools	50m ² for every 100 students
10	Stock market	30% of maximum permissible F.S.I. 50% of total parking space shall be reserved for cars.

Garage Parking: The term “Parking Lot” came to signify vacant spaces used to store cars. It might be surrounded by a fence, but a parking garage had solid walls and a ceiling as well as floor. The French verb garer meant to make safe to secure or to protect (Jakle and Sculle, 2004).

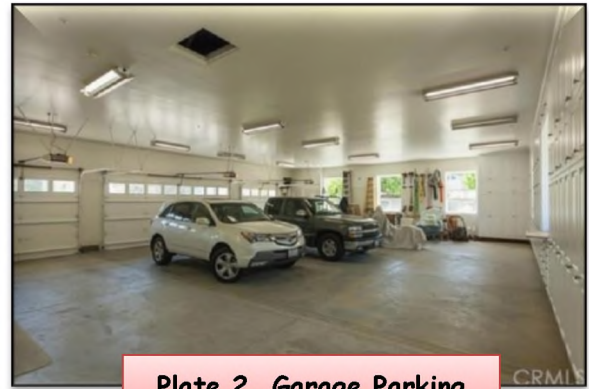


Plate 2. Garage Parking

The height of a garage should not be less than 2.4 m size. The size of garages depends upon whether it is private or public; if private 3 m x 6 m minimum and if it is the latter provisions to be made based on the number of vehicles to be parked.

Basement Parking: Basement or cellar is the lower storey of a building below or partly below ground level, which is not used for residential purposes.

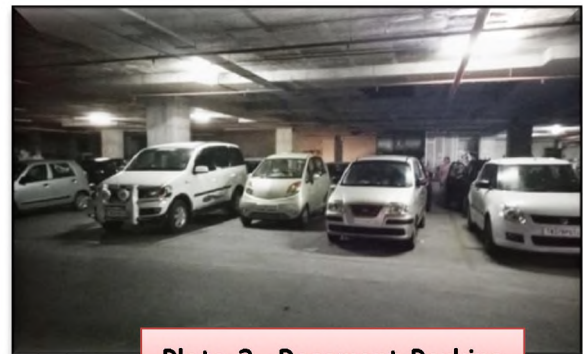


Plate 3. Basement Parking

The basement is to be constructed within the building envelope and subject to maximum coverage and used as parking spaces apart from other works. If basement is used as parking space then it should satisfy the following requirements opine Sharma (2013).

- **Every basement shall be atleast 2.4 m in height from the floor to the underside of the roof slab or ceiling.**
- **Adequate ventilation shall be provided for the basement. Any deficiency may be met by providing adequate mechanical ventilation in the form of blowers, exhaust fans, air-conditioning systems etc.**
- **Adequate arrangements shall be made such that surface drainage does not enter the basement.**
- **The walls and floors of the basement shall be watertight and be so designed that the effect of the surrounding soil and moisture, if any, are taken into account in design and adequate damp proofing treatment is given.**

- **The access to the basement shall be separate from the main and alternative staircase providing access and exit from higher floors. When the staircase is continuous in the case of buildings served by more than one staircase, the same shall be of enclosed type serving as a fire separation from the basement floor and higher floors. Open ramps shall be permitted if they are constructed within the building line subject to the provision of parking spaces.**
- **Adequate exit requirements in basement should be provided.**

Off-street parking design standards:

Dimensions: Each parking space shall be nine feet wide and 18 feet long. Compact parking space shall be a minimum of 8.5 feet wide and 16 feet long.

Pavement and Drainage: Off-street parking facilities shall be hard-surfaced like concrete and maintained with materials that would be sufficient to prevent mud, dust or loose material. Off-street parking facilities shall be designed and built to prevent the free flow of water onto adjacent properties.

Entrances and exits: The driveways and access points are to be designed in such a way that each parking facility shall be accessed and to direct non-residential traffic away from residential areas.

Safety features: Parking facilities shall be designed to provide visibility of and between pedestrians and vehicles when circulating, entering and leaving the facility. There should not be any blind, hidden or hazardous areas. Circulation patterns shall be designed in accord with accepted standards of traffic engineering and safety.

Maintenance: All parking facilities shall be maintained to assure the continued usefulness and compatibility of the facility. Acceptable maintenance includes keeping the facility free of refuse, debris, and litter, maintaining parking surfaces in sound condition and providing proper care of landscaped areas.

Location of Parking: Parking is permitted within any enclosed structure when such structure conforms to the regulations of its zoning district. The parking

space is provided on a paved, hard-surfaced, or gravelled drive way or pavement. The vehicle does not encroach on public right-of-way. (https://www.plattsmouth.org/PDF/Land_Dev_Ordinance/09-Off-StreetParking.pdf)

Parking Demand Characteristics: There are few types of characteristic demands, which have full impact on parking demand. According to Garber and Hoel (2014), Mathew, Smith and Carwile (2016), they are:

Parking accumulation: It is defined as the number of parked vehicle at a specific time.

Parking duration: Is defined as the length of time for which vehicle uses the facility.

Parking volume: Means number of vehicle involved in parking activity.

Occupancy: It is defined as the ratio of number of vehicles using parking facility to the number of parking facility available at a specific time.

Parking Load: It is the area under the accumulation curve between two specific times. It is usually given as the number of space-hours used during the specified period of time.

Space hour: A space hour is a unit of parking that defines the use of a single parking space for a period of one hour.

Parking efficiency: It is defined as the parking floor area constructed per parking space, stated as sq.ft or sq.m. It excludes exterior walls, sidewalks, stair and elevator shaft and any infrastructure for a mixed-use parking facility such as electrical and HVAC rooms.

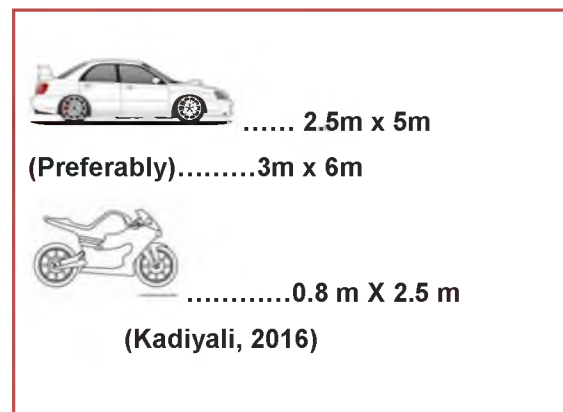
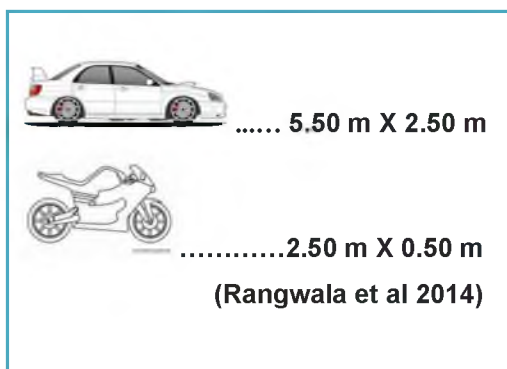
D. Conventional Vs Innovative Parking Spaces: Conventional parking is of two types based on location and parking pattern states, Singh (2015). They are:

1. On street Parking: This type of parking refers to parking on the sides of the street itself, which will be usually controlled by government agencies itself. The classification of on street parking is done based on the angle in which the vehicles are parked with respect to the road alignment (Mathew,

2014). On-street parking can be parallel parking where space is restricted or angle parking which is preferred for making parking and un-parking manoeuvres (Kadiyali, 2016). In on-street parking, the vehicles are allowed to be parked on the kerb and it may either be restricted kerb parking or unrestricted kerb parking. The former is controlled by police or parking metres and there is no such control in the latter one. On-street parking reduces the effective width of the road, and if not properly designed and planned, it leads to traffic congestion, especially during peak hours. Most of the drivers prefer to park at the kerb, if space is available (Rangwala et al, 1999).

2. Off street Parking: According to Rangwala, et al (2014), the public parking facilities are inadequate and hence, when a new building is constructed for uses or when the use of old building is changed to any of the uses or when new additions are made to the existing buildings for certain other uses, the bye-laws relating to off-street parking are to be respected. In many urban centres, some areas are exclusively allotted for parking which will be at some distance away from the main stream of traffic. Such a parking is referred to as off-street parking (Mathew, 2014). Most of the bye-laws contain provisions for parking of these vehicles namely cars and scooters. Depending upon the use of the building, the bye-laws specify the provision to be made for the parking spaces of cars, scooters. The space required for parking is as given below:

Box 7 & 8. Minimum Space Required for Parking



Parking of vehicles is a problem which has to be addressed by the traffic engineer. Surface off street parking, multi storey car parks and

underground car parks are common in major cities. Off street parking are of various types. They are: surface car parking, multi-storey/ multilevel car parking, roof parking, underground car parking and mechanical / hydraulic car parking (Singh, 2015).

Parking facilities are further classified as:

a) Conventional parking systems

b) Innovative parking system

a) *Conventional Parking system:* Those systems can be underground, above ground or both under and above ground. The open parking structure is preferable to enclosed structures for above ground parking, as it does not require mechanical ventilation and specialized fire protection systems.

b) *Innovative Parking Systems or Automated Parking Facility:* To cater the need of parking facility, there arises the innovation of an automated car parking system that regulates the number of cars that can be parked in an area at any given time based on the parking space availability. The entry and exit of vehicles are facilitated using a totally automated gate. The available space, whether the car is currently in the process of entering or leaving the parking space will be indicated by the status signals. After the installation, no manual control is required. Everything right from maintaining the count of vehicles, opening and closing of the gate is automatically controlled. Various forms of innovative technologies are used for parking facilities. (Apte et al, 2007) They are as follows:

- i. **Puzzle Parking**
- ii. **Elevated Type or Tower system**
- iii. **Multi-Level Automated Parking System**
- iv. **Vertical Rotary system**
- v. **Stacked System (www.secureparking.co.in)**

Exhibit 4 a. Types of Conventional Off-Street Parking



Exhibit 4 b. Types of Conventional Off-Street Parking



Roof Parking

Where open space is not available to provide parking space, within walking distance of the activity centre, one has to go in for the simplest form of providing parking space within the building that is the "Roof Parking". The open terrace roof of commercial or institution building can be utilized for parking for their employees and customer's cars at a little extra cost. Access to roof can be provided by ramps or mechanical lifts. Number of cars that can be parked in this roof top will be limited (Victor and Ponnuswamy, 2012).

Multilevel or multi-storey parking has multiple floors to park at. The design of a multilevel parking can be different. The most common design is a garage, with ramps to move from one level to another. The concept of using lifts from one level to level is not commonly seen. A multilevel car parking system is implemented to increase vehicle parking capability by making use of vertical space. There are a number of floors or storeys on which the vehicles can be parked. This system consumes very less space. In India, management of space is very critical in terms of parking and hence this system is most widely used (Yerojwar and Rojatkar, 2015)

Multi-level Parking



i. **Puzzle Parking:** Puzzle parking consists of a checker board pattern of parking “cells” on 2,3 or more vertical tiers where cars are parked on pallets that are moved along vertical and horizontal rails to a vacant slot. The system works like a “numbers puzzle” game in which there is one empty location. At least one cell must remain vacant to allow pallets to be shuffled around to gain access to the vehicle that is being retrieved. The computer controlled system operates by moving pallets on a cushion of air. They also track the location of each vehicle and work around in order to move the cars to the exit in the shortest and fastest way. The computer software allows simultaneous movement of pallets within the system, so multiple cars can be retrieved simultaneously.

Advantages

- ✦ The cubic volume of space with this system is 50 per cent less than a typical ramp-access garage
- ✦ The overall parking efficiency would then be 150 sqft per stall

Disadvantages

- ✦ A breakdown of only one cell could prevent the retrieval of all the parked vehicles
- ✦ Two computers are used to monitor each other and take off if one fails
- ✦ Speed of operation is the biggest concern with this system. Shuffling several vehicles to gain access to the vehicle being retrieved takes time. Larger the number of cells and levels, makes the system slower (Chrest et al, 2001).

ii. **Tower Parking System:** This system is a fully automated parking solution where, a separate tower/building is constructed only for the parking space. This helps to increase the number of parkings vertically. This system uses the latest technology to park and retrieve cars from the parking lots. It is designed using micro-processor based logic controller which brings the desired car to the level where it could be driven off. Parking uses micro-

processor based logic controller along with a combination of various types of sensors and actuators to bring a parking solution. Control system ensures that the car is parked perfectly on the pallet. Each car park will be allotted a ticket automatically (with / without payment as required) before taking the car for parking and the same ticket on depositing it back in the machine will retrieve the car. Each car is stored on steel Pallet (movable platform) which is carried by lifts and then to horizontal movers to keep the pallet parked until it is later carried away for retrieving the car. Multiple Vertical and Horizontal moving equipment will be used to move the pallets from one point to another.

Advantages

- + This is a hassle free solution for parking space without driving through the drive ways and finding the parking space
- + Also as no human may enter this parking lot, it is much safer

Disadvantages

- + Breakdown in any equipment will lead to breakdown of the entire parking system(<http://www.parkingsolution.in/tower-parking.html>).

iii. Multi-Level Automated Parking System: Automated garages are particularly useful in dense city areas, the greatest advantage is in the space saving (Pastore, 2005). A multilevel car parking is essentially a building with number of floors or layers for the cars to be parked. An automated car parking has mechanized lifts which transport the car to the different levels at a certain position. Therefore these car parks need less building volume and less ground space and thus save on the cost of the building. Multilevel automated car parking is considered effective in tackling the issue of parking. If there is no vacant space on the first floor, the lift automatically will go to the second floor and so on. The layer of floors and the elevator are equipped with sensors. The elevator carries the car to each floor under control of programmable logic controller (PLC) after reaching the signal from sensors and stops automatically. The elevator comes in front of the floors to allow the car to get in or get out.

Advantages according to Albagul et al (2011) and Yerojwar and Rojatkar (2015) are:

- + Maximum utilization of ground space
- + Quick entry and exit due to the independent operation of lifts
- + Designed for driver convenience
- + Partial breakdown, does not affect the other parts
- + Governed by computers, results in high efficiency
- + Multiple safety guarantee of the drivers and cars too
- + Vehicle retrieve time is less
- + Require less building volume and less ground area.
- + Human intervention is not required while parking and retrieval of vehicle
- + More safe and secure.

Advantages for Customers

- + No need to search for available parking space
- + No need to walk through the parking garage
- + Time, energy saving.
- + Consistent parking experience.
- + The car is parked at a safe and secured place. No worry about theft/damage

Advantages for municipalities/ property owners

- + Space efficiency
- + Environmental friendliness (no driving around outside)
- + Visual impact increased
- + Increases public safety
- + No litter, fights and accidents by the users
- + Provision is not required for signs, pedestrian areas etc.
- + Expensive ventilation system is not required as cars are moved automatically to its allotted places.
- + Attenders are not required. (<http://www.parking-net.com/about-parking/parking-facilities>)

Disadvantages according to Albagul et al (2011) are:

- + Expensive as the whole parking and retrieval operation is multi-level.

- ✚ Any fault in the system will lead to great haphazard and inconvenience to the people.
- ✚ Power consumption is high.
- ✚ More complex to build.
- ✚ Customers have to pay large amount of fares to park their vehicle.
- ✚ Construction cost is high.

iv. Vertical Rotary System: This system consists of a steel tower with a conveyor that lifts vehicles in a narrow circular loop up one side and down the other (Chrestetal, 2001).

The traditional parking systems such as multilevel or multi-storeyed car parking systems (non-automated) and new trends like puzzle and automated multilevel etc have been implemented on a huge scale. But, these systems have a major disadvantage of large space consumption which is successfully eliminated with the use of a rotary car parking system. Moreover this system provides the added benefits of flexible operation without the need of an attendant and added security and least chances of vehicle damage.

Since the model makes use of composite parts, it is easy to assemble and dismantle and is thus more convenient than the traditional car parking systems. The rotary model is specifically designed to accommodate multiple cars in the horizontal space of two cars and can hold a greater number depending upon the requirements of the user and can be effectively used in space crunched areas. The idea behind this innovation is to park and take out the cars with no disturbance to the already parked cars in the rotary car parking system.

Advantages according to Patel et al (2015) and Waghmare et al (2016) are:

- ✚ It ensures quick and automated parking and easy retrieval of vehicles.
- ✚ The surface space required is equivalent to the parking space of two cars only.
- ✚ Most suitable for parking in offices, malls and similar places.
- ✚ Engineered to ensure driver safety by use of an electronic safety zone.
- ✚ Low maintenance levels are required by the system.

- + Does not require attendant.
- + It can be easily constructed in a small area, just requiring a simple concrete base and three phase electricity.
- + It adopts rotating for mechanism so as to minimize the vibration and noise.
- + Flexible operation.
- + No caretaker is needed, only key pressing operation.
- + High safety, complete inspection of devices for stability and reliability.

v. Stacked System: This is the economical and simple parking solution for new buildings or existing ones where parking can be doubled. This parking system can be operated by hydraulic or mechanical action. Various variations of the system is available such as two level stack car parking (G+1), three level stack car parking (G+2) and pit level car parking. In both the two and three level stack car parking, one car is parked on the ground floor, and the another one on the first level and the third car on the second layer in two and three stack system respectively. The car on the ground level will need to be moved out before parking /removing the car on the raised platform.

(<http://www.hydraulicjackind.com/pdf/final%20brochure%20%20BROCHURE.pdf>). Pit level car stackers can retrieve any vehicle without moving another vehicle. A pit must be provided to accommodate the vehicle that is parked in the ground floor (Chrest et al,2004). Exhibit (5) portrays all the four innovative automated (Kinetic) parking systems.

Advantages

- + Low cost
- + Can be installed in existing buildings
- + Low ceiling height (as low as 9'4")
- + Less than 60 seconds to retrieve a car
- + Suitable for outdoors

Disadvantages

- + Lower car must be moved out by the user in order to retrieve the car on top.
- + User must have keys of both the vehicles (http://www.icclabc.org/uploads/Vehicle_Lift_-_Klaus_Presentation.pdf).

E. Impacts of Parking Space Allocation: In many municipalities, parking consumes not only the time of governing bodies and planning boards, but also scarce financial resources. As the number and size of parking spaces has increased - the environmental, health and social impacts has also increased. Parking has some ill-effects like congestion, accidents, pollution, obstruction to fire-fighting operations etc. The various impacts are discussed below under the following aspects:

1. Consumers Viewpoint: From the consumers viewpoint there are certain felt problems.

a) Congestion: Parking takes considerable street space leading to the lowering of the road capacity. Hence, speed will be reduced, journey time and delay will also be subsequently increased. The operational cost of the vehicle increases leading to great economical loss to the community state, Rathi and Patel (2017).

b) Inefficient use of existing parking capacity: Local zoning ordinances, building codes, and other development practices can result in an oversupply of parking spaces and an inefficient use of existing parking.

c) Inconvenient parking locations: Parking within a reasonable walking distance is hard to find during specific times of the day.

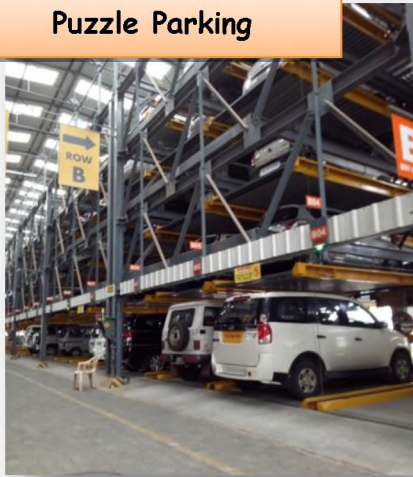
d) Inadequate pricing methods: Many require motorists to prepay based on the maximum amount of time that they may be parked and the price structure used at a particular parking space. As a result, motorists often end up paying for time they don't actually use, and if they guess wrong they face a fine (Banerjee Associates, 2003)

e) Parking charges: Collecting parking charges is one of the most widely used forms of parking control. They enable demand to be kept below the supply of parkingspace, thus reducing time spent for searching. This will affect the low income drivers more accords, Flaherty (2006).

f) Signs: Proper signs are to be designed that are readable by the users and it should be instantly recognizable, such as stop and speed limit signs including the colours, fonts, borders and background. The inadequacies are listed in the next page.

Exhibit 5. Types of Innovative Kinetic Parking Systems

Puzzle Parking



Tower Parking



Multi-level Automated Parking System



Innovative
Kinetic Parking
System

Vertical Rotary System

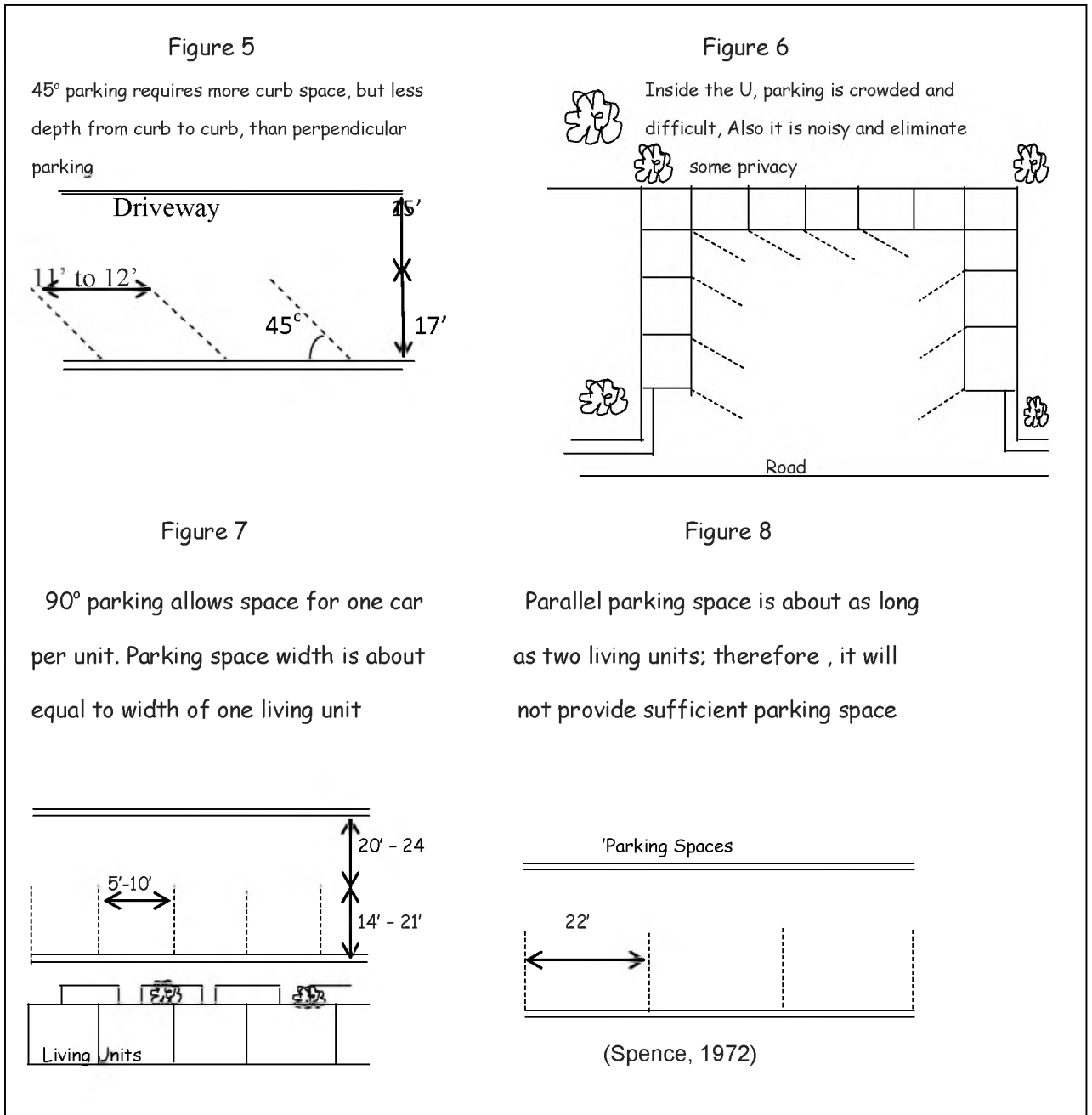


Stacked System



- ✚ Lack of contrast between messages and background (generally white retro reflective letters on dark background are best).
- ✚ Font sizes that is too small or difficult to read by the users.
- ✚ Difficulty reading and understanding over complex messages (Smith and Carwile, 2016).

Here are some Figures 5,6,7 and 8 which explain some common parking problems:



2. **Environmental Aspect:** Major influencing factors are:

a) **Environmental pollution:** Parking also causes pollution to the environment because stopping and starting of vehicles while parking and un-parking results in noise and fumes. (Rathi and Patel, 2017)

b) **Economic and aesthetic impacts of parking facilities:** Businesses ultimately bear the costs of un-priced parking, directly or through taxes that they must pass on to customers. Generous parking requirements can constrain businesses in other ways (Banerjee Associates, 2003)

c) **Spoils the Aesthetic:** The haphazard parking spoils the aesthetics of road (Rangwala et al, 1999). They also affect the aesthetic beauty of the buildings because cars parked at every available space create a feeling that building rises from a plinth of cars.

3. **Commuters and Traffic:** Significant factors leading to impact are:

a) **Accidents:** Careless manoeuvring of parking and un-parking leads to accidents. Common type of parking accidents occur while driving out a car from the parking area, careless opening of the doors of parked cars, and while bringing in the vehicle to the parking lot for parking.

b) **Obstruction to fire fighting operations:** Parked vehicles may obstruct the movement of fire fighting vehicles (Rathi and Patel, 2017).

c) **Inadequate information for motorists:** Inadequate information for motorists on parking availability and of price. Motorists are likely to be frustrated if they expected abundant and free parking but find limited or expensive parking, or if they must spend excessive time searching for a parking space.

d) **Loading and unloading zones:** Scarce parking for commercial vehicles to load or unload will cause them to block travel lanes.

e) **Difficulties with parking regulation:** This can cause problems, including traffic congestion as motorist cruise for parking or stop in a traffic lane to wait for a space, and cause parking congestion in nearby areas. (Banerjee Associates, 2003).

f) Reduced capacity of roads: The standing vehicles on road decrease the effective width of road causing practical problems (Rangwala et al, 1999).

4. Providers Viewpoint: This aspect seeks satisfaction of the following:

a) Demand for handicapped parking spaces: These spaces are generally located, in both garages and surface lots, as close to access ramps and curb cuts as possible.

b) Low parking turnover rate: This can occur when cars are parked in the same space for atleast on an average of 4 hours (Banerjee Associates, 2003), when they become a real problem to casual visitors to the site.

All these problems get magnified especially in conventional parking spaces. But in innovative kinetic parking spaces many of these could be avoided.

III. PLAN AND PROCEDURE

Research is an academic activity and a systematised effort to gain new knowledge and it is one of the ways to find answers to some unanswered questions (Gupta and Gupta, 2011). Plan includes everything to be done by the investigator in research procedure (Thakur, 2009). The final major component of methodology section describes the processes and procedures that an investigator employed throughout the conduct of the study (https://www.pacifica.edu/gems/thesis/Methodology_Procedures.pdf).

The plan and procedure adopted for the study on, “**Paradigm Shift Through Kinetic Parking Spaces in Commercial / Essential Services Buildings - An User Friendly Analysis**” included the following phases:

Phase I – Facility Providers' Survey

Phase II – Case Study on Innovative Parking Systems

Phase III - Users' Survey

Phase I : Facility Providers' Survey

According to Mouton and Marais (1988), methodology is defined as the logic of the application of scientific methods to the investigation of phenomena. With reference to research it is a type of inquiry states Singh and Nath (2007). The methods chosen for this phase of the study therefore included:

A. Selection of the Locale:

Coimbatore – the administrative headquarters and a major textile and engineering hub of Southern India also known as Manchester of South India was the broad area chosen for the study. It is known for its textiles mills, factories, engineering firms, automobile



Figure 9. Locale of the Study

parts manufacturers, healthcare facilities, educational institutions and hospitality – all **commercial / essential services centers**. The city is a traditional, multi-cultural inclusive society (Bali et al, 2013). Hence the sampling method chosen was convenience. According to Gupta (2008), Convenience sampling is known as unsystematic, careless, accidental or opportunistic sampling. A sample is selected according to the convenience of the investigator. This convenience may be in respect of availability of data and accessibility of the units.

The survey was carried out in the sub areas located within the city limits of Coimbatore like Avinashi Road, Town Hall, Gandhipuram, Thudiyalur, and Kavundampalayam. **Commercial buildings** like garment shop, grocery, multipurpose building, home accessories, jewelry, office and **essential service buildings** like hotels, hospitals and wedding hall having off-street parking facility to cater the car parking needs of customers were selected for conduct of the survey adopting purposive sampling. Purposive sampling is selected by some arbitrary method because it is known to be representation of the total population, or it is known that it will produce well matched groups. The idea is to pick out the sample in relation to some criteria, which is considered important for the particular study (Singh and Nath, 2007).

As the commercial and essential services buildings prefer to function in the main area of the city convenient for their customers with necessary amenities like parking spaces incorporated with either conventional or innovative parking systems, these areas were chosen. As they were located in good numbers in these selected areas also facilitated in choosing them.

B. Selection of the Sample: Sampling is the process of selecting an adequate number of elements from the population, so that the study of the sample will not only help in understanding the characteristics of the population but will also enable generalizing the results (Chawla and Sondhi, 2014).

A sample is a sub group or sub set of the population. Some of the elements but not all, of the population form the sample (Yin, 2009).

For the concerned study, **30 samples out of which 20 belonged to commercial buildings and 10 of essential services buildings** were selected using purposive sampling method. According to Gupta (2008) when the researcher deliberately selects certain units for study from the universe, it is known as purposive sampling. The idea is to pick out the sample in relation to some criteria, which is considered important for the particular study (Singh and Nath, 2007). Here sample buildings were selected based on the presence of either conventional or innovative kinetic parking facilities.

C. Selection of the Method: In order to gather information from the parking facility providers, a field **survey** was found essential. A survey collects information about a well-defined population and it is a powerful instrument to collect new statistical information opines Bethlehem, (2009). In field survey method particularly data/information are obtained from a general study of a large number of respondents, eliciting direct responses to specific questions (Krishnaswamy et al, 2009). It is commonly used to collect primary data from the respondents states Beri, (2000). Hence the method chosen was **face to face interview method** along with **observation** as it affords collection of **primary data**. Primary data are data acquired at their sources through observation, experimentation, interviews, questionnaire surveys and searches through company records reports, Kuiper (2009).

Interview is a technique that is primarily used to gain an understanding of the underlying reasons and motivations for people's attitudes, preferences or behaviour and it involves presentation of oral-verbal stimuli reply in terms of oral-verbal responses states Das, (2010). Observation implies the collection of information by way of investigator's own observations, without interviewing the respondents (Kumar, 2008). Parameters like noise, temperature etc were measured using standard instruments.



Plate 4. Investigator Recording Temperature and Noise

D. Formulation of the Research Tool: The tool selected for the study was a structured interview schedule. A structured interview schedule is one which is based upon structured set of questions and therefore highly standardised in form of content states, Kumar (2008).

According to Taylor et al, (2006) an interview schedule is a formal list used in interviews to aid in the systematic collection of data through questions

To this effect an **interview schedule** was prepared to obtain the required data. The schedule included queries related to the parking systems incorporated, functional aspects provided, their operational details, consumer friendly aspects, economics of construction, and their pros and cons.

The schedule was put to a **pretesting** choosing one sample for each category. It is important to pre-test the instrument to ensure that the questions are understood by the respondents, and no problems arise with the wording or measurement. Pretesting involves the use of a small number of respondents to test the appropriateness of the questions. This helps to rectify any inadequacies before administering the instrument orally or through a questionnaire and reduce bias states, Sekaran and Bougie, (2015)

The prepared interview schedule was pretested to locate lacuna if any, necessary modifications were then made and finalized. A sample of the interview schedule is enclosed in Annexure – I.

E. Collection of Data: The investigator approached the commercial and essential services buildings in person to get in depth details on the availability

of parking space, parking facilities provided both innovative and conventional, their features, and all the aspects covered in parking spaces, by administering the interview schedule. The investigator contacted the concerned personnel authorized to disclose pertinent information and explained the purpose of the study. Questions were asked in sequence to know the necessary details.

Overt observation method was adopted. As defined by Brain, (2000) overt observations are ones where the participants know they are being observed. Overt means that the observation is done openly, are more ethical, but the people being watched are less likely to behave naturally. The type of parking systems facilitated was thoroughly observed and recorded. Observation is a skill that most people use consciously in everyday life. It might be carried out in a naturalistic environment where there are no controlled conditions or it might happen in a simulated environment under certain controlled conditions state, Chawla and Sondhi, (2014). Physical facilities, capacity, access points, ergonomic aspects, ambience provided with particular reference to each type of system were observed and details were recorded.

A. Collection and interpretation of Data: The collected data was consolidated, analysed, tabulated and are presented in Results and Discussion.

Phase II :- Case Study on Innovative Parking Systems

A. Selection of Area: Coimbatore city was the area selected for the study using Purposive sampling. According to Kumar (2008) the sampling method which includes purposive or deliberate selection of particular units of the universe, then it is known as **purposive sampling**. As this affords availability of the selected samples, this area was chosen.

B. Selection of Sample: Six buildings and one fabricator of all the four types of innovative kinetic parking systems installed in Coimbatore were selected choosing convenience sampling. When population elements are selected for inclusion in the sample based on the ease of access, it is termed

as convenience sampling states, Kumar (2008). Availability of needed sample and their willingness to disclose data enabled choosing them.

C. Selection of Method and Tool: Face to face interview, observation and a checklist formed the method and tool for the study. An *interview* is a face-to-face situation in which an interviewer asks questions of one or more interviewees states Mark, (1996). **Observation** is the information obtained relates to what is currently happening and is not complicated by either the past behaviour or future intentions (Khantzode, 2007). Scheduled interview method starts with the development of a questionnaire schedule or **check list** (Kumar, 2008). The **checklist** included details on type, mechanism, year of installation, benefits, parking accumulation and car volume, merits and demerits of the parking systems.

D. Collection and Interpretation of data: The data was collected by using the checklist and recorded then and there. The findings of case studies are presented under Chapter IV.

Phase III : Users' Survey

This phase of the study was streamlined to find out the extent of satisfaction the consumers, the users of the parking facilities evinced from those provided. Hence the steps included the following:

A. Selection of the Area: The survey was carried out in and around the city of Coimbatore like Avinashi Road, Town Hall, Saibaba Colony, Gandhi Puram, Thudiyalur, Kavundampalayam and T.V.S.Nagar. Presence of many commercial and essential services centers for the benefit of the public encouraged the selection. Evidently the sampling method was purposive. A purposive sample is one where people from a pre specified group are purposely sought out and sampled quote, Gerrish and Lacey (2010).

B. Selection of the Sample: Sampling is selection of definite units from a certain group according to the pre-decided structure. It is a small group selected according to a definite method from a big population which represents the whole population opines Jha, (2014). To this effect 100 samples (the parking facility users) were selected from various categories like public sector employees (30), professionals (28), business people (19), home

makers (14) and students (9) to carry out the study. Convenience sampling was adopted to survey the samples. According to Sekaran and Bougie (2015), convenience sampling refers to the collection of information from members of the population who are conveniently available to provide it.

C. Selection of the Method: Survey was the method adopted to conduct the study. Willd and Diggins (2009) define survey as a method of primary data collection in which information is gathered by communicating with a representative sample of people. It is commonly used to collect primary data from the respondents (Beri, 2000). **Interview** may be regarded as a systematic method by which a person enters more or less imaginatively into the inner life of a comparative stranger and a rapport is established between the interviewer and the interviewee (Sharma, 2008). With this in view interview method was chosen to decipher details from the samples.

D. Formulation of the Research Tool: An **interview guide** and **checklist** were the tools selected to proceed with the study. According to Saravanel (2007), an **interview guide** is a list of topic questions or areas which the interviewer uses merely as a prompter during the interview; a simple **checklist** is one of the most basic structural methods of observation. **checklist** is completely structured and all questions are close-ended states, Uys and Basson (1985).

The investigator prepared the interview guide to be filled in with the personal opinions and ratings given by the users who had experienced the parking facilities provided in the commercial and essential services buildings. Their opinion on feasibility of both conventional and innovative systems was deciphered.

One way of making sure that the questions are understood is to carry out a pilot study. It means testing the prepared questionnaire out on a small group to find out any problems before undertaking the main study states, Brain (2000). Hence a pilot study was done by the investigator on a limited sample before the original studies were carried out in order to gain some primary information to be added or deleted from the formulated guide.

This required changes, which were done and the tools were finalized. The interview guide–cum - checklist used for the study is enclosed in Annexure– II.

E. Collection of Data: The investigator approached the samples at their leisure and administered the tools after explaining to them the purpose of the study. Opinions and suggestions of the customers with respect to the various aspects of parking facilities were welcomed and registered carefully. Thus the desired information was collected from the user survey by the investigator. Taxonomy of the plan and procedure is given as Figure 10.

F. Collection and Interpretation of Data: The collected data was consolidated, analysed, tabulated and are presented under Chapter: IV

Ethical clearance (AUW/IHEC/IDRM-16-17/XMT-10) was obtained before selecting the sample and conduct of the study - is enclosed in Annexure–III

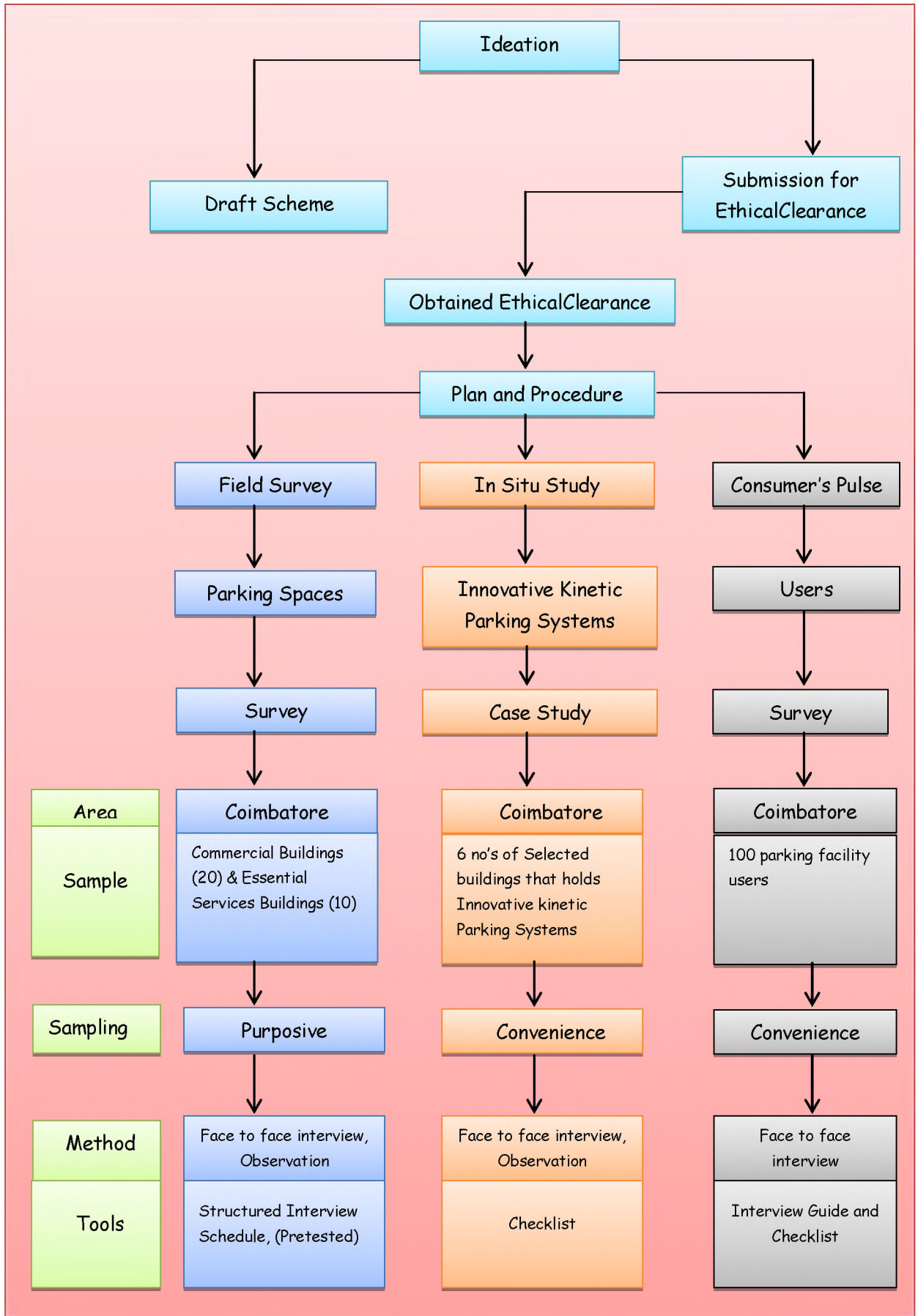


Figure 10. Taxonomy of the Study

IV. RESULTS AND DISCUSSION

The findings pertaining to the study on '**Paradigm Shift Through Kinetic Parking Spaces Offered by Commercial / Essential Services Buildings - An User Friendly Analysis**' is discussed under the following broad headings:

- A. Parking Systems in Vogue**
- B. Innovative Parking System Scenario**
- C. Customer's Pulse**

The first two phases analysed the buildings while the third documented customer's viewpoints.

A. *Parking systems in Vogue*

With increase in onroad traffic and vehicular movement need for proper parking spaces have been receiving attention of at least a few construction companies and owners of business joints. The existing scenario is very obscure. Hence this aspect of the findings are discussed under the following headings, so as to decipher data on the status.

- 1. Parking Systems Incorporated**
- 2. Functional Aspects Provided**
- 3. Operational Details**
- 4. Economics of Construction**
- 5. User Friendly Aspects**
- 6. Ergonomic Aspects Considered for User friendliness**

1. Parking Systems Incorporated: This part of the findings is discussed under the following headings:

- a. Nature of Business and Service**
- b. Nature of Parking System**
- c. Years of Standing**

a. Nature of Business and Service: The Table in the next page presents details on the same.

Table 2. Nature of Business and Service

Type of Building	Nature of Business	Percent Responding
Essential Buildings (ESB) (N=10)	Hotel	50
	Hospital	40
	Wedding Hall	10
Commercial Buildings (CB) (N=20)	Garment Shop	30
	Grocery Stores	25
	Multi purpose stores	15
	Home accessories shop	10
	Jewelry	10
	Office	10

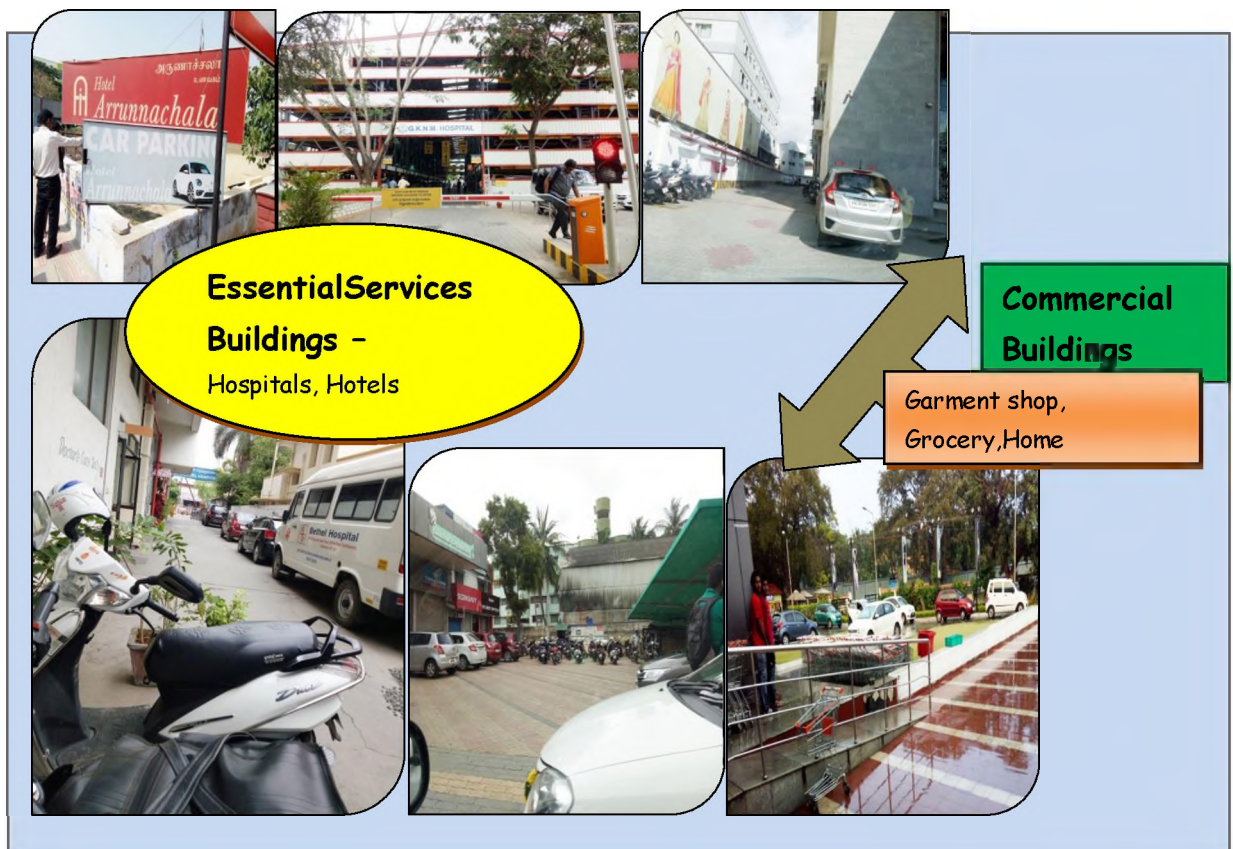


Plate 5. Commercial / Essential Services Buildings

The study revealed that among the samples selected **ten** provided essential services and the rest **20** performed commercial functions. Hotels predominated followed by hospitals and wedding halls. Among commercial buildings garment shops stole the show as depicted by 30 per cent followed

by grocery (25%) and multipurpose shops (15%). Those catering to home accessories, jewelry and offices were represented by only ten per cent each.

b. Nature of Parking System: Table presents details on the same.

Table 3. Nature of Parking System

Nature of Parking	Type of Building								
	Percent Responding								
	ESB			CB**					
	Hospital (N=4)	Wedding hall(N=1)	Hotels (N=5)	GS (N=6)	HA (N=2)	G (N=5)	JW (N=2)	MP (N=3)	OF (N=2)
Surface parking	50	100	100	33.3	100	60		66.6	50
Under ground parking				16.7		20	50	33.3	
Surface & underground	25			50		20	50		
Innovative parking	25			50					100

*Multiple Response

**GS–Garment Shop, HA – Home Accessories, JW – Jewelry, MP – Multi purpose,OF-Office

Two existing off-street parking facilities were found to have been made available by the selected sample. Among essential services, surface parking was most popular. In commercial buildings like garment shop, grocery and jewelry the provision of both, surface and underground parking found equal representation. Innovative parking was also found to have been installed along with the surface and ground parking by both the groups of buildings.

c. Years of Standing: Details on this aspect is presented under the Table

Table 4. Years of Standing

Years of Standing (in years)	Type of Building								
	Percent Responding								
	ESB			CB					
	Hospital (N=3)	Wedding Hall(N=1)	Hotels (N=5)	GS (N=6)	HA (N=2)	Grocery (N=5)	JW (N=2)	MP (N=3)	OF (N=1)
1 – 5				50		80	50	33.3	
5 – 10	66.6		60	33.3	50				
10 – 15			20				50		
More than 15	33.3	100	20	16.7	50	20		66.7	100

*Multiple Response

Among essential services buildings, wedding hall was found to have a long standing (100%) while the rest had been doing service for just 5-10 years and beyond. Among commercial buildings, grocery(80%), garment (50%), and jewelry (50%) were constructed only recently that is, within the past five years, and evidently were found to have incorporated latest trends in construction. But many of the buildings were found to be in service for more than 10 to 15 years.

2. Functional aspects provided: This aspect of the findings are analyzed under the following headings:

- a. **Space Allocation Made for Accommodation**
- b. **Vertical Space Provided in Underground Parking**
- c. **Horizontal Space Provisions**
- d. **Parking Accumulation**
- e. **Structural Elements in the Parking Space**

a. Space Allocation Made for Accommodation:The Table gives details on the same

Table 5. Space Allocation made for Accommodation

Type of Parking Service	Nature of Business	Marked area to park the vehicle with dimensions						
		Those who provided	Percent Responding					
			Size of each marked space (in feet)					
			7x10	7x11	7x15	8x10	8x12	uneven
Surface Parking	Hospital (N=3)							
	Wedding Hall(N=1)							
	Hotels (N=5)	60		20		20	20	
	Garment Shop (N=5)	20		20				
	Home accessories(N=2)							
	Grocery (N=4)	50	25	25				
	Jewelry (N=1)							
	Multi purpose (N=2)	100			50			50
	Office (N=1)	100	100					
Under Ground Parking	Hospital (N=1)							
	Garment Shop (N=4)	25		25				
	Grocery (N=2)	50	50					
	Jewelry (N=2)							
	Multi purpose (N=1)	100	100					

In surface parking all multi purpose and office buildings along with hotels (60%), grocery (50%) and garment shop (20%) and in underground parking all multipurpose, 50 per cent of grocery and 25 per cent of garment shops had ear marked areas for parking following specific dimensions. The space allotted extended from 7'x10' to a maximum of 8'x12'. These dimensions they agreed could accommodate all types of cars. Almost 50 per cent of multi purpose buildings had allotted space, but were found to be uneven. Many of them had provided exclusive spaces for parking two wheelers too.

b. Vertical Space Provided in Underground Parking: The Table gives details on this aspect

Table 6. Vertical Space Provided in Underground Parking

Nature of Business	Height of the headroom in under ground parking (in feet)	
	Percent Responding	
	7 - 10	10 - 12
Hospital (N=1)	100	-
Garment Shop (N=4)	25	75
Grocery (N=2)	-	100
Jewelry (N=2)	-	100
Multi purpose (N=1)	-	100

Clear headway of 2.4 m shall be provided on every access leading to parking space and at any point in parking space states, Shoba (2006). The head room provided was quite satisfactory (7' – 12') in almost all the buildings studied.

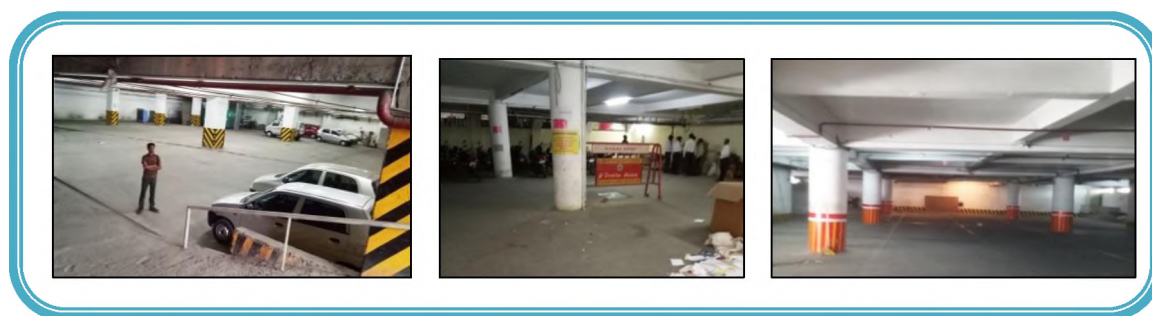


Plate 6. Vertical space provided in selected sample buildings

c. Horizontal Space Provisions: Space provided between two vehicles differed with the type of parking service and the parking space. Table 7 gives the necessary details.

Table 7. Horizontal Space Provisions

Type of Parking Service	Type of Building	Nature of Business	Space between each parked vehicle (in feet and inches)	
			Percent Responding	
			1' – 1' 6"	More than 1'6"
Surface Parking	ESB	Hospital (N=3)	66.6	33.3
		Wedding Hall(N=1)	100	
		Hotels (N=5)	40	60
	CB	Garment Shop (N=5)	60	40
		Home accessories (N=2)	50	50
		Grocery (N=4)	100	
		Jewelry (N=1)	100	
		Multi purpose (N=2)	50	50
		Office (N=1)	100	
Under Ground parking	ESB	Hospital (N=1)		100
	CB	Garment Shop (N=4)	50	50
		Grocery (N=2)	50	50
		Jewelry (N=2)	50	50
		Multi purpose (N=1)		100



Plate 7. Horizontal space provision

Hospitals and hotels comparatively gave larger clearance space between vehicles in surface parking, while essential services provided only minimal (1' – 1'6") except garment, home accessories and multipurpose shops. In underground parking too clearance provided was comparatively less than the dimensions needed for free manoeuvrability by vehicles in all the

d. Parking Accumulation : Parking accumulation is defined as the number of parked vehicle at a specific time defines Mathew (2014). Depending on inflow, and the number of customers visiting the places, parking facilities at different levels including underground were found to be made. Table presents the relevant issue.

Table 8. Parking Accumulation

Type of Building	Nature of Business	Number of cars that can be parked in each parking level							
		Percent Responding							
		Ground floor		Basement1		Basement 2		Basement 3	
		1-50	50-100	1-50	50-100	1-50	50-100	1-50	50-100
ESB	Hospital (N-1)		100	100					
CB	Garment Shop (N-4)	100		100		25			
	Grocery (N-2)	50		100					
	Jewelry (N-2)	50		100					
	Multi purpose (N-1)				100		100		100

Provision for ground level parking was very popular, while parking in ground floor and in basement (1) was prevalent in hospital, grocery and jewelry stores. Garment shops and multi purpose buildings had found space to provide more than two basements for parking. Evidently, the magnitude of business decided provision for parking made. At the most all buildings had made provisions to accommodate upto 50 cars at a time for parking, while hospitals among essential services buildings and garment, jewelry and grocery could accommodate upto 100 cars in one basement floor. Multi purpose buildings evinced interest to provide parking space for 50 – 100 cars at a time in basement (2) or (3). With the nature of job executed the allotment for parking also differed.

e. Structural Elements in the Parking Space: To make way for cars to enter into or exit a parking lot, necessary structural elements had to be made. The Table presented below highlights on those aspects.

Table 9. Structural Elements in the Parking Space

Type of Parking Service	Nature of Business	Structural elements in the parking space		
		Percent Responding		
		Ramps	Driving Lane	Pedestrian Lane
Surface Parking	Hospital (N=3)	33.3	100	
	Wedding Hall (N=1)		100	
	Hotels (N=5)		80	40
	Garment Shop (N=5)	20	80	40
	Home accessories(N=2)		100	
	Grocery (N=4)		100	
	Jewelry (N=1)		100	100
	Multi purpose (N=2)		100	50
Under Ground parking	Hospital (N=1)	100	100	100
	Garment Shop (N=4)	100	100	50
	Grocery (N=2)	100	100	
	Jewelry (N=2)	100	100	
	Multi purpose (N=1)	100	100	

In surface parking pedestrian paths and ramps were additional aspects provided in places other than the wedding hall and home accessories shop. Even driving lanes were found to be missing in 20 per cent of hotels and garment shops. In underground parking all the elements like ramps, driving lanes and pedestrian lanes were commonly seen except in grocery, jewelry and multi purpose buildings. The parking layout should include adequate vehicular access to the street, drive ways and above the parking space. If the parking is not provided at street-level, the gradient of ramp leading to parking space should not exceed 14.3 per cent i.e. the vertical rise should not be more than one metre over a horizontal distance of seven metres states, Shoba, (2006). This was not followed in the constructions.

3. Operational Details: This aspect of the findings on conventional parking spaces provided are discussed under the following heads:

- a) **Occupancy Data**
- b) **Capacity for Simultaneous Parking**
- c) **Logistics for Parking**
- d) **Entry and Exit to the Parking Area**

a) Occupancy Data: Parking volume is the number of vehicles involved in parking activity. Occupancy is defined as the ratio of number of vehicles using parking facility to the number of parking facility available at a specific time states Mathew (2014). The Table throws light on the same

Table 10. Occupancy Data

Type of Parking Service	Nature of Business	Average number of vehicles parked in a day		
		Percent Responding		
		Less than 100	100 - 500	500 - 1000
Surface Parking	Hospital (N=3)	66.7		33.3
	Wedding Hall (N=1)	100		
	Hotels (N=5)	100		
	Garment Shop (N=5)	60	40	
	Home accessories (N=2)	100		
	Grocery (N=4)	50	50	
	Jewelry (N=1)	100		
	Multi purpose (N=2)		100	
	Office (N=1)	100		
Under Ground parking	Hospital (N=1)			100
	Garment Shop (N=4)	50	50	
	Grocery (N=2)	50	50	
	Jewelry (N=2)	100		
	Multi purpose (N=1)		100	

Use of parking space was highest (more than 500 cars a day) in hospitals. Garment shop, grocery and multi purpose buildings were found to be filled up with more than 100 vehicles a day in both surface and underground parking. In all others it was less than 100 a day. This aspect highlights the places maximum visited by customers. Ofcourse it can be patients/visitors in hospitals, but thronging of customers in the other commercial centres is quiet obvious and pictures a glimpse on consumer behaviour and mobility, where availability of cars and parking spaces have definitely increased shopping spaces and frequent shopping behaviour. Provisions made for both surface and underground parking in these buildings can be attributed as a reason.

b. Capacity for Simultaneous Parking: Table given below illustrates the same

Table 11. Capacity for Simultaneous Parking

Type of Parking Service	Nature of Business	Total number of vehicles occupying the parking at a Time		
		Percent Responding		
		Less than 100	100 - 150	More than 200
Surface Parking	Hospital (N=3)	66.7		33.3
	Wedding Hall (N=1)	100		
	Hotels (N=5)	100		
	Garment Shop (N=5)	60	40	
	Home accessories (N=2)	100		
	Grocery (N=4)	100		
	Jewelry (N=1)	100		
	Multi purpose (N=2)	50	50	
	Office (N=1)	100		
Under Ground parking	Hospital (N=1)			100
	Garment Shop (N=4)	50	50	
	Grocery (N=2)	100		
	Jewelry (N=2)	100		
	Multi purpose (N=1)			100

Except hospitals, garment shops and multi purpose buildings provision for parking more than 100 vehicles at a time was found not to exist, both in surface and underground parking. Hospital and multi purpose buildings by virtue of surface parking could accommodate even above 200 vehicles at a time. Combining of surface with underground parking facilitated accommodation of more number of vehicles at a time, it is clear.

c. Logistics for Parking: In all the buildings studied, their surface and underground parking lots were found to have been planned to accommodate all types of cars like hatch back, sedan, MPV/MUV, SUV and convertibles.

d. Entry and Exit to the Parking Area: Even if cars could be accommodated, unless provisions for free entry and exit is made it becomes useless. Hence this aspect of the study was done, the analysis of which is given in the next table.

Table 12. Entry and Exit to the Parking Area

Type of Parking Service	Nature of Business	Service ways from and to the parking space	
		Percent Responding	
		Separate entry and exit ways	Single entry and exit
Surface Parking	Hospital (N=3)	33.3	66.7
	Wedding Hall(N=1)		100
	Hotels (N=5)		100
	Garment Shop (N=5)	20	80
	Home accessories (N=2)		100
	Grocery (N=4)	50	50
	Jewelry (N=1)	100	
	Multi purpose (N=2)	50	50
	Office (N=1)		100
Under Ground parking	Hospital (N=1)		100
	Garment Shop (N=4)	25	75
	Grocery(N=2)	50	50
	Jewelry (N=2)	50	50
	Multi purpose (N=1)	100	

This is another factor found unfavourable in parking lots. In surface parking while jewelry stores had provided separate entry and exit ways, wedding hall, hotels and office had a single entry – cum-exit way. Many hospitals, garment shops, grocery and jewelry shops and multipurpose buildings also had a separate entry/exit. In underground parking multipurpose holdings offered separate entry and exit ways, while garment shop, grocery and jewelry had single ways. This aspect can pose a problem during peak hours and may also lead to congestion, accidents etc which customers may not prefer.

4. Economics of Maintenance: This part of the findings covered both ease in maintenance and operation and are analysed under Table

Table 13. Economics of Maintenance

Type of Parking Service	Nature of Business	Maintenance and operation	
		Percent Responding	
		Easy to clean	Easy to handle
Surface Parking	Hospital (N=3)	33.3	100
	Wedding Hall(N=1)	100	100
	Hotels (N=5)	100	100
	Garment Shop (N=5)	80	80
	Home accessories (N=2)	100	50
	Grocery (N=4)	75	100
	Jewelry (N=1)	100	100
	Multi purpose (N=2)	50	100
	Office (N=1)	100	100
Under Ground parking	Hospital (N=1)		100
	Garment Shop (N=4)	100	100
	Grocery (N=2)	50	100
	Jewelry (N=2)	50	100
	Multi purpose (N=1)	100	100

In surface parking wedding hall, hotels, home accessories, jewelry and office maintenance was found to be quite easy. Hospitals (66.7%) followed by multi purpose shops (50%) reported maintaining needed cleanliness was quite difficult. Garment shop and grocery (25%) also had the same opinion. In underground parking, garment shop and multi purpose building reported that cleaning job was easy followed by grocery and jewelry with both ratings of easy and difficult. In hospitals, as expected, because of floating traffic it was felt hard to clean. Nature of business definitely had a say in the ease with which the buildings could be maintained.

All the samples surveyed had employed house keeping staffs and the general cleaning was done with necessary tools and equipments regularly. This shows the modern trend in all joints to have an exclusive housekeeping department and the significance it receives in modern days. In surface parking, operation of the parking lots was found to be easily handled by the staff employed by the sample buildings except in home accessories (50%), and garment shops (20%) which found some discrepancies in handling them. All the samples using underground parking stated to have found accessing the parking facility quite easily.

5. User friendly Aspects: This aspect analyses the important factors provided to make driving and parking easier in the parking space.

Table 14. User-friendly Aspects considered

Type of Parking service	Nature of Business	Signages provided and the sufficiency of parking during all seasons	
		Percent Responding	
		Signages Indicated	Sufficiency Sufficient
Surface Parking	Hospital (N=3)	-	66.7
	Wedding Hall(N=1)	-	-
	Hotels (N=5)	60	80
	Garment Shop (N=5)	40	20
	Home accessories (N=2)	-	-
	Grocery (N=4)	25	25
	Jewelry (N=1)	-	100
	Multi purpose (N=2)	50	100
	Office (N=1)	-	100
Under Ground parking	Hospital (N=1)	-	100
	Garment Shop (N=4)	50	25
	Grocery (N=2)	50	50
	Jewelry (N=2)	-	50
	Multi purpose (N=1)	100	100

According to Shoba (2006), it is necessary to put up a sign board indicating the location of parking spaces for different types of vehicles. Provision of proper signages to enable the driver to park appropriately and accommodating as many vehicles during peak seasons have become unwritten mandates in the evaluation of parking spaces. On observation, it was found that the signages provided were not to the expectation of the users in finding the parking lots. Only 60, 40, 25 and 50 per cent of hotels, garment shops, grocery and multi purpose stores respectively had reported to have placed signages at required places in surface parking. Hospitals, wedding hall, home accessories and grocery had not given proper signages which help the driving persons to locate the car destination. In underground parking multi purpose buildings alone had provided signages followed by few in garment shop and grocery.

In all the multi purpose buildings, jewelry and offices the parking space provided was sufficient during all the times. Other than wedding hall and home accessories shop others tried little to satisfy the sufficiency requirements for parking in their places.

6. Ergonomic Factors Considered for User- friendliness: Consumers or users are the king in the market scenario. Whatever they feel as convenient goes. Their comfort is of prime importance. Anything that can be described as

user-friendly can also be said to be ergonomic. Things that are unfriendly are not ergonomic. Hence this part of the study analyses the feelings of consumers about the parking spaces provided to them. The various ergonomic factors like internal temperature, noise level, air quality, ventilation, flooring and safety aspects were observed and recorded with the help of concerned *measuring instruments* in the selected sample buildings.

- a. Internal Temperature
- b. Noise Level
- c. Adequacy of Lighting
- d. Air Quality and Ventilation Maintained
- e. Quality of Flooring
- f. Safety Considerations

a. Internal Temperature: This is an important ergonomic issue as the interest and comfort felt to use a place depends upon the temperature maintained within the enclosure. If not always at least at some point of time the owners of the buildings should be able to provide optimum temperature. Table portrays the true picture.

Table 15. Maintenance of Internal Temperature

Type of Parking service	Nature of Business	Level of temperature*		
		Percent Responding		
		86 – 90 ⁰ F	90 – 94 ⁰ F	94 – 98 ⁰ F
Surface Parking	Hospital (N=3)		33.3	66.7
	Wedding Hall (N=1)	100		
	Hotels (N=5)		60	40
	Garment Shop (N=5)		60	40
	Home accessories(N=2)		100	
	Grocery (N=4)		25	75
	Jewelry (N=1)		100	
	Multi purpose (N=2)	50	50	
	Office (N=1)		100	
Under Ground parking	Hospital (N=1)		100	
	Garment Shop (N=4)		50	50
	Grocery (N=2)		50	50
	Jewelry (N=2)		100	
	Multi purpose (N=1)	100		

*(Optimum temperature: 70 – 75⁰ F)

As surface parking is beyond control of the building owners it was inevitable that the consumers had to face the ambient temperature. But, enclosed spaces are different; there the temperature could be controlled and maintained at an optimum temperature 70 – 75⁰ F. But in all the surveyed sample buildings the temperature that prevailed ranged from a minimum of 86⁰F to a maximum of 98⁰F and it varied from time to time and from place to place. Either because it is only the vehicles that stay there or that users

occupy the space only for minimal time, due consideration was not afforded to this matter. The ease with which people use them depends largely on temperature control as many of the buildings function on conditioned air (AC), and once out of it the difference in temperature can have health impacts.

b. Noise level: This is another factor contributing to consumer's feelings of comfort and user – friendliness.

Table 16. Noise Level Maintained

Type of Parking Service	Nature of Business	Level of Noise (in dB)*						
		Percent Responding						
		40-50	40-55	50-60	60-70	65-75	70-80	75-85
Surface Parking	Hospital (N=3)	33.3			33.3			33.3
	Wedding Hall (N=1)							100
	Hotels (N=5)				20	40	20	20
	Garment Shop (N=5)			20	20	20	20	20
	Home accessories (N=2)		50	50				
	Grocery (N=4)	25			25		25	25
	Jewelry (N=1)						100	
	Multi purpose (N=2)		50		50			
	Office (N=1)				100			
Under Ground parking	Hospital (N=1)							100
	Garment Shop (N=4)	25		25		25	25	
	Grocery (N=2)	50					50	
	Jewelry (N=2)			50			50	
	Multi purpose (N=1)				100			

*(Optimum noise level: Upto 85 dB)

Surface parking especially in essential services buildings were prone to high levels of noise pollution as is evident from the study. In both the surface and underground parking the noise level ranged from a minimum of 40 dB to a maximum of 85 dB which shows that it had not exceeded the threshold level of the using public. In most of the buildings an average of 60-70 dB was recorded followed by 75-85 dB where noise of the vehicles contributed to the maximum.

c. Adequacy of Lighting: Yet another factor in the ambience that can contribute to user friendliness of a space is adequate lighting. Table gives details on the lighting provided in the selected parking spaces.

Table 17. Adequacy of Lighting provided

Type of Parking Service	Nature of Business	Type and level of lighting provided						
		Percent Responding						
		Artificial lighting			Level of Lighting***			
		I**	F**	LED	Excellent	Good	Average	Poor
Surface Parking	Hospital (N=3)		100			33.3	66.7	
	Wedding Hall (N=1)		100				100	
	Hotels (N=5)	40	40	20		100		
	Garment Shop (N=5)		60	50		40	40	20
	Home accessories (N=2)		50	50		50	50	
	Grocery (N=4)	25	50	25	25	25	25	25
	Jewelry (N=1)		100				100	
	Multi purpose (N=2)	50	100		50	50		
Under Ground parking	Office (N=1)			100			100	
	Hospital (N=1)		100			100		
	Garment Shop (N=4)		100	50			75	25
	Grocery (N=2)		100					100
	Jewelry (N=2)		100				100	
	Multi purpose (N=1)		100				100	

*Multiple Response ** I – Incandescent, F – Flourescent; ***Optimum – 50 Lux

In surface parking multi purpose shops (50%), hotels (40%) and grocery (25%) were found to be using incandescent bulbs, while in rest of the buildings flourescent tubes and LED lighting were used in the parking areas. Hotels (20%), all offices (100%), home accessories and garment shop (50%) and grocery (25%) promoted use of LED lighting as a welcome decision in energy conservation. In underground parking all the buildings used flourescent bulbs and 50 per cent of garment shops also used them along with LED lights. It is highly encouraging that the owners had understood the benefits of LED lighting both for personal as well as National cause.

Except in a majority of places like wedding hall, jewelry and office, lighting was found to be good and excellent. The lighting provided in all other areas were found to be either average or poor. Except hospital all the parkings had been rated either average or poor in underground facilities, This is a very discouraging finding because for parking especially in basements adequate lighting for proper visibility, prevention of accidents and safety/security issues holds priority – a factor pointing to poor **ergonomic designing**.

d. Air Quality and Ventilation Maintained: This aspect of the study pertains to maintenance of fresh air, circulation and ventilation, prevention of dampness within the interior of the parking space, the data on which is described in the Table overleaf

Table 18. Air Quality and Ventilation Maintained

Nature of Business	Factors that affect the efficiency of the under ground parking area				
	Percent Responding				
	Circulation of fresh air	Dampness	Ventilation	If yes, method used	
Windows/ Openings				Mechanical ventilation	
Hospital (N=1)	100	100	100	100	
Garment Shop (N=4)	75	75	25	100	
Grocery (N=2)	50	100	50	100	
Jewelry (N=2)		100	50	100	
Multi purpose (N=1)	100	100	100		100

In parking spaces provided by all the jewelry shops, provision for circulation of fresh air (air movement) was found to be absolutely lacking. Fifty and 25 per cent of grocery and garment shops also had not given heed to this important ergonomic factor in their parking spaces. Especially in enclosed environment like underground parking facility, provision for air movement is mandatory. This study had proved that among the selected buildings there were those which are not safe in terms of human comfort, health and hygiene. As restricted air movement can contribute to stale smell and microbial/fungal growth it may affect the respiratory system, breathing mechanism, at the least on those using the spaces for parking. It may also affect the health of especially multi tasking staffs.

Except in 25 per cent of garment shops, in all other buildings treatment was being done to control the dampness in the parking lots. In garment shop (75%), grocery (50%) and jewelry (50%) provision was not made for ventilation; rest of the buildings had provided windows and openings to serve the purpose where as in 100 per cent of hospital and multi purpose buildings provision was made through window/opening and mechanical ventilation respectively.

e. Quality of Flooring provided: This is another aspect that contributes to customer comfort in driving. Table gives the relevant data

Table 19. Quality of Flooring Provided

Type of Parking service	Nature of Business	Type of flooring				
		Percent Responding				
		Concrete	Cement	Pavement	Tar	Without laid flooring
Surface Parking	Hospital (N=3)		33.3	33.3		33.3
	Wedding Hall (N=1)		100			
	Hotels (N=5)			60	20	20
	Garment Shop (N=5)	80	20	20		40
	Home accessories (N=2)			100		
	Grocery (N=4)	50		50		
	Jewelry (N=1)		100			
	Multi purpose (N=2)			50	50	
	Office (N=1)		100			
Under Ground parking	Hospital (N=1)			100		
	Garment Shop (N=4)	75	50	25		
	Grocery (N=2)		100			
	Jewelry (N=2)		100			
	Multi purpose (N=1)		100			

In surface parking only hotels and multi purpose buildings had thought of providing good flooring with pavement and tar. Garment shops and grocery too provided concrete flooring. In hospitals, hotel and garment shops parking lots especially surface parking were without a laid flooring. Despite providing a space for parking, the study proved that providing level surface was yet to gain significance. Except hospital and garment shop with pavement flooring rest of the others were laid with cement flooring in underground parking. As these floors are supposed to be non – slippery, yet provide the necessary friction, this gains considerable significance. Unfortunately due respect was not accorded to it.

f.Safety Factors: Safety is an important issue in any building. Surface parking in hotels and grocery stores were not found to have bothered with incorporating safety aspects. Similarly, grocery stores alone did not give heed to this factor in their underground parking spaces too. Ultimately customers bore the brunt as they reported of minor accidents and scratches and dents in their vehicles.

Overall, the parking spaces provided by none of the buildings studied attempted to satisfy the consumer to the fullest extent. All had some discrepancy or the other which could contribute to their dissatisfaction. Many of them could even be rated poor.

Limitations like insufficient parking spaces, poor lighting facility, and cramped area were but a few factors observed. The survey revealed that the main limitation with underground parking was the poor lighting done. Those buildings which had served for more than a decade lacked sufficient parking spaces itself. High ramp angle also can be commented upon as a major drawback.

B. Paradigm Shift in Parking – Innovative Kinetic Systems

This part of the study focused on deriving information about the innovative kinetic parking systems installed in various buildings. The data obtained is analysed and presented under the following broad headings:

1. **Vignette on the Four Types of Innovative Kinetic or Automated Parking Systems**
2. **Innovative Kinetic Parking systems in the City: an Introduction**
3. **In-situ Comments from Providers**

1. Vignette on the Four Types of Innovative Kinetic or Automated Parking Systems

Box 9

Automated parking has many advantages over conventional parking, including:

- Improved peak-hour handling capacity
- Environmental friendliness — cars do not idle in the parking bay
- Absence of harmful smoke emission reduces ventilation requirements.
- Secure parking — no dents, damage or vandalism
- Reduced infrastructure cost where space is at a premium
- Handles high-traffic volume better, saving driver time
- Provides fully integrated parking and retrieval functions
- Reduced traffic congestion
- Creates parking spaces where conventional parking does not permit high density, requiring less space and providing 50 per cent more slots
- Automated parking entrance afford reduced lighting requirement.
- Use of radio-frequency identification (RFID) technology makes the system user friendly and saves registration time.
- Higher depreciation on investment as finding a parking space in cities is posing more of a challenge.

A short introduction to the four different types of innovative kinetic parking systems incorporated in various buildings rendering essential services and commercial operations are depicted as **individual vignettes**.

In addition to addressing our existing needs, Intelligent kinetic systems will expose new programs and forms as this technology is incorporated into one's everyday lives. One of its specific application may include automobile-parking solutions. Intelligent kinetic systems are an approach for utilizing technology to create architecture that addresses today's dynamic, flexible and constantly changing activities

Box 10

Kinetic systems are physical constructions consisting of moveable interconnected parts that can rearrange their relative positions, according to demand, either manually or through feedback control systems resulting in an overall change of the physical configuration of the structures states, Yiannoudes (2016).
(http://echo.iat.sfu.ca/library/fox_kinetic_systems.pdf)

Puzzle parking

The system works like a “numbers puzzle” game in which there is one empty location. At least one cell must remain vacant to allow pallets to be shuffled around to gain access to the vehicle that is being retrieved. The computer controlled system operates by moving pallets on a cushion of air. They also track the location of each vehicle and work around in order to move the cars to the exit in the shortest and fastest way. The computer software allows simultaneous movement of pallets within the system, so multiple cars can be retrieved simultaneously, opines Chrest et al (2001).

The puzzle parking system works on principles similar to those of the “word puzzle” game. The lower pallets move laterally and the upper pallets move vertically (in the case of two stage puzzle parking systems) and laterally and/or vertically. With this type of arrangement, it is possible to park or remove any car from the parking system without taking another parked car out. The system is easy to operate due to its simple construction. It is possible to use various combinations to adapt to restricted spaces. It can be installed in driveways, basements and rooftops. It is also very economical to operate and maintain, and it takes under 2 min. to park or remove a car from the system. The puzzle parking system is as versatile as it is modular and can be installed progressively when the need for additional parking arises (Kileda, 2011).



**PUZZLE
PARKING**

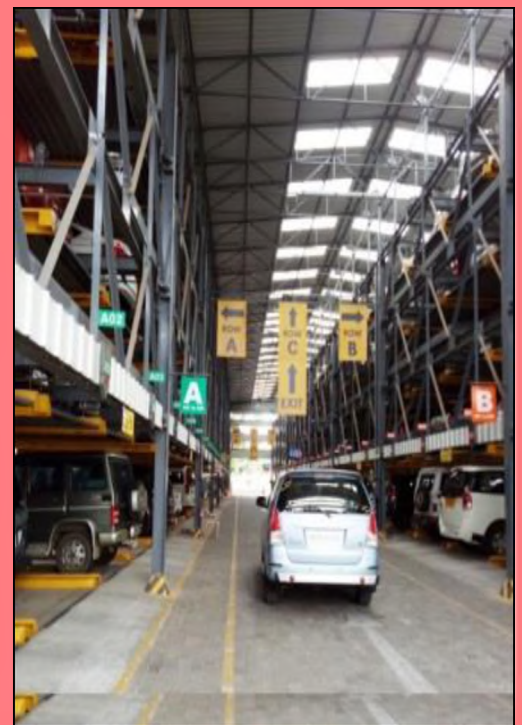


Exhibit 6. Puzzle Parking

VRS - Vertical Rotary System

According to Chrest et al (2001), this system consists of a steel tower with a conveyor that lifts vehicles in a narrow circular loop up one side and down the other. The rotary model is specifically designed to accommodate multiple cars in the horizontal space of two cars and can hold a greater number depending upon the requirements of the user and can be effectively used in space crunched areas. This system consists of a steel tower with a conveyor that lifts vehicles in a narrow circular loop up side and down the other. The idea behind this innovation is to park and take out the cars with no disturbance to the already parked cars in the rotary car parking system states, Patel et al (2015).

Vertical Rotary System



Plate 7. Vertical Rotary System (VRS)

Stacked System

This is the economical and simple parking solution for new buildings or existing ones where parking can be doubled. This parking system can be operated by hydraulic or mechanical action. Various variations of the system is available such as two level stack car parking (G+1), three level stack car parking (G+2) and pit level car parking. In both the two and three level stack car parking, one car is parked on the ground floor, and the another one on the first level and the third car on the second layer in two and three stack system respectively. The car on the ground level will need to be moved out before parking /removing the car on the raised platform.

(<http://www.hydraulicjackind.com/pdf/final%20brochure%20%20BROCHURE.pdf>).

Stacked Parking



Plate 8. Stacked Parking

Car lift system

Car lift is a simple mechanical parking mechanism that can be installed in multi-storey car parks to replace the function of ramps, because of lack of space. The lift transports the vehicle with driver to the chosen level, states, Kister (2012). This system is accommodated in basement level, hence could facilitate parking in both ground and level 1. Unlike other systems each pallet in this system was fabricated to the maximum of 9'x16'. Among the four, for car lifting the builders had to provide double the roof height in order to lift the car from one level to the other. It is the only semi automatic system operated manually in case there is power failure.



Plate 9. Car Lift

2. Innovative Kinetic Parking systems in the City: an Introduction

Details on the four types of innovative parking systems in use are delineated below.

a) Puzzle Parking Facility in Selected Buildings

This type of parking was provided in a hospital, office building and a garment shop. By virtue of inflow, the hospitals had allocated more than 20,000 sqft for installing the system followed by garment shop providing more than 10,000 sq ft. For offices an installation occupying less than 10,000 sqft was found sufficient. Puzzle parking was found to be flexible enough for being installed in the open space or within the structure of a building. This method facilitated parking in many levels like ground with level 1 and or level 2 and even more. Hence parking provisions was quite satisfactory. Size of pallets ranged at 7'x15', which is quite sufficient to park any car. The clearance provided also was above 1' 6" enabling ease in manoeuverability. Headroom of 7' – 10' was required for efficient use. It is fully automatic, with provision for a generator when in need.

Average number of cars parked in a day was upto 100 in hospitals and upto 150 in garment shops. In offices it was found to be less than 50. Nevertheless the office and garment shop buildings had extended space for parking upto 100 cars at a time. Hospitals were more generous and had provided for parking more than 100 cars at a time.

Puzzle parking had four decks apart from the ground level. It afforded parking of all types of cars, namely, hatchback, sedan, MPV, MUV and convertibles in all decks inclusive of ground level. SUV's alone were parked only in ground level. Being a horizontal system in a circular pattern as the number of decks increased, the cars that could be parked at a time also increased; hence this was found to be more efficient. Along with that this type was also found to cost exorbitantly for installation. Maintenance was reportedly heavy as it required special cleaning devices over and above normal cleaning tools. Safety and security measures like car set in brake while parking, presence of human sensors, front/ back mirrors, close side mirrors and non brick construction added to their value. This has emerged as one of the **user –friendly parking system of the future.**

b) VRS- Vertical Rotary System in Selected Buildings

This is a fully automatic system, operated by generators during periods of emergency. The area covered for installing this system was less than 10,000 sqft. It was found to be constructed in the open space, adjacent to a building. Since this is a vertical stand alone type it could accommodate parking only in the ground level. Size of each car pallet was a standard 7'x 11'

with a clearance of one foot to 1'6". They were not customized. This type of parking needed only life size headroom (upto 7'). Along with pedestrian and driving lanes, these catered to ramps and turntable facilities to make access easier. Pedestrian and driving lanes were provided for easy access. The system is fully automatic, yet yielding to operation using a generator during emergency.

This system provided in offices and garment shop had provisions for accommodating only 50 cars. The capacity was the same at all times. As this is a stand alone type it catered to parking only vertically in different decks as provided by the fabricators. All cars except SUV's were found to be accommodated. The cost factor pointed this type to be exorbitant, yet maintenance too with simple cleaning tools sufficed.

This system had incorporated five safety/ security measures like car set in brake while parking, presence of human sensors, front/ back mirrors, close side mirrors and non brick construction. All these added to their value. This also has emerged as one of the **user –friendly parking system of the future.**

c) Stacked Parking in Selected Buildings

Garment shop alone was found to adopt this system. The system required only a space less than 10,000 sq ft. This system was accommodated in basement level, hence could facilitate parking in both ground and level 1. They were not customized. stacked parking required only life size headroom (upto 7'). In this system too pedestrian and driving lanes sufficed for ease in access. It is a fully automated device, which can also function on a generator during emergency. These provided adequate space to park only less than 50 cars at a time. This stacked all cars in two levels, except SUV's. Cleanliness in this parking type was found to be quite easy.

This system had two important safety measures incorporated, presence of an indicator showing improper parking and the absence of brick constructions which added to the dependability of the system among the public.

d) Car Lift in Selected Building

This system was provided as an additional parking space by a garment shop. It required only a space less than 10,000 sq ft. Along with pedestrian and driving lanes, ramps were also incorporated to make access easier. It was funny to see all cars, except SUV's to be parked in Basement 2 of the parking lot. This type costed very inexpensive for installation and at the same time was the one most difficult to clean and maintain. Provision for ramp grip and absence of brick construction made this system quite popular.

3. In-Situ comments from Providers

➤ **Site and Type:** One hospital, two offices and three garment shops had adopted the systems. While hospital had installed VRS, offices had both VRS and puzzle parking. There were three garment shops which had installed all the four types.

Four types of innovative parking systems surfaced as being put to practice in the selected sites namely VRS, puzzle, stacked and car lift. Exhibits (6) to (9) portray the varied types. Among them puzzle parking, followed by VRS were found to be more popular. The financial year of 2014-2016 had witnessed the emergence of this innovative endeavour, namely puzzle parking in the selected city. It was evident that stacked and car lift systems and stand alone systems were installed only in 2015 and 2016. The system had picked up good momentum within three years in the city, is quiet an encouraging aspect.

➤ **Space Requirement:** Table gives details on the same

Table 20. Space allocated for accomodating the systems

Nature of business	Type of Innovative Parking	Percent Responding					
		Number of floors allotted for parking in the building			Number of parking levels in the parking system		
		Ground floor	B 1**	B 2**	Ground floor	Ground + level 1	Ground + level 2
Hospital (N=1)	Puzzle parking	100					100
Office (N=2)	VRS (stand alone)	50			50		
	Puzzle parking	50					50
Garment Shop (N=3)	VRS (stand alone)	33.3			33.3		
	Puzzle parking	33.3					33.3
	Stacked parking		33.3			33.3	
	Car Lift			33.3		33.3	

*Multiple Response **B 1 – Basement 1, B 2 – Basement 2

The survey revealed one important aspect. VRS type was installed in an open space adjacent to the building. All others were found to be a part of the structure, though puzzle parking also accomodated construction in the open. Despite provision made in one or two basements, puzzle parking mainly could accommodate parking of cars in more than one level vertically (upto four) along with ground level. Similarly stacked and car lift too permitted upto ground and over basement level. It is clear that in general, puzzle system accomodated various levels of parking.

➤ **Logistics of Installation :** All four models were company fabricated with provision for car pallets in standard dimensions. They were not customized. VRS and stacked parking required only life size headroom, while puzzle parking required 7' – 10' headroom. Among the four, for car lifting the

builders had to provide a height of 10' – 12' headroom to accommodate cars while lifting them.

While in all the other types, pedestrian lanes and driving lanes were common features, in car lifting and VRS alone ramps were an addition. To accommodate ease in driving out, turn table was provided in VRS system alone. All the systems except car lifting, which was semi automatic, others operated as fully automatic devices, controlled during power failures too using a generator. Car lifting was done manually in case of emergency. All cars except SUV's were found to find a comfortable space in all levels and decks provided by all the four systems.

All the spaces provided were reported to be sufficient except in car lifting. In both puzzle and VRS parking provided by office buildings, and stacked system provided in garment shops users reported that proper signages were a felt lacuna.

➤ **The Cost Factor:** This aspect being an important criterion is tabulated as under:

Table 21 .Cost of Construction

Nature of Building	Type of Innovative Parking	Percent responding				
		Cost of single pallet		Total cost of the parking		
		1 – 2	2 - 3	< 10	10 - 50	> 50
Hospital(N=1)	Puzzle Parking	100				100
Office(N=2)	VRS (stand alone)		50		50	
	Puzzle parking	50				50
Garment Shop (N=3)	VRS (stand alone)		33.3			33.3
	Puzzle parking	33.3				33.3
	Stacked parking	33.3			33.3	
	Car lift	33.3		33.3		

*Multiple Response

The cost of construction rather depended on the number of pallets to be incorporated. For single pallet except VRS which costed between two and three lakhs, others were available between one to two lakhs per pallet. Comparatively VRS emerged as the most expensive. Similarly as puzzle parking boasted of greater capacity (more than 100 cars), the cost of installation of puzzle parking also was found to be heavy. As expected VRS and puzzle parking were found to have been installed at an exorbitant cost exceeding even 50 lakhs. Among the four, car lift emerged as the least expensive.

Maintenance Factor: This part of the study analyses the methods of servicing and the mechanical components are explained in the next Table.

Table 22. Maintenance Factor

Nature of Building	Type of Innovative Parking	Frequency and nature of servicing the mechanical components					
		Percent responding					
		Frequency of servicing			Nature of service		
		weekly	monthly	quarterly	Dusting	Greasing/ lubrication	Repairing the working parts
Hospital(N=1)	Puzzle parking		100			100	
Office(N=2)	VRS (stand alone)		50		50	50	
	Puzzle parking		50		50	50	50
Garment Shop (N=3)	VRS (stand alone)	33.3				33.3	
	Puzzle parking		33.3		33.3	33.3	
	Stacked parking		33.3		33.3	33.3	
	Car lift			33.3		33.3	

*Multiple Response

Mostly in all the parking spaces the mechanical components like ball bearing, chain drive, gear wheels, roller chain, shafts- main and counter and sprockets were serviced or overhauling done on a monthly basis whereas in one of the VRS system it was done weekly and in car lift servicing was done only quarterly.



Exhibit 10. The Mechanical Components

General maintenance services like dusting, greasing/ lubricating the mechanical components for their smooth run was done in all the four types of systems regularly. Repair / replacement of the working parts was reported in puzzle parking alone. In all the parking systems the operation/handling and the functioning of the parking facilities seemed to be handled with ease.

➤ **Ergonomic factors considered:**

(a). Temperature and Noise: This aspect of the study is explained under Table

Table 23. Temperature and Noise

Aspect considered	Particulars	Percent Responding						
		Type of parking						
		Puzzle			VRS		Stacking	Car lift
		1	2	3	1	2		
Temperature (in °F)	86-90	100						
	90-94		50	33.3	50		33.3	
	94-98					33.3		33.3
Noise level (in dB)	50-60							33.3
	60-70				50	33.3		
	65-75						33.3	
	70-80	100	33.3					
	75-85			50				

Hospitals having puzzle parking among the essential services buildings recorded the minimum temperature that ranged from 86 – 90⁰ F. In commercial buildings like offices, temperature in VRS (50%) and puzzle parking (50%) were found to be within 90 – 94⁰ F. Likewise puzzle and stacked parking in garment shop, also recorded from 94 – 98⁰ F. It is known from the study that the temperature in all the parking systems ranged above the optimum temperature of 70-75⁰F.

Carlift has been recorded as the least noise producing when compared to the other systems and the maximum level was reported in the puzzle parking. In all spaces the noise level ranged only within the optimum level of noise that a human ear could bear.

(b).Provision for Lighting: The details are presented in the Table

Table 24. Provision of Lighting

Nature of Building	Type of Innovative Parking	Nature and type of artificial lighting provided			
		Percent responding			
		Nature of lighting		Type of artificial lighting	
		Artificial lighting	Natural and artificial lighting	Flourescent lights	LED Lights
Hospital (N=1)	Puzzle parking		100	100	
Office (N=2)	VRS (stand alone)		50		50
	Puzzle parking		50	50	
Garment Shop (N=3)	VRS (stand alone)		33.3	33.3	33.3
	Puzzle parking		33.3	33.3	33.3
	Stacked parking		33.3		
	Car lift	33.3		33.3	

Except car lift parking, which depended extremely on artificial lights, others were found to have made provision for entry of natural light too which could not only provide for a natural ambiance but also effect saving on electricity.

Unfortunately only a few samples had provided LED lighting which could further reduce energy use in the system. All others used flourescent lights. This aspect evidently requires further attention. Despite provisions made for lights 50 and 33.3 per cent in office and garment shops who had installed VRS felt that the lighting provided were not good and satisfied only on an average. Efforts to improve lighting in these areas can be attempted.

(c) Flooring Provided: This aspect is presented under Table

Table 25. Flooring Provided

Nature of Building	Type of Innovative Parking	Type of flooring		
		Percent responding		
		Concrete	Cement	Pavement
Hospital (N=1)	Puzzle parking	100		100
Office (N=2)	VRS (stand alone)		50	
	Puzzle parking	50		
Garment Shop (N=3)	VRS (stand alone)	33.3		
	Puzzle parking	33.3		33.3
	Stacked parking		33.3	
	Car lift	16.7		

*Multiple Response

Though in many of the systems, concrete was the flooring used, cement flooring was preferred for VRS and stacked parking in more sites. For puzzle parking concrete flooring was required in the construction area and leads by pavement in the driveway and aisle.

(d) Safety Features Looked into: This aspect is discussed under Table

Table 26. Safety Features Found Present

Safety Features	Stated as present			
	Puzzle	VRS	Stacking	Car lift
Car set on brake	✓	✓	-	-
Human sensors	✓	✓	-	-
Front/ back mirror	✓	✓	-	-
Close side mirror	✓	✓	-	-
Indictor (showing improper parking)	-	-	✓	-
Ramp grip	-	-	-	✓
Non - brick Construction	✓	✓	✓	✓

Seven different safety measures, as portrayed in Exhibit (11) have been devised to ensure safety when parking cars among which puzzle and VRS system utilized major five each. Only two aspects were considered by the other two.



Exhibit 11. Safety measures incorporated

(e) Satisfaction Derived with the Options: VRS parking ranked high in satisfaction and it was rated to be very good while puzzle parking users had

mixed feelings, with one half stating it to be average. Stacked and car lift were found to be reported as good. Among the four VRS had procured confidence and acceptance among the user public.

(f) User-friendly Aspects Identified; Table illustrates the pointers which have made the systems acceptable by users

Table 27. User-friendly Aspects Identified

User-friendly Aspects	Types identified as user-friendly			
	Puzzle	VRS	Stacking	Car lift
Space saving	✓	✓		
Secured parking	✓	✓	✓	
Less dependent on other parking	✓			
Time saving	✓	✓		
Intelligent system	✓			
Low cost			✓	✓
Good performance	✓	✓		
Demands regular maintenance	✓			
Nice and welcome concept	✓	✓		

All the providers were found to have very positive comments for all the parking systems. All the puzzle and VRS parking users reported that the system helped to save space. More than one half of them reported that the system offered security to the parked vehicles in puzzle, VRS and stacked parking respectively. Negligible response on not depending on other types of parking like on-street etc, saving on time, intelligent parking system and of low cost were also reported. Both puzzle and VRS systems also received appreciations for their good performance and for being nice and welcome concepts. The innovativeness through kinetics was found to be laudable, by the providers.

(g) Apprehensions Expressed: From the study it was clear that puzzle parking required a lot of initial investment, continuous maintenance, and SUV cars could be parked only in the ground level. Almost 66.7 per cent had reported that the parked cars could not be retrieved till the generator (back up) started up in the absence of electricity and 33.3 per cent opined these as expensive technology. Noise was reported in puzzle parking. Waiting for the cars to be retrieved by the customers was reported as a limitation by 50 and 100 per cent of VRS and car lift providers respectively.

C. Customer's Pulse

The success of any facility provided for public use, gains significance and popularity among users based on customer's acceptance and its **user friendliness**. **Customers are individuals who use an agency's facilities or seek services from an agency**, state, Stein and Sloane,(2003). To know the feel of the customers, a survey of 100 users benefiting from these facilities, namely parking spaces, was done. The responses received from the customer survey revealed the following which are discussed under:

1. **Customer Profile - Users of the Facilities**
2. **Reflections on Conventional Parking Facilities**
3. **Impressions on Innovative Kinetic Parking Facilities**

1. **Customer Profile - Users of the Facilities:** The findings on this aspect of the study is presented under Table

Table 28. Customer Profile - Users of the Facilities

Sample surveyed	Type of parking experienced		
	Surface	Basement	Multi level
Public Sector Employees (<i>PSE</i>) (N=30)	100	100	50
Professionals (<i>P</i>) (N=28)	100	100	46.4
Businessmen (<i>BM</i>) (N=19)	100	100	47.3
Homemakers (<i>H</i>) (N=14)	100	100	-
Students (<i>S</i>) (N=9)	100	100	66.7

Among users, public sector employees and professionals responded more than businessmen, homemakers and students. A customer is the recipient of one or more of a process's specific outcomes (Shaw, 2011). To this effect, obviously, there appeared three types of parking spaces, namely surface parking, basement and multi level parking. While surface and basement were patronized by all, the third type was used by 45 - 68 per cent belonging to all other categories of users except homemakers. Another important feature was that preference for multi level was comparatively less.

2. **Reflections on Conventional Parking Facilities:** This part of the findings is discussed under the following headings:

- a) **Parking Space and Accomodation Provided**
- b) **Sufficiency of Parking Space**
- c) **Ergonomic Aspects Found Satisfactory**
- d) **Cost of Parking**

a) **Parking Space and Accomodation Provided:** Table explains concerned data

Table 29. Parking Space and Accomodation Provided

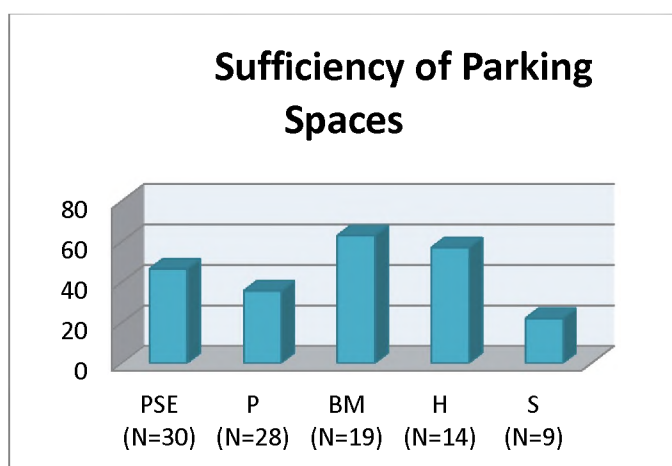
Status of people	Allocated area to park the vehicle	Vehicle fitting in the marked space	Space between each parked vehicle				
	Marked	Yes	E*	V.G*	G*	A*	P*
PSE (N=30)	83.3	83.3	3.3	30	36.6	20	16.6
P (N=28)	100	96.4	3.5	7.1	46.4	17.8	7.1
BM (N=19)	100	89.5	10.5	15.7	36.8	26.3	10.5
H (N=14)	85.7	85.7	14.2	35.7	21.4	14.2	14.2
S (N=9)	88.8	100		11.1	33.3	33.3	22.2

*E – Excellent, V.G – Very Good, G – Good, A- Average, P – Poor

While professionals and businessmen agreed that the facilities were earmarked properly, ‘the parking spaces’ for vehicles, only 85-89 per cent of the others agreed. When students accepted that they could fit their cars within the allotted spaces, not all the others agreed. The space provided between each parked vehicle was also reported only as good by majority of the users. Irrespective of their status, many reported that to be even poor and inadequate.

b) **Sufficiency of Parking Space:** Findings on this issue is depicted in Table

Figure 11. Sufficiency of Parking Space **Table 30. Sufficiency of Parking Space**



Sample	Percent stating as sufficient
PSE (N=30)	46.6
P (N=28)	35.7
BM (N=19)	63.1
H (N=14)	57.1
S (N=9)	22.2

Except businessmen (63.1%) who responded in a larger proportion as sufficient to park their vehicles and homemakers who also found it sufficiently comfortable, the other groups expressed insufficiency felt with the spaces allotted for parking. Hence the **demand-supply balance** as explained in Review of Literature does not get satisfied.

c) Ergonomic aspects considered: Ergonomics is defined as the scientific discipline concerned with understanding of the interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design, in order to optimize human well-being and overall system performance (Duland Weerdmeester, (2008). This aspect of the study therefore analyzes the customers feel on the following lines

- i. Ambience Provided**
- ii. Treatment Given in Parking Space Interiors**
- iii. Signages Provided**
- iv. Ease with Process of Parking**
- v. Access Providers**
- vi. Gradient (slope) of Access Points**

i. Ambience Provided: Details regarding this are explained under the following headings:

- *Facilities Contributing to Efficient Parking**
- **General Concepts Considered**

***Facilities Contributing to Efficient Parking:** This part of the study dealt with satisfaction evinced by users on lighting, ventilation and air quality prevalent in parking spaces that they frequented (Table)

Table 31. Facilities Contributing to Efficient Parking

Ambience Provided	Level of Satisfaction	Percent Responding				
		Status of People				
		PSE (N=30)	BP (N=19)	P (N=28)	HM (N=14)	S (N=9)
Lighting	E	6.6			14.2	11.1
	V.G	16.6	26.3	17.8	35.7	
	G	60	21	50	42.8	44.4
	A	16.6	26.3	25	14.2	22.2
	P		26.3	7.4		22.2
Ventilation	E	6.6			14.2	
	V.G	13.3	21	17.8	28.5	11.1
	G	60	21	39.2	14.2	33.3
	A	16.6	15.7	25	42.8	11.1
	P	3.3	42.1	17.8		44.4
Air Quality	E	3.3			14.2	11.1
	V.G	13.3	10.5	14.2	28.5	
	G	33.3	26.3	32.1	14.2	44.4
	A	40	36.8	32.1	35.7	22.2
	P	10	26.3	21.4	14.2	22.2

Only 40-60 per cent among all categories stated that the lighting provided was good. About 14-25 per cent even stated that it was poor. Regarding ventilation, the samples had mixed feelings. While 60 per cent of employees stated that to be good, it was rated poor by businessmen and students. Air quality too was rated average by a majority except 44.4 per cent of students who reported to be good. ***These factors which contribute to healthy ambience were not found to be satisfactory.***

****General Concepts Considered:** This aspect looked into the flooring and cleanliness maintained within the parking premises (Table)

Table 32. General Concepts Considered

Ambience Provided	Level of Satisfaction	Percent Responding				
		Status of People				
		PSE (N=30)	BP (N=19)	P (N=28)	HM (N=14)	S (N=9)
Type of Flooring	E	10	10.5	3.5	21.4	
	V.G	10		25	14.2	11.1
	G	66.6	73.7	42.8	64.2	66.6
	A	6.6	15.7	21.4		22.2
	P	6.6		7.1	14.2	
Cleanliness	E	3.3			19.2	
	V.G	13.3	21	32.1	35.7	11.1
	G	40	47.3	28.5	21.4	44.4
	A	36.6	10.5	32.1	28.5	11.1
	P	6.6	21	7.1		33.3

Acceptable maintenance includes keeping the facility free of refuse, debris, and litter, maintaining parking surfaces in sound condition and providing proper care of landscaped areas. Majority of samples from all the groups explained that the flooring provided was good (42-74%). Employees and Professionals (almost 7% each) stated that to be poorly laid. Nevertheless, many had opted to record that it was average. This being an important factor that decided the confidence with which one will be able to drive was not found to be given due consideration. According to standard stipulations the parking space should be provided on a paved, hard-surfaced, or gravelled drive way or pavement. . With regard to general cleanliness again, the samples differed. While 40-47 per cent of employees, students and businessmen stated it to be good, 32-36 per cent opined that it was very good. On the whole, the general ambience provided was not upto expectations.

ii. **Treatment Given in Parking Space Interiors:** This aspect of the study is presented under table

Table 33. Treatment Provided

Level of Comfort and convenience of the users (N=100)	Percent responding				
	Treatment Given				
	Sound Insulation	Under ground water Treatment	Damp Proof	Fresh Air Circulation	Fire Control devices
Excellent		2	1	8	4
Very Good	16	10	8	12	15
Good	34	31	46	30	63
Average	39	43	28	34	14
Poor	11	14	17	16	4

All treatments on the whole scored a rating only as good or average as recorded by 30 – 63 per cent of the samples, where 4 -17 per cent even rated it as poor.

iii. **Signages Provided:** Table below indicates the opinion of users about signages provided in the interiors of parking spaces

Table 34. Signages provided

Opinion on Signages provided	Percent responding				
	Status of people				
	PSE (N=30)	BM (N=19)	P (N=28)	H (N=14)	S (N=9)
Excellent	3.3	10.5	3.5	14.2	-
Very good	6.6	15.7	21.4	7.1	11.1
Good	70	36.8	39.2	64.2	44.4
Average	16.6	36.8	28.5	14.2	44.4
Poor	3.3	-	7.1	-	-

Providing proper signages is an important criterion in parking spaces; yet, signages provided to enable ease in locating vacant spaces and then parking was again reported by employees and homemakers as good (64 - 70%). Others stated it as good or average. This is a felt lacuna in Indian parking spaces, as the number of drivers and vehicles on road have increased only recently, unlike other countries where it had taken roots quite earlier.

iv. Ease with Process of Parking: This aspect of the study is explained through Table

Table 35. Ease with Process of Parking

Process in Conventional Parking	Percent responding				
	Status of People				
	PSE (N=30)	BM (N=19)	P (N=28)	H (N=14)	S (N=9)
Easy to park	43.3	36.8	32.1	21.4	55.5
Moderately hard	40	36.8	57.1	57.1	22.2
Hard		5.2	3.5		
Confusion	16.7	15.7	10.7	21.4	22.2

*Multiple Response

The convenience and comfort of parking stalls depends on two issues:

- ✚ The first is the width of the parking space and the convenience for people getting in and out of the automobile.
- ✚ The second is the ease of the turning movements required to park and unpark an automobile, which is determined by the module and the parking angle as well as the width of the parking space (Smith and Carville, 2016)

Box 11. Comfortable Parking Stalls

In this aspect too employees and students found it easy to maneuver while for others it was moderately taxing. Almost upto 10-22 per cent felt that the process of parking, the layouts given and angles of manoeuvrability was confusing in many of the parking spaces. As many of the drivers of late are

amateurs and take to the steering at a very young age, parking in a hap hazard way could also be a reason.

v. Access Providers: These depict the ways that can lead to and out of the parking space. Table (36) gives an insight into this aspect.

Table 36. Access Providers

Level of Comfort and convenience of the users (N=100)	Percent responding		
	Facilities Provided		
	Ramps	Driving Lane	Pedestrian Lane
Excellent	3	7	
Very good	16	9	
Good	31	40	14
Average	39	35	34
Poor	11	9	52

The driveways and access points are to be designed in such a way that each parking facility shall be accessed and to direct non-residential traffic away from residential areas. Ramps and driving lanes are major access points in any parking space. Ramps provided were rated average by employees, businessmen and professionals, while homemakers felt it as very good and the students as good.

Parking vehicles consumes considerable space and becomes quite a problem on a small site and warrant consideration of certain factors in planning parking spaces states, Spence (1972).

- + Providing sufficient space for each other. This should be as near to the door of the unit as possible.
- + Provision to park each car under cover, a carport is popular which is easy enough and permits the doors on both sides of the car and the trunk to be opened.
- + Clear labelling of the parking space to curtail dispute over who should use the space
- + Providing sufficient room for cars to manoeuvre.

Box 12. Factors in planning Parking Spaces

Many of them of course also rated it as poor. Regarding driving lanes too, the users felt it only as good at the most or as average. With regard to pedestrian paths which is an absolute necessity for drivers and commuters to reach their destined parking, was not given due importance. More than one sixth of the samples stated it to be poor. They were not set to standard specifications. Parking facilities shall be designed to provide visibility of and between pedestrians and vehicles when circulating, entering and leaving the facility. There should not be any blind, hidden or hazardous areas. Circulation patterns should be designed in accord with accepted standards of traffic engineering and safety. Evidently the **consumers did not find the access providers user friendly.**

Gradient (slope) of Access Points: Table presents the concerned data

Table 37. Gradient (slope) of Access Points

Gradient (Slope) of access points	Percent responding				
	Status of people				
	PSE (N=30)	BM (N=19)	P (N=28)	H (N=14)	S (N=9)
Higher angle leads to accident	26.6	10.5	25	14.2	22.2
Angle not be a problem	30	10.5	7.1	35.7	33.3
It should be noticed and reduced	26.6	31.5	21.4	14.2	44.4
No option due to lack of space to park	10	15.7	3.5		11.1
Are dangerous	3.3	5.2	7.1	14.2	
Standards should be followed	16.6	26.3	21.4	14.2	11.1
It is difficult	10			7.1	
Check for compliance of all standards before approval	16.6	5.2	21.4	14.2	11.1
It is convenient	3.3			14.2	

*Multiple response

Though many felt that the gradient at access points was an important factor which tested the experience and efficiency of drivers, general opinion was to have taken to what was offered as there was no go. Providers need to give this due consideration, and not take users for granted. However steeper angles were not found to be user friendly.

c) Cost – benefit Factor: This part of the findings is discussed under the following headings:

- i. Cost of Parking**
- ii. Safety Considerations**

i. Cost of Parking: Table presents details on the same

Table 38. Cost of Parking

Cost of parking	Percent responding				
	Status of people				
	PSE (N=30)	BM (N=19)	P (N=28)	H (N=14)	S (N=9)
Affordable	3.3	10.5	7.1	28.5	
Reasonable	46.6	42.1	60.7	42.8	77.7
Very expensive	50	47.3	32.1	28.5	11.1
Not worthy paying					11.1

Majority of the samples (40-77%) felt that parking fees charged was quite reasonable, while 28 – 50 per cent expressed as being expensive. A minority group among students reported that it was not worth paying as the providers had not given spaces for efficient parking. As many of the factors pointing to user friendliness were felt absent in these parking spaces, it would have brought out these expressions.

ii. Safety Considerations: Table gives the relevant data

Table 39. Safety Considerations

Safety Considerations	Percent responding				
	Status of People				
	PSE (N=30)	BP (N=19)	P (N=28)	HM (N=14)	S (N=9)
Excellent	3.3			14.2	
Very good	13.3	21	17.8	28.5	11.1
Good	40	47.3	39.2	14.2	44.4
Average	36.6	10.5	28.5	28.5	11.1
Poor	6.6	21	14.2	14.2	33.3

Safety aspects provided scored only as good or average ranking from the sample studied. It was pathetic to record many state that this was poorly provided leading to dissatisfaction among the samples. Thus the survey highlighted the dissatisfaction felt by the users on conventional parking systems, where they vented out all their pent up feelings about the same. Hence as these parking spaces were not rated high, hypothesis (1) is rejected.

3. Impressions on Innovative Kinetic Parking Facilities: This part of the findings is discussed under the following headings:

- a. Response Reflecting Acceptance
- b. Unique Features of Innovative Kinetic Systems
- c. SWOC Analysis – Benefits Vs Apprehensions

a. Response Reflecting Acceptance: Only 56.6 per cent among employees, followed by businessmen (47.7%), professionals and homemakers (35.7% respectively) and students (33.3%), stated that the innovative parking was convenient. Hence how far the concepts, the paradigm shift in parking systems was impressive was found out and are presented under Table

Table 40. Impressions on Innovative Kinetic Parking Systems

Pointers reflecting acceptance	Percent responding			
	Status of people			
	PSE (N=30)	BP (N=19)	P (N=28)	S (N=9)
It makes parking easy	13.3	15.7	3.5	11.1
Good Idea	36.6	57.8	35.7	22.2
Innovative Idea	10	15.7	10.7	11.1
More convenient	20	10.5	7.1	33.3
Has laid foundation for future needs	13.3	21	21.4	11.1
Extend provision in other busy commercial areas	10	15.7	3.5	
Very useful	3.3		7.1	
Not so good	3.3			
Time saving				11.1
Space conserving, but appreciable capacity	6.6		3.5	
No idea	16.6	21	28.5	11.1

*Multiple Response

Though not all the samples had experienced parking in these innovative kinetic systems, from hearsay and print media, they were able to record their comments. A majority accepted them as a good idea facilitating ease in parking and as a convenient system. None of the homemakers, unfortunately were aware about them. On the whole the rest of the samples welcomed the kinetic systems citing various positive points.

b. Unique features of Innovative parking systems: Table explains the concerned data

Table 41. Unique features of Innovative Parking Systems

Status of people	Percent responding		
	Unique features		
	Feasible	Saves space	Provide safety
	Yes	Yes	Yes
Private sector employees (N=30)	96.6	96.6	90
Business People (N=19)	100	100	89.4
Professionals (N=28)	100	100	85.7
Students (N=9)	100	100	55.5

The unique features as listed by the samples were its feasibility for ease in parking, novel idea, space saving technique and promise for safety of vehicles. These factors were recorded by almost 90 – 100 per cent of the samples.

c. SWOC Analysis - Benefits Vs Apprehensions

Various benefits accrued and apprehensions felt by the users of kinetic parking systems were evaluated by SWOC Analysis which is given below:



Exhibit 12. SWOC Analysis

Ultimately these innovative kinetic systems or automated systems have got the appreciation of the users as a user-friendly concept because they are a welcome change among commuting consumers. Hence the **alternative hypothesis (2) set for the study is rejected.**

V. SUMMARY AND CONCLUSION

Burgeoning population, lifestyle modifications, plenty of commercial and essential services vying with each other to render service to the consuming public coupled with mobility and cars and car drivers on the roads have urged in the need to offer commendable parking services. Demand – supply characteristics of this sector is unique in that any building constructed today has to provide for the service in any form. Evidently, as building owners lack adequate space to accommodate demands, they go in for varied options in off – street parking, both in conventional and innovative parking spaces in which the latter is kinetic. How far these services stand to user expectations and the extent of use and satisfaction felt with each type is a felt lacuna. Hence a micro – level study on “**Paradigm Shift Through Kinetic Parking Spaces in Commercial / Essential Services Buildings – An User Friendly Analysis**“ was launched in Coimbatore City. The findings of the study are summarized under the following phases

- I. Existing Conventional Parking Scenario**
- II. Innovative Kinetic Parking Systems in Vogue**
- III. User – friendliness of the Systems – User’s comments**

I. Existing Conventional Parking Scenario

- Among the sample buildings selected ten provided essential services and the rest 20 performed commercial functions.
- Hotels predominated followed by hospitals and wedding halls. Among commercial buildings garment shops stole the show as depicted by 30 per cent followed by grocery (25%) and multipurpose shops (15%).
- Those catering to home accessories, jewelry and offices were represented by only ten per cent each.
- **Off- street provisions made**
- Two existing off-street parking facilities were found to have been made by the selected sample.
- Among essential services, surface parking was most popular. In commercial buildings provision of both, surface and under ground parking found equal representation.
- Innovative parking was installed along with the surface and ground parking by both the groups of buildings, hospitals, grocery stores and office to be specific.

- Among essential services buildings, wedding halls were found to have a long standing (100%). The rest had been doing service only since 5-10 years and beyond.
- Among commercial type, many of the buildings were found to be in service for more than 10 to 15 years.
- In surface parking all multi purpose and office buildings along with hotels (60%), grocery (50%) and garment shop (20%) and in underground parking all multipurpose, 50 per cent of grocery and 25 per cent of garment shops had ear marked areas for parking following specific dimensions.

➤ **Parking volume**

- The space allotted extended from 7'x10' to a maximum of 8'x12'. These dimensions they agreed could accommodate all types of cars
- The head room provided was quite satisfactory (7' – 12') in almost all the buildings studied.
- Hospitals and hotels comparatively gave larger clearance space between vehicles in surface parking, while essential services provided only minimal (1' – 1'6") except garment, home accessories and multipurpose shops.
- In underground parking too clearance provided was comparatively less than the dimensions needed for free manoeuvrability by vehicles in all the places.
- Provision for ground level parking was very popular, while parking in ground floor and in basement (1) was prevalent in hospital, grocery and jewelry stores.
- Garment shops and multi purpose buildings had found space to provide more than two basements for parking.
- Evidently, the magnitude of business decided provision for parking made. At the most all buildings had made provisions to accommodate upto 50 cars at a time for parking, while hospitals among essential services buildings and garment, jewelry and grocery could accommodate upto 100 cars in one basement floor.
- Multi purpose buildings evinced interest to provide parking space for 50 – 100 cars at a time in basement (2) or (3). With the nature of job executed the allotment for parking also differed.
- Use of parking space was highest (more than 500 cars a day) in hospitals.
- Garment shop, grocery and multi purpose buildings were found to be filled up with more than 100 vehicles a day in both surface and underground parking. In all others it was less than 100 a day.
- Except hospitals, garment shops and multi purpose buildings provision for parking more than 100 vehicles at a time was found not to exist, both in surface and underground parking.

- Hospital and multi purpose building by virtue of providing surface parking could accommodate even above 200 vehicles at a time
- In all the buildings studied, their surface and underground parking lots were found to have been planned to accommodate all types of cars like hatch back, sedan, MPV/MUV, SUV and convertibles.

➤ **Egress and Ingress**

- Jewelry shops provided separate entry and exit in surface parking while others provided single entry – cum – exit.
- In underground parking multipurpose holdings offered separate entry and exit ways, while garment shop, grocery and jewelry had single ways.
- In surface parking pedestrian paths and ramps were additional aspects provided in places other than the wedding hall and home accessories shop.
- Even driving lanes were found to be missing in 20 per cent of hotels and garment shops.
- In underground parking all the elements like ramps, driving lanes and pedestrian lanes were commonly seen except in grocery, jewelry and multi purpose buildings.

➤ **Housekeeping**

- Nature of business definitely had a say in the ease with which the buildings could be maintained.
- In the sample buildings surveyed they had employed house keeping staffs and the general cleaning was done with necessary tools and equipments regularly.
- All the samples using underground parking stated to have found accessing the parking facility quite easily owners reported.
- Observation, revealed that the **signages** provided were not to the expectation of the users in finding the parking lots. Only 60, 40, 25, 50 per cent of hotels, garment shops, grocery and multi purpose stores respectively had reported to have placed signages at required places in **surface parking**. In **underground parking** multi purpose buildings alone had provided signages followed by few in garment shop and grocery

➤ **Ergonomic aspects found satisfactory**

Parameters like temperature and noise within underground/basement parking was measured using proper instruments.

- **Temperature:** In all the surveyed sample buildings the temperature that prevailed ranged from a minimum of 86⁰F to a maximum of 98⁰F and it varied from time to time and from place to place, well above the **optimum of 70 – 75⁰F**.

- **Noise:** In both the surface and under ground parking the noise level ranged from a minimum of 40 dB to a maximum of 85 dB which shows that it had **not exceeded the threshold level** of the user public.
- **Lighting:** In surface parking, multi purpose shops (50%), hotels (40%) and grocery (25%) were found to use **incandescent bulbs**, while in rest of the buildings **fluorescent tubes** and LED lighting were used in the parking areas.
 - ✦ Hotels (20%), all offices (100%), home accessories and garment shop (50%) and grocery (25%) promoted use of **LED lighting** as a welcome decision in energy conservation. In underground parking all the buildings used fluorescent bulbs and 50 percent of garment shops used them along with LED lights.
 - ✦ The lighting provided in all areas were found to be either **average or poor**. Except hospital all the parkings had been rated either average or poor in underground facilities.
 - ✦ This is a very discouraging finding because for parking especially in basements adequate lighting for proper visibility, prevention of accidents and safety/security issues holds priority – **a factor pointing to poor ergonomic designing.**
- **Air Quality and Ventilation:** In parking spaces provided by all the jewelry shops, provision for **circulation of fresh air (air movement)** was found to be absolutely **lacking**.
 - ✦ Fifty and 25 per cent of grocery and garment shops also had not given heed to this important ergonomic factor in their parking spaces. Especially in enclosed environment like underground parking facility provision for air movement is mandatory.
 - ✦ This study had proved that among the selected buildings there were those which are **not safe in terms of human comfort, health and hygiene.**
 - ✦ As restricted air movement can contribute to stale smell and microbial/fungal growth it may **affect the respiratory system and breathing mechanism** at the least on those using the spaces for parking. It may also affect the health of **especially multi tasking staffs.**
 - ✦ Except in 25 per cent of garment shops, in all other buildings treatment was being done to **control the dampness** in the parking lots.
 - ✦ In garment shop (75%), grocery (50%) and jewelry (50%) provision was not made for **ventilation**; rest of the buildings had provided windows and openings to serve the purpose where as in 100 percent of hospital and multi purpose buildings provision

was made through **window/opening and mechanical ventilation** respectively.

- **Flooring Provided:** In surface parking only hotels and multi purpose buildings had thought of providing good flooring with **pavement and tar**. Garment shops and grocery too provided **concrete flooring**.
 - ✦ In hospitals, hotel and garment shops parking lots especially surface parking were without a laid flooring. Despite providing a space for parking, the study proved that providing level surface was yet to gain significance.
 - ✦ Except hospital and garment shop with pavement flooring rest of the others were laid with cement flooring in underground parking.
 - ✦ As these floors are supposed to be non – slippery, yet provide the necessary friction, this gains considerable significance. **Unfortunately due respect was not accorded to it.**
- **Safety factors:** Surface parking in hotels and grocery stores were not found to have bothered with incorporating safety aspects.
 - ✦ Similarly, grocery stores alone did not give heed to this factor in their underground parking spaces too. Ultimately customers bore the brunt as they reported of minor accidents and scratches and dents in their vehicles.
- **Satisfaction provided:** Overall, none of the parking spaces provided by any of the buildings studied was meant to satisfy the consumer to the fullest extent.
 - ✦ All had some discrepancy or the other which contributed to their dissatisfaction. Many of them also could be even rated poor.
 - ✦ Limitations like insufficient parking spaces, poor lighting facility, and cramped area were but a few factors observed.
 - ✦ The survey revealed that the main limitation with underground parking was the poor lighting done.
 - ✦ Those buildings which had served for more than a decade lacked sufficient parking spaces itself.
 - ✦ High ramp angle also was commented upon as a major drawback.

II. Innovative Kinetic Parking Systems in Vogue

- **Four types of innovative parking systems** were in vogue in the selected City, offered by a hospital under essential services and an office and garment shop under commercial services.

- *The automated systems are Puzzle parking, Vertical Rotary System (VRS), stacked and Car Lift.*
- The systems had a successful take off only between 2014 -2016.
- Among the four types **puzzle parking** was found to require larger space as evident by the report given by hospital (more than 20,000 sqft) and the garment shop which had allocated more than 10,000 sq ft.
- All four models were company fabricated with provision for car pallets in standard dimensions extending from 7'x11' the least (VRS) to 9'x16', the maximum for car lifting.
- Like size of pallets, provision made for headroom also was found to differ.
- To make access easier, facilities like pedestrian and driving lanes and ramps were incorporated. In VRS system alone a turntable was provided to change the facing of the cars.
- All the systems were fully automatic except car lifting, which is semi automatic. Generators were put to use during emergency by all except in car lifting which still depended on manual operation.
- Among the systems, puzzle parking was the one which accommodated more space and enabled parking of more number of cars at a time. VRS system followed next.
- Though parking was found at different levels and decks based on the system, the study revealed finding a space for SUV's alone was a problem as none could accommodate them.
- All other types of cars fitted comfortably in these pallets. Cost of construction depended on the number of pallets fitted and the decks provided.
- Puzzle and VRS emerged as the most expensive, while car lift the least.
- Cleaning of puzzle parking though moderately heavy required special tools, but car lift system emerged as the most difficult to maintain.
- Three different wings given in different designations like house keeping, facility operator and service provider were made use of for maintenance jobs.

III. User - friendliness of the Systems - User's comments

- The success of any facility provided for public use gains significance and popularity among users based on customer's acceptance and its **user friendliness**
- A survey of 100 users benefiting from these facilities, namely parking spaces, was done.
- Among users, public sector employees and professionals responded more than businessmen, homemakers and students

➤ **User's comments on conventional parking Spaces**

- ✚ There appeared three types of parking spaces, namely surface parking, basement and multi level parking.
- ✚ While **surface and basement** were patronized by all, the third type was used by 45 - 68 per cent belonging to all other categories of users except homemakers.
- ✚ Another important feature was that preference for multi level was comparatively less.
- ✚ While professionals and businessmen agreed that the facilities were **earmarked** properly, the parking spaces for vehicles, only 85-89 per cent of the others agreed.
- ✚ When students accepted that they could fit their cars within the allotted spaces, not all the others agreed.
- ✚ The space provided between each parked vehicle was also reported only as good by majority of the users; irrespective of their status, many reported that to be even poor and inadequate.
- ✚ Except businessmen (63.1%) who responded in a larger proportion as sufficient to park their vehicles and homemakers who also found it sufficiently comfortable, the other groups expressed insufficiency felt with the spaces allotted for parking.
- ✚ Hence the **demand-supply balance** does not get satisfied.

➤ **Satisfaction of Ergonomic Aspects**

- ✚ Factors which contribute to healthy ambience like **circulation, ventilation, lighting and air quality were not found to be satisfactory.**
- ✚ Acceptable maintenance includes keeping the facility free of refuse, debris, and litter, maintaining parking surfaces in sound condition and providing proper care of landscaped areas.
- ✚ Majority of samples from all the groups explained that the flooring provided was good (42-74%).
 - ✚ Employees and professionals (almost 7% each) stated that to be poorly laid. Nevertheless, many had opted to record that it was average
 - ✚ Regarding general cleanliness, while 40-47 per cent of employees, students and businessmen stated it to be good, 32-36 per cent opined that it was very good.
- ✚ **On the whole, the general ambience provided was not upto expectations.**

➤ **Parking Ease**

✚ **Signages** provided to enable ease in locating vacant spaces and then parking was again reported by employees and homemakers as good (64 - 70%). Others stated it as good or average.

✚ Inquiry on ease of parking revealed employees and students to find it easy to manoeuvre while for others it was **moderately taxing**.

✚ Almost upto 10-22 per cent felt that the **process of parking, the layouts given and angles of manoeuvrability was confusing** in many of the parking spaces.

• **Access Points**

✚ **Ramps** provided were rated average by employees, businessmen and professionals, while homemakers felt it as very good and the students as good. Many of them of course also rated it as poor. **Angle of ramps was found difficult to manoeuvre**. Steeper angles were not found to be user friendly.

✚ Regarding **driving lanes** too, the users felt it only as good at the most or as average.

✚ With regard to **pedestrian paths** which is an absolute necessity for drivers and commuters to reach their destined parking, was not given due importance. More than one sixth of the sample stated it to be poor.

✚ Though many felt that the gradient at access points was an important factor which tested the experience and efficiency of drivers, general opinion was to have taken to what was offered as there was no go.

✚ Providers did not give this due consideration, and had taken users for granted.

✚ Evidently the consumers **did not find the “access providers” user friendly**.

✚ Majority of the samples (40-77%) felt that **parking fees** charged was quite reasonable, while 28 – 50 per cent expressed as being expensive

✚ **Safety aspects** provided scored only as good or average ranking from the sample studied

✚ As conventional parking spaces were **not rated high, the hypothesis (1) set for the study is rejected**.

- **User's comments on innovative kinetic parking systems**

- ✚ Only 56.6 per cent among employees, followed by businessmen (47.7%), professionals and homemakers (35.7% respectively) and students (33.3%), stated that the innovative parking was convenient.
- ✚ Though not all the samples had experienced parking in these innovative kinetic systems, from hearsay and print media, they were able to record their comments.
- ✚ A majority accepted them as a **good idea facilitating ease in parking and as a convenient system.**
- ✚ None of the homemakers, unfortunately were aware about them.
- ✚ On the whole the rest of the samples **welcomed the kinetic systems citing various positive points.**
- ✚ The **unique features** as listed by the samples were its feasibility for ease in parking, novel idea, space saving technique and promise for safety of vehicles.
- ✚ These factors were recorded by almost 90 – 100 per cent of the samples.
- ✚ Yet a **SWOC analysis** done focused on equal pointers for all the four.
- ✚ As the users welcomed the automated systems, the alternative hypothesis (2) set for the study is rejected.

- **Recommendations**

1. Awareness generation campaigns to improve conventional parking spaces and to popularize innovative systems hold priority.
2. Aspects to enhance user friendliness can be ensured through public hearing sessions
3. Government civic authorities should lay strict rules and regulations to improve the services
4. Can build to provide status signals in the entrance itself (like Western countries) to enable ease of parking.

- **Future research endeavours**

1. Civil engineers can identify the felt lacunae and suggest modifications to improve conventional parking
2. Conferences/ seminar presentations can generate awareness among users regarding innovative systems

3. Parking space signages provided can be studied to incorporate them in our country
4. Studies to estimate space hours of parking in can be encouraged.

➤ **Conclusion**

Innovative parking systems have had a good take off. Though these systems have come to stay, becoming more popular and user friendly for consumers, still remains in the hands of the providers and the users alike. Let us expect surprises in the future.

REFERENCES

Book References:

- Bali Rajeev, TroshaniIndrit, Goldberg Steve, WickramasingheNilmini, (2013), **Pervasive Health Knowledge Management**, Springer Science+Business media, New York, 293
- Bennett Andy, (2005), **Culture and Everyday Life**, Sage Publications, London, 12.
- Beri, (2000), **Marketing Research**, Tata Mc.Graw-Hill Publishing Company Limited, New Delhi, 45
- Bethlehem Jelke, (2009), **Applied Survey Methods – A Statistical Perspective**, John Wiley & Sons Inc Publication, New Jersey, 1.
- Bhatia.S.K, RanjanMeenuArora, (2016), **Business Studies**, New Saraswati House (India) Pvt Ltd, New Delhi, 89.
- Bhavikatti.S.S., &Chitawadagi.M.V, (2014), **Building Planning and Drawing**, I.K.International Publishing House Pvt Ltd, New Delhi, 145 - 163.
- Brain Christine, (2000), **Psychology – Approaches and Methods**,Nelson Thornes Ltd, United Kingdom, 240,242
- Carr Stephen, Francis Mark, Rivlin.G.Leanne, Stone.M.Andrew, (1992), **Public Space**, Cambridge University Press, USA, 19, 20.
- Chakrabarti.S and Mazumder.T, 2010, **Behavioral Characteristics of Car Parking Demand: A case study of Kolkata**, Institute of Town Planners, India Journal 7-4, 1
- Chawla Deepak, SondhiNeena, (2014), **Research Methodology – concept and cases**, Vikas publishing House Pvt Ltd, New Delhi, 112,221.
- Chrest.P.A, Smith,S.M, Bhuyan Sam, Monahan.R.D, Iqbal Mohammad, (2004), **Parking Structures: Planning, Design, Construction, Maintenance & Repair**, Springer Science + Business Media, LLC, NewYork, 285,286.
- Coleman.P, (2006), **Shopping Environments, Evolution, Planning and Design**, Elsevier Ltd, USA, 366 – 368.
- Das.S.K, (2010), **Research Methods for Business: A Skill Building Approach**, Surendra Publications, New Delhi, 171.
- Dul Jan, Weerdmeester Bernard, (2008), **Ergonomics for Beginners: A Quick Reference Guide**, CRC Press, USA, 1
- Flaherty.CA O, (2006), **Transport Planning and Traffic Engineering**, Elsevier Ltd, USA, 58,70
- Garber.J.N, Hoel.A.L, (2014), **Traffic & Highway Engineering**, Cengage Learning, USA, 134.
- Gerrish Kate, Lacey Anne, 2010, **The Research Process in Nursing**, John Wiley & Sons Inc Publishing, United Kingdom, 348-349, 149
- Gupta Mukul and Gupta Deepa, (2011), **Research Methodology**, PHI Learning Private Ltd, New Delhi, 4
- Gupta Santhosh, (2008), **Research Methodology and Statistical Techniques**, Deep & Deep Publications Pvt Ltd, New Delhi, 28, 43, 44, 108-113.
- Jakle.A.John and Sculle, A.Keith, (2004), **Lots of Parking: Land use in a Car Culture**, University of Virginia Press, London, 1 – 16

- Jefferis Alan, Smith.D.Kenneth, (2016), **Commercial Drafting and Detailing**, Cengage learning, U.S.A, 4
- JhaAvdhesh. S, (2014), **Social Research Methods**, McGraw Hill Education (India) Private Limited, New Delhi, 222,188
- Kadiyali.L.R, (2016), **Transportation Engineering**,Kanna Book Publishing Co (P) Ltd, NewDelhi, 258.
- Khazode.V.V, (2007), **Research Methodology Techniques and Trends**, **APH Publishing Corporation**, New Delhi, 10.
- Kliment.A.Stephen, (2004), **Building Type Basics for Retail and Mixed-use Facilities**, John Wiley & Sons INC, New Jersey, 1
- Krishnaswamy.K.N, IyerSivakumarAppa, Mathirajan.M, (2009), **Management Research Methodology- Integration of Principles, Methods and Techniques**, Dorling Kindersley India Pvt Ltd, New Delhi, 30, 269.
- Kuiper Shirley, (2009), **Contemporary Business Report Writing**, South-Western Cengage Learning, USA, 275,
- Kumar Rajendra.C, (2008), **Research Methodology**, APH Publishing Corporation, New Delhi, 103, 84-86
- LongstrethRichard.W, (2000), **The drive-in, the Super Market, and the transformation of Commercial Space in Los Angeles**, First MIT Press, U.S.A, 7.
- Mouton Johann, Marais HC, (1988), **Basic Concepts in the Methodology of the Social Sciences**, HSRC Publishers, South Africa, 16.
- Okulicz-Kozaryn Adam, (2015), **Happiness and Place: Why Life is Better Outside of the City**, Palgrave Macmillan, NewYork, 2.1,2.2.
- PandeAnurag, Wolshon Brian, (2016), **Traffic Engineering Handbook**, John Wiley & Sons, New Jersey, 437.
- Quirk Bary, (2011), **Re-Imagining Government: Public Leadership and Management in Challenging Times**, Palgrave Macmillan, New York, 116.
- Rangwala,S.C., Rangwala,K.S., &Rangwala.P,S, (1999), **Town Planning**, Charotar Publishing House, India,142, 180, 243-245.
- Rangwala.S.C, Ketki.B, Dalal, (2014), **Town Planning**, Charotar Publishing House Pvt Ltd, Gujarat, India, 203-207.
- Saravanel.P, (2007), **Research Methodology**, KitabMahal Publications, Allahabad, 275, 249, 253, 281,314.
- Seetharaman.S, (2014), **Construction Engineering and Management**, Umesh Publications, Delhi, 742.
- Sekaran Uma, Bougie Roger, (2015), **Research methods for Business, A skill Building Approach**, John Wiley & Sons, New Delhi, 158, 276.
- Sharma.R.K, (2008), **Sociological Methods and Technique**, Atlantic Publishers &Distributors(P) Ltd, New Delhi, 309.
- Sharma.S.K, (2013), **A Text Book of Building Construction**, S.Chand& Company Pvt Ltd, New Delhi, 12,13.
- Shoba Mohan Muthu.G, (2006), **Principles of Architecture**, Oxford University Press, India, 199.

- Singh.Y.K and RuchikaNath, (2007), **Research Methodology**, APH Publishing Corporation, New Delhi, 118,173-174.
- Smith Mary.S, CarwileRandall.W, (2016), **Traffic Engineering Handbook**, John Wiley & Sons, New Jersey, 441 – 485.
- Spence William.P, (1972), **Architecture .Design .Engineering . Drawing**, Mc Knight &Mc Knight Publishing Company, Bloomington, 436 – 451.
- Stein Kathleen.E, Sloane Robert.K, (2003), **NCHRP Report 487**, National Cooperative Highway Research Program, Transportation Research Board, Washington, 10.
- Taylor Bill, SinhaGautam, GhoshalTaposh, (2006), **Research Methodology-A Guide for Researchers In Management & Social Sciences**, Prentice-Hall of India Private Limited, New Delhi, 76
- Thakur Devendra, (2009), **Research Methodology in Social Sciences**, Deep & Deep Publications Pvt Ltd, New Delhi. 163.
- Uys.H.H.M, Basson.A.A, (1985), **Research Methodology in Nursing**, Kagiso Tertiary, Cape Town, 72.
- Victor.D.Johnson, Ponnuswamy.S, (2012), **Urban Transportation: Planning, Operation and Management**, Tata McGrawHill Education Private Limited, NewDelhi, 199, 201
- Wild Jan and Diggines Colin, (2009), **Marketing Research**, Juta and Company Ltd, South Africa, 107.
- Yiannoudes Socrates, (2016), **Architecture and Adaption: From Cybernetics to Tangible Computing**, Routledge, New York, 38.
- Yin.R, (2009), **Case study Research: Design and Methods**,Sage Publications India Pvt Ltd, New Delhi, 103, 218

Journal Reference:

- Albagul.A, Alsharef.K, Saad.M, Abujeela.Y, (2011), **Design and Fabrication of an Automated Multi level car Parking System**, Manufacturing Engineering, Automatic Control and Robotics, ISBN: 978-960-474-371-1, 1-6.
- ApteAtul, Ajmera.K.Sheetal, RohanD'sa, Godbole Rahul, (2007), **Electronics Project**, Vol:24, ISBN 978-81-88152-19-3, EFY enterprises Pvt Ltd, New Delhi, ISO 9001-2000, 59-61
- Banerjee Tridib, (1994), **The Future of Public Space**,Journal of the American Planning Association, Winter 2001, Vol.67, No: 1, 12.
- Barter. A.P, (2011), **Off-street Parking Policies Surprises in Asian Cities**, j.cities:2011.06.007, 10-11.
- Kileda Vijay, **Puzzle Parking**, (2011), **Elevator World India**, Issue 3, Volume 4, 3rd Quarter.
- MandloiNeeraj.Sh, (2016), **Model Building Bye-laws, Town and Country Planning Organisation**, Ministry of Urban Development, Government of India, 10.
- Mathew.T.V, (2014), **Transportation Systems Engineering**, Chapter: 41, 41.1, 41.3.
- Mitchell Don, (1995), **The End of Public Space? People's Park, Definitions of the Public, and Democracy**, Annuals of the Association of American Geographers, Vol.85, No:1, 108-133.
- Pastore.R, (February15th2005), CIO-The Resource for Information Executives, **Valet Parking is So Last Year**, Vol:18, No:9

Patel Chandni, Swami Monalisa, SaxenaPriya, Shah Sejal, (2015), **Rotary Automated Car Parking System**, International Journal of Engineering Science and Innovative Technology, Vol:4, Issue:2, ISSN:2319-5967, ISO 9001:2008 Certified, 408 – 415.

RajaGopalan.V, **Automated Car Parking System**, (2011), **Elevator World India**, Issue 3, Volume 4, 3rd Quarter.

Singh.S.K, (2015), **Study of parking patterns for different parking facilities**, International Journal of Civil and Structural Engineering Research, ISSN 2348-7607, Vol-2, Issue-2, 35 – 39.

WaghmareAkash, NirwanTrupti, RaheteGaurav, ShahuAdarsh, BhujadeKartik, Ali Ashraf Saiyyed, IPASI International Journal of Mechanical Engineering (IJME), Volume 4, Issue 4, April 2016, ISSN: 2321-6441, 17.

Yerojwar.G.N, Rojatkar.V.D, (2015), **Automated Vehicle Parking in India and Challenges**, International Journal of Electrical and Electronics Research, ISSN 2348-6988, Vol:3, Issue:4, 121-124.

Web References:

Retrieved from <https://en.wikipedia.org/wiki/Parking> accessed on 08.02.2017

Retrieved from <http://pipta.org/wp-content/uploads/2014/04/Parking-Problems-and-Creative-Solutions.pdf> (Banerjee Associates, An overview of common parking issues, parking management options and creative solutions, 2003) accessed on 24.02.2017

Martoni John, (2010), *Public Spaces*. Retrieved from https://planning-org-uploaded-media.s3.amazonaws.com/legacy_resources/kidsandcommunity/metropolis/pdf/5publicspaces.pdf accessed on 09.03.2017

Retrieved from http://www.secureparking.co.in/product_view?productId=73 accessed on 08.03.2017

Retrieved from <http://www.parkingsolution.in/tower-parking.html> accessed on 08.03.2017

Retrieved from <http://www.parking-net.com/about-parking/parking-facilities> accessed on 09.03.2017

Retrieved from https://www.plattsmouth.org/PDF/Land_Dev_Ordinance/09-Off-Street-Parking.pdf accessed on 23.02.2017

Retrieved from <http://www.engineeringcivil.com/different-types-of-parking-spaces-and-multiple-level-car-parking.html>, Madhuri K. Rathi, Darshan V Patel, *Different types of Parking Spaces and Multiple Level Car Parking*, Department of Civil Engineering, Pune University, India, accessed on 24.02.2017

Retrieved from <http://www.hydraulicjackind.com/pdf/final%20brochure%20%20BROCHURE.pdf> accessed on 10.03.2017.

Retrieved from http://www.icclabc.org/uploads/Vehicle_Lift_-_Klaus_Presentation.pdf accessed on 10.03.2017

Retrieved from <https://www.simplypsychology.org/interviews.html> accessed on 31.03.2017.

Retrieved from <http://www.qualres.org/HomeSemi-3629.html> accessed on 31.03.2017.

Retrieved from https://www.pacifica.edu/gems/thesis/Methodology_Procedures.pdf accessed on 04.04.2017

Retrieved from http://echo.iat.sfu.ca/library/fox_kinetic_systems.pdf accessed on 05.04.2017

**AVINASHILINGAM INSTITUTE FOR HOMESCIENCE AND HIGHER
EDUCATION FOR WOMEN COIMBATORE – 641043**

APPENDIX – I

An Interview Schedule to Conduct a survey of parking facility providers in Commercial /
Essential Services Buildings in Coimbatore city

“Paradigm Shift Through Kinetic Parking Spaces in Commercial / Essential Services Buildings –
An User Friendly Analysis”

I. GENERAL INFORMATION:

- a. Name of the firm:
- b. Address :
- c. Name of the Interviewee :
- d. Designation :
- e. Contact number :
- f. Year of establishment at the location:

II. DETAILED INFORMATION:

1. Availability of parking: Yes No
2. Nature of parking: On-street parking Off-street parking
3. Style of parking adopted: Conventional parking:
 Surface parking
 Under ground parking
 Roof parking

Innovative parking:

- Multi level hydraulic system
- Car lift
- Puzzle parking system
- Vertical rotary system
4. Mode of operation: Fully automatic Semi-automatic
 Mechanical Manual
5. If fully/semi automatic, then alternate way to operate the parking facility in absence of electricity:
6. Area covered for parking: (in sqft)
7. Marked slot for vehicles in the parking area:
8. Size of each marked parking slot:
9. Number of floors allotted for parking facility:
10. If multi-level parking facility is provided then the number of floors:
11. Size of each car pallet provided in the multi level car parking: (length x breadth)
12. Structural elements present in the parking space:
 Ramps Driving lanes
 Pedestrian lane Others specify
13. Separate parking space allotted for motor cycles and cars
 Yes No
14. The types of cars that can be parked in different level of height:
15. Average number of parked vehicles in a day:

16. Number of vehicles that can be parked in each parking level:

Number of vehicles that can be parked in each parking level		
Ground floor	1-50 Cars	
	50-100 cars	
	> 100 cars	
Basement(-1)	1-50 Cars	
	50-100 cars	
Basement(-2)	1-50 Cars	
	50-100 cars	
Basement(-3)	1-50 Cars	
	50-100 cars	
Basement(-4)	1-50 Cars	
	50-100 cars	

17. Total number of vehicles that can occupy the parking space simultaneously:

18. Is the allotted parking sufficient during all seasons:

Yes No

19. Height of head room (ceiling height) provided in the parking area:

20. Space provided between each parked vehicle:

21. Nature of lighting adopted in the parking area:

22. If artificial lighting, then include the type

23. Adequacy of lighting inside the parking space:

24. Provision for ventilation:

Yes No

If yes, then methods of ventilation, provided at numbers

- Ceiling ventilation -
- Wall ventilator -
- Exhausts / fans -
- Windows and other openings -

If no why:

25. How is the supply of fresh air inside the parking area ensured?

26. Type of flooring provided?

27. Service openings from and to the parking:

Separate entry and exit ways Single entry and exit ways

28. Cost of the installed parking facility:(in rupees)(single stack)

29. Total cost of the parking facility construction:(in rupees)

30. How is cleanliness of the parking space / area:

31. The process and procedure of cleaning:
32. Who does the cleaning work:
33. State if any mechanical devices are used in the maintenance of parking areas. If yes, specify?
34. Maintenance done by:
35. Operation/handling/function of the parking facility:
 Easy to handle Medium Difficult
36. Level of temperature inside the parking facility during different hours of the day
37. Is sound insulation provided ?
38. If yes specify material used
39. Is damp proof treatment given?
40. Are signages provided in all plaIndicated?
 Yes No

41. How do you rate the felt by users?
 Very good
 Good
 Average
 Poor
 Others
42. Are safety precautions against any disaster provided”?
43. Any situation with respect to safety and security? if yes, specify:
44. Advantages of the parking facility provided
45. Disadvantages of the parking facility provided
46. Other comments if any

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Appendix - II

An Interview Schedule to elicit details on the Extent of use and satisfaction felt with conventional and innovative parking spaces in Coimbatore

III. GENERAL INFORMATION:

- a) Name of the interviewee:
- b) Occupation :
- c) Address :
- d) Contact number :
- e) Name the vehicle you own:

IV. DETAILED INFORMATION:

- 1. Type of parking: (personal parking) used
 - Surface parking
 - Under ground parking
 - Multi-level parking
 - Roof parking
 - Automated parking system
- 2. Is the head room space is sufficient in the parking space: rate your answer
- 3. Is the allocated area to park the vehicle marked?
- 4. If marked, does the vehicle fit within the space?
YesNo
- 5. Is the space between each parked vehicle is adequate?
- 6. Opine on the ambience provided in the parking space.

Ambience Provided	Excellent	Very Good	Good	Average	Poor
Lighting					
Ventilation					
Air Control					
Flooring					
Cleanliness					
Safety					

- 7. Is it easy to park the vehicle? Yes No If No, specify
- 8. Rate the level of satisfaction derived from the facility
- 9. Comment on the charges levied.
- 10. Do you think that the parking space provided by the builder is sufficient for all the vehicles
- 11. Which type of parking is convenient?
 - Manual parking
 - Automatic / multi level hydraulic parking
- 12. State your opinion about access points(ramps) provided.
- 13. How do you rate the provisions for structural elements in the parking space:

Elements Provided	Excellent	Very Good	Good	Average	Poor
Ramps					
Driving Lanes					
Pedestrian lane					

14. Are adequate signages provided?:

15.

- a) Sound insulation :Excellent very good good average poor
- b) Under ground water treatment :Excellent very good good average poor
- c) Damp proof treatment :Excellent very good good average poor
- d) Fresh air circulation :Excellent very good good average poor
- e) Fire control devices :Excellent very good good average poor

16. What do you feel about conventional and innovative parking systems?

17. Do you feel that the multi-level parking is feasible?

18. Really will it save space?

19. Does this parking facility offer safety and security to the parked vehicle?

20. Some of the advantages of multi-level parking:

21. Disadvantages of conventional parking facility, if any?

22. Any practical difficulties faced by you while parking in multi level parking?

23. Opine on the ambience provided in the Innovative parking space.

Ambience Provided	Excellent	Very Good	Good	Average	Poor
Lighting					
Ventilation					
Air Control					
Flooring					
Cleanliness					
Safety					

Elements Provided	Excellent	Very Good	Good	Average	Poor
Ramps					
Driving Lanes					
Pedestrian lane					

24. Sound insulation :Excellent very good good average poor

25. Under ground water treatment :Excellent very good good average poor

26. Damp proof treatment :Excellent very good good average poor

INSTITUTIONAL HUMAN ETHICS COMMITTEE



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Dr. Subhashini K. Sripathi
Mrs. S. Radha Devi
Mrs. Judith Justin

3rd February 2017

To
Ms. Sofia Jannet J
Department of Interior Design and Resource Management
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043

Dear Madam,

Ref: Your proposal No. IHEC/16-17/IDRM-10 entitled “Paradigm shift in parking spaces offered by commercial/essential services buildings – an user friendly analysis” submitted for approval of the IHEC

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No. IHEC/16-17/IDRM-10 entitled “Paradigm shift in parking spaces offered by commercial/essential services buildings – an user friendly analysis” submitted by you. The Approval number for the same is AUW/IHEC/IDRM-16-17/XMT-10.

We wish you all the best in your research endeavours.

Regards,

P.R. Padma
3/2/17

Dr. P. R. Padma
Member Secretary

