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SCHOOL FOR TRANSPORTATION SCIENCES
Master of Transportation Sciences

Master's thesis
New concepts for parking in residential areas

Supervisor :
Prof. dr. Gerhard WETS

Annum Khaliq
*Thesis presented in fulfillment of the requirements for the degree of Master of
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PREFACE

As parking issues are creating concerns for urban planners all over the world. Being an urban planner and a transport scientist I was looking forward to search about new ideas for parking being used in other countries, having special significance to residential areas. This is the reason I found this topic very interesting for my Master thesis.

Commercial areas have already grabbed the attention of city planners and researchers to devise policies and solutions to reduce the parking problems prevailing in the city center. These parking issues are not just confined to the commercial areas but have progressed to residential areas as well. Basically, residential areas are the points where vehicles are parked for longer durations so the parking problems would definitely be more visible in such areas. Due to significant increase in car ownership rates during last decades, the need to house the vehicles has also increased. A lot of parking search traffic can be seen in areas with different land uses that is creating nuisance for overall traffic flow. In case of residential areas people want their car to be in front of their doors that makes the residential areas aesthetically look unpleasant and affects the livability and safety of the area. Also the parking of cars in front of the resident's house creates obstruction for other road users. All these issues urge for new parking concepts to be introduced and implemented in residential areas. Many developed countries in the world have introduced new concepts of parking to mitigate the parking issues.

At University of Hasselt, the course of Masters in transportation sciences is very diverse. It covers almost all dimensions of transportation planning and engineering. A transportation scientist should see a transport related problem from every aspect and parking issues are a dilemma of automobile age. In this piece of research, the residential parking issues and the drawbacks of conventional parking techniques are highlighted and new concepts of parking used in developed countries are identified. The applicability and acceptability of these identified concepts in the study area is measured using observations and focus group. A focus group discussion with the concerned authority of the study area revealed the views of parking experts regarding the benefits and feasibility of adopting the identified concepts regarding the study area. This research aims to direct the policy makers while planning to devise solutions of parking problems in residential area. It does not provide any directions for the implementation of a certain parking concept in the study area. This study would be useful to find out the importance of focus group while collecting data for qualitative research and to gain insights of decision makers regarding the introduction of a new idea or program.

At the end, I would like to acknowledge my supervisors, experts from the municipality who have participated in the focus group and my family, who have helped me to complete this research.

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SUMMARY

This report is about parking in residential areas. The purpose of writing this report is to have a thorough insight on various parking concepts, systems and techniques used to regulate residential parking. The prime focus was to study in detail the types of parking techniques and systems, when, where and how these can be applied and to check the applicability and acceptance of these parking techniques using the focus group. The study has identified the existing concepts used for parking in residential areas. The issues and drawbacks of the conventional parking methods, solutions to various parking problems and better ways to manage the existing parking methods have also been listed along with their benefits. The study highlights the innovative concepts which are flourishing nowadays that can be modified and applied to the study area (Runkst) as a solution to its parking issues. The cities where these systems have been implemented successfully are also discussed. Moreover, the report also discusses the significance of focus group in collecting data for qualitative research.

First chapter describes the problem statement, objectives, scope, justification, methodology of research and structure of the report. Second chapter provides an overview of literature in the context of residential parking. These include on-street and off-street parking, sub types of on-street and off-street are also highlighted. Explaining these methods were necessary to have a clear view about the residential parking techniques and reflect on the inconveniences these methods are bringing in the overall urban environment. Parking regulations that are used by the local authorities to regulate residential parking are also mentioned. The draw backs of conventional parking methods (on-street, off-street), different perspectives of residential parking issues and their solutions described in the scientific literature are also explained. Keeping in view the literature, some innovative parking utilization techniques (in-lieu fees, shared parking, centralized parking, smart parking, demand reduction, parking freezes, private car parks) and systems (automated, semi-automated parking systems) are also discussed which are being adopted by most of the developed cities (Manhattan, Munich & Toronto) to overcome parking related issues. The innovative parking systems and their potential benefits over conventional parking are also highlighted along with their successful implementation (case studies).

Third chapter describes the research methodology. It starts from topic selection, finding out background information in order to identify the true nature of problem and to define the focus of research regarding this problem. The literature studied, focused mainly on characteristics of residential parking and the ways in which it is done, draw backs of conventional parking techniques, better ways of parking utilization, innovative concepts of parking and their potential benefits over conventional parking. Data collection process, analysis and conclusions are also discussed in detail. Fourth chapter briefly discusses the profile of the study area and the methodology adopted for data collection. The qualitative data collection method of focus group along with its advantages & limitations are highlighted in this chapter.

Fifth chapter discusses the analysis & findings of observations and focus group session. This existing condition of parking was analyzed using observation technique. It further elaborates the way how the focus group was conducted in collaboration of municipality of Hasselt, to identify the best parking concept that can be applied in the selected study area. The detailed procedure of observations, focus group session, its analysis and findings are also highlighted in this chapter.

The last chapter discusses the conclusions that have been deduced from a detailed study of literature and analysis of observation forms & focus group. It is concluded that the car ownership rate is growing with the population so the places to reside these vehicles also need to be increased. It is a challenge for the local authorities to provide spaces and manage the demand efficiently without damaging the environment and aesthetics of urban fabric. The issues with residential parking are not just limited to demand and supply of parking but these also raise the concerns regarding proper

utilization of the existing parking facilities. The existing facilities can only be utilized by making efficient parking policies and their enforcement. Parking regulations such as fines or penalties for noncompliance of parking rules can help solving problems such as illegal parking, obstructive driveways or leaving abandoned vehicles on road. On-street parking, is always preferred by the residents and authorities because it is close and cheap but on the other hand it is aesthetically unpleasant to see lot of cars parked on the road. Off-street parking facilities are efficient but these raise concerns such as underutilization because very less residents are willing to pay for them or to park their cars at a distance. The efficiency and effectiveness of these conventional parking methods can be enhanced greatly by using the innovative parking concepts such as shared parking, centralized parking and smart parking. Some of these concepts also provide strategies for reducing car use such as demand reduction and parking freezes. All these concepts are helpful not only for the residents but also for the authorities because no or very less additional cost is incurred in applying these strategies. Furthermore, automated driving systems are technically very advanced and can be used as the most efficient car parking concepts. Although these systems are expensive but have very successfully solved all the issues regarding parking. The features of automated systems such as less fuel usage, sustainable designs, reduced space, lighting, heating and ventilation requirements have grasped the eyes of investors. The increased acceptance of such system is creating innovation in performing parking management efficiently. Moreover, the focus group session elaborated that the residents and the parking experts at the municipality of Hasselt need a combination of the centralized parking, shared parking and private car parks as a solution to parking issues that are being faced by the residents in Runkst. Also the participants of the focus group were agree that the actual parking problem in Runkst is less availability of free parking space on street. Residential parking problems have various perspectives and dimensions, so it is recommended that a combination of parking management strategies or innovative parking systems should be implemented, depending on the level of acceptance, affordability and ease of usage by the community. As in case of study area (Runkst) a combination of centralized parking, shared parking and private car parks would be accepted by the community due to the high acceptance, financial feasibility, integration with current policy and ease of usage of these concepts.

CHAPTER NO. 1

INTRODUCTION

This chapter describes the problem statement that leads to the actual problem situation. Furthermore the objectives, scope, justification, methodology of research and structure of thesis are also discussed in the later sections of this chapter.

1.1. Problem Statement

Parking related concerns are no longer confined to the commercial areas rather they are extended throughout the urban region. There are different types of parking used for residential and commercial areas. In literature there are many studies that focused on these types of parking. The examples of such studies include the on-street parking market (Calthrop, 2002; Kelly & Clinch, 2003, 2006, and 2009), the off-street parking market (Shiftan, 2002) and work place parking (Ison & Wall, 2002; Kuppam et al., 1995). Excluding the type of area (residential or commercial), there are distinctions in the focus of parking research.

A lot of research is being done in parking management and design of parking facilities in order to address the issues of parking in the commercial areas. Conventional parking policies have focused on accommodating travel demand but often overlook their social, economic, and environmental consequences (McShane & Meyer, 1982). Parking contributes to the appearance of city and suburbs; affects traffic operations; and is a vital component of the urban street and transit systems. With the increase in car ownership rate (Coevering & Snellen, 2008) and poor management of parking spaces, planners need to think about other ways and devise innovative solutions to the parking issues in the context of residential areas. To manage the allocated space for parking efficiently and to have an improved urban quality in future, there is a need to define some innovative measures for proper planning and management of parking vehicles in residential areas.

The currently used procedures for parking in residential areas include on-street and off-street parking. Off-street parking is usually done in parking garages and other parking facilities placed at a certain distance from the houses of the residents. While on-street parking is done on the pavement using the signs and road markings just in front of the house. On-street parking is usually free for the residents. The local authorities allows the residents to use the pavement space in front of their houses for parking purposes. In case of off-street parking there are some specially designated areas such as parking facilities or garages where people pay for using the facility.

There are certain issues that can cause concerns and distress in a local community concerning the residential on-street parking such as illegal parking, visitor parking, parking of abandoned vehicles or commercial vehicles. The nature and magnitude of parking problems vary between different types of neighborhoods. For instance, in the old mixed-use neighborhoods in the center of cities, the car was not part of the initial urban development plan. The streets are narrow and there is a lack of parking space while there is a demand for both resident and visitor parking. This leads to high parking pressures during peak hours.

Obstruction of driveways, damage to soft landscaping and footways are just some examples of what can occur as a result of these parking problems. In some cases, emergency vehicles are unable to pass as a result of obstructive parking. On-street parking constitutes a serious emergency hazard wherever cars block fire hydrants or obstruct fire apparatus. Alternatively, on-street parking bays may be designated for use by ambulances or police rather than being used for the parking of resident's cars. Proper road markings alongside the bay can be used to indicate the type of vehicle allowed to use the bay (Chick, 1996). Literature review also reveals that the on-street arrangement of parking spaces,

either parallel to the curb or at an angle, affects safety. In smaller communities, higher percentages of local and collector street crashes involve curb parking. One study in a community of 65,000 population found that 43% of all local and collector street crashes involved on-street parking (Box, 1968). In the same city, annual frequencies of 14 parking crashes per mile were found on major streets, but only 1.8 parking crashes per mile on local and collector streets (Box, 1966).

Another related study reported that parking-related midblock crashes accounted for 49% of all crashes along major streets, 68% along collector streets, and 72% along local streets (Humphreys J.B. et al, 1979). On-street parking is also a cause of noise pollution, air pollution and visual intrusion. The increasing parking pressure also affects other aspects of livability in neighborhoods. Due to high parking pressure, the residential street loses its function as a play space for children and green areas are affected by illegally parked cars. Furthermore, a profusion of parked cars reduces visibility and leads to parking search traffic. This affects traffic safety and increases traffic-induced air and noise pollution. It can be generally stated that on-street parking decreases roadway capacity, impedes traffic flow and increases crash potential. For these reasons, it is desirable to avoid on-street parking.

With the growing rate of car ownership the need for the availability of space has also increased, the local authorities' do not have any power to limit the number of vehicles owned by residents and also the property's frontage looks like a car sales forecourt, and is out of character with the residential area. The number of cars will continue to grow in the future. The extent of this growth highly depends on the population growth and economic developments (Coevering & Snellen, 2008). Conventional parking techniques in residential areas would not stay as effective in future so there is a need to provide more options of parking for residents and define a proper system of parking in residential areas, thus finding out some concepts other than already available in order to meet the future parking needs.

The purpose of the research is to explore some innovative residential parking ideas which are being adopted in other countries and see which of those solutions can fit in Belgian context. As the aim of parking management is not only the provision of parking spaces but also to check the validity of that solution in the context of area where it is going to be applied. Thus the research is to make an inventory of parking solutions in the residential areas by identifying the issues which are being faced by the residents and local authorities and to justify the solution with some innovative ideas.

1.2. Objectives of the Study

The objective of the research is to

1. Explore parking related issues in residential areas faced by the residents.
2. Study in detail the conventional parking concepts in residential areas and their draw backs.
3. Explore new concepts of parking that can be adopted by local authorities in order to efficiently meet the growing need of parking demand in residential areas.
4. Explore innovative concepts of parking being used in other countries.
5. Identify which of the innovative parking concepts is most applicable in Belgium.

1.3. Scope of the Study

The scope of the research is to explore new parking systems used for residential parking in specific countries (e.g. U.S.A., Germany & Canada) that can be introduced in the residential areas of Belgium (selected study area) and to see if the identified concepts, replicated in Belgium would be acceptable by the community. The limitation of the research is that it does not accounts for the financial feasibility of the identified innovative parking concepts, also it does not provide any directions for changing the parking policies and regulations. Also the focus group was conducted to gain insights of parking experts regarding the identified concepts.

1.4. Justification of Research

Residential areas are the points where vehicles are parked for longer durations so the parking problems are more visible in such areas. Due to significant increase in car ownership rates during last decades, the need to house the vehicles has also increased. Residents want their cars to be in front of their doors that makes the residential areas aesthetically look unpleasant and affects the livability and safety of the area. Also the parking of cars in front of the resident's house creates obstruction for other road users. All these issues urge for new parking concepts to be introduced in residential areas. Many developed countries in the world have introduced new concepts of parking to mitigate the parking issues. There is a strong need to study various types of parking concepts being used in other countries and to check their applicability and acceptance by the residents and municipality.

1.5. Research Questions

In addition to the central research question sub-research questions identified are given below:

Q: What types of parking are being used nowadays in residential areas?

Q: What are the draw backs of existing parking concepts?

Q: Are there any other ways to manage parking in residential areas than the already defined concepts of on-street and off-street parking?

Q: What other countries are doing to cater the problems of parking in residential areas?

Q: Are there any case studies of successful implementation of new parking systems in residential areas?

Q: Are those systems applicable in Belgium and are acceptable by the community?

Q: What benefits the innovative system will bring if introduced in the current situation?

1.6. Methodology

The steps taken to complete the report are described below:

Topic selection

The first task was to select the topic for conducting research. The motivation behind selecting this topic was to explore innovative parking techniques that can be used to address the parking problems arising in the residential areas.

Problem Identification

The second task was to identify the problem that exists in the context of residential parking. The issues face by the residents and factors that influence residential parking.

Literature Search

The next task was to search for scientific literature. The literature search was carried out to review the work done by different authors with respect to residential parking. The review was mainly done with the help of desk research in order to generate different ideas and to elaborate the topic from diverse viewpoints.

Defining Research Approach

The next task after literature study was defining the research methodology. The research methodology proposed is based on experiences from previous studies and achieving the research objectives.

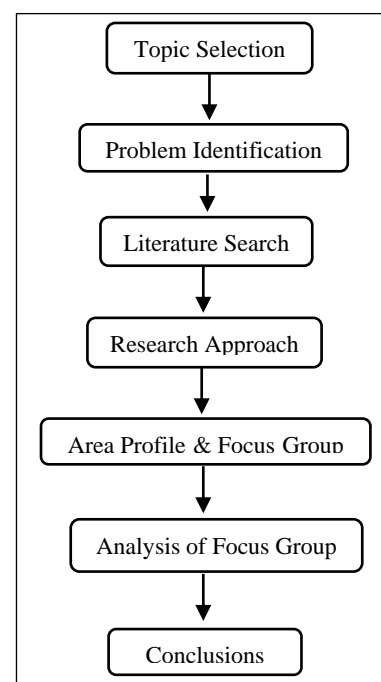


Figure 1: Research Methodology

Setting up Observations & Conducting Focus Group

Observation forms were made and focus group questionnaire were prepared to set up observations and conduct focus group.

Analysis of Focus Group

After conducting focus group analysis was made and results were deduced using suitable qualitative analysis technique.

Conclusions & Recommendations

The last task was to conclude the report. The conclusions are made based on facts deduced from the analysis of focus group.

1.7. Structure of Thesis

The report consists of the following chapters:

Chapter No.1. Introduction comprises of the problems statement, objectives, justifications and research questions and scope of research.

Chapter No. 2. Residential Parking Overview deals with scientific literature focused on selected topic.

Chapter No. 3. Research Approach defines the research method to be adopted to carry out the research.

Chapter No. 4. Area Profile & Focus Group comprises of the area profile of Runkst and guidelines for conducting focus group.

Chapter No. 5. Analysis of Focus group deals with the analysis & findings from observations & focus group.

Chapter No. 6. Conclusions & Recommendations comprises of the conclusions deduced from literature, and results obtained from analysis are discussed.

CHAPTER NO. 2

RESIDENTIAL PARKING OVERVIEW

This chapter discusses the literature in the context of residential parking, it includes different methods in which residential parking is being done nowadays. These include on-street and off-street parking, furthermore sub types of on-street and off-street are also highlighted. Explaining these methods were necessary to have a clear view about the residential parking techniques and reflect on the inconveniences these methods are bringing in the overall urban environment. Parking regulations are also mentioned that are used by the local authorities to maintain residential parking.

The draw backs of conventional parking methods (on-street, off-street) along with various parking issues and their solutions, described in the scientific literature are also explained. Keeping in view the literature some innovative parking techniques for better utilization of existing parking facilities such as (in-lieu fees, shared parking, centralized parking, smart parking, private car parks) and systems (automated, semi-automated parking systems) are also discussed which are being adopted by most of the developed cities (Manhattan, Munich & Toronto) to overcome parking related issues. The innovative parking systems and their potential benefits are also highlighted in the end using the project information of various parking systems developers.

2.1. Parking in Residential Areas

People like to park their car closely to their homes. Residential parking is also a part of municipal parking. The city has the responsibility to provide the residents with a place to park their cars. Especially the people who live close to the downtown area struggle to secure a space to park their cars. Usually the city manages residential parking with parking permits, to be requested by residents to place their cars on-street.

Parking management is done by making parking laws and policies, these are then regulated using certain measures of enforcement. A system of parking fees, restrictions and fines is in place throughout towns and cities all over the world, to ensure that careless parking does not cause obstructions for other motorists, businesses and impinge on the safety of pedestrians.

Most local authorities employ their own traffic wardens to enforce the parking regulations and issue fines. Local authority is responsible for creating bye-laws that list places in town/city where parking fees will be imposed. Parking fees and paying methods (disc parking, permit parking, car parks and "pay and display" parking) vary throughout the country and can be set and adjusted by the local authority. Revenue generated from public parking fees and fines is used to cover the costs of operating these services.

Enforcement of parking regulations is done with the help of traffic wardens. They are representatives of local authority and can issue tickets for illegal parking and non-payment of parking fees. A system of fixed charge parking fines for illegal parking and non-payment of parking fees has been in place throughout different countries. Fines are issued by traffic wardens. Parking is restricted in certain parts of most towns and cities during business hours. Parking information signs on the streets clearly display the hours when the restrictions are in operation. During these hours, drivers are not allowed to obstruct driveways, bus lanes and loading zones. Disabled parking spaces are off limits at all times to all motorists unless they have an appropriate permit.

If residents need to avail on-street parking in their area, resident's permit can be obtained from the traffic division of local authority that allows to park on street. This permit cost approximately €25

(prices may vary, depending on location). Permit usually specifies the name of that street. Only one permit is issued to any individual car owner and one household can only have four permits. For a building divided into more than one unit of accommodation, one parking permit per unit is entitled (Citizen Information board Ireland, 2013).

Disc parking operates outside the central zone and in some suburban areas of cities. Many urban areas are divided into zones for traffic management purposes. The central zone contains town center where the demand for parking is highest and the parking fees are most expensive. Information signs are erected in areas where disc parking is in operation, giving details about the hours of operation of the scheme, the maximum parking time and the parking fees. Pay and display parking operates with a single solar powered meter serving about 20 spaces. There are signs in pay and display parking areas giving details of the hours that scheme operates and the maximum duration for parking. Prices range per hour, depending on area, but in general fees range from 80 cent to €2.90 per hour. Dublin City Council have a parking tag scheme that allows citizens pay for parking using their mobile (Citizen Information board Ireland, 2013).

Private car parks are not regulated by the government. These are privately owned and revenue earned from parking in these car parks goes directly to the owners and not to local authority. The prices charged in private car parks vary from place to place, ranging from about 80 cent to €2.50 per hour. Prices are determined by the car park owner. Vehicle clamping in public places is in place in some cities. Services are operated in those cities by private companies on behalf of the local authority. Local authorities have power to tow away vehicles that have been abandoned or illegally parked on a public road or in a local authority car park. Vehicles are towed to a car pound and a significant fee (up to 160 euro) may be charged for their release. Most local authority web sites have details of parking restrictions and the type of pay parking in operation in the area. Any contravention of local authority parking bye laws carries a fixed-charge fine. Details of where parking fine can be paid are written on parking ticket. A clamped vehicle, can be fined ranging from €25 to €90, depending on the local authority or private company involved (Citizen Information board Ireland, 2013).

2.1.1. On-Street Parking

On-street parking refers to park anywhere on or along the curb of streets, in contrast to parking it in a parking garage. In some streets it is allowed to park the vehicle on the street, but sometimes there are restrictions. Mostly these restrictions are presented by traffic signs. Residents need a parking permit to park their cars on-street. To make sure people follow these rules and restrictions, cities hire enforcement officers. Types of on-street parking can be controlled (paid) on-street parking or uncontrolled (free) on-street parking. On-street parking can be done in many ways. It can be parallel, angled or back in angled.

Parallel parking achieves the greatest efficiency in terms of the street cross-section, or the distance from curb to curb across a street. However, it is the least efficient in terms of quantity of spaces provided. Many cities and downtowns utilize on-street parallel parking.

Angled parking provide efficiency along with user-friendly method for parking on the street. Generally, it should be used as a mean of traffic calming and as a way of providing efficient on-street parking. The disadvantages is the additional street width necessary to accommodate angled parking. 45° angled parking is utilized in many historic downtowns where right-of-way space is limited. The angle of the parking decreases the necessary adjacent lane width along with the setback from the curb for the lane to begin. Where right-of-ways are very limited, most municipalities utilize the parallel parking option.

Back-in angled parking (or reverse-angled parking) has similar advantages to that of angled parking. When reverse angled parking is utilized, less maneuvering space is needed in the street cross-section (John, 2011).

2.1.2. Off-Street Parking

Off-street parking refers to park the vehicle anywhere but not on the street. Off-street parking include different types of parking facilities. These can be both indoor and outdoor, public or private. Off-street parking can be a parking garage or a parking space that belongs to the property of a person's house. In other ways, off-street parking can be (short stay, long-stay and contract).

A **parking lot** is an area that is assigned for parking. Normally, the parking spaces are marked on the ground with white or yellow lines that form squares and each square fits one car.

Detached garages are sometimes built after the completion of house construction and come in variety of sizes and configurations. **Attached garages** are part of the house structure and are easier to heat than detached garages. **Indoor parking** means that the area is completely enclosed and is above the ground. **Underground parking** is usually reserved for high-rise apartment condominiums because building an underground parking garage is expensive, they are not that common except in the downtown core.

Outdoor parking stalls are often reserved for condominium and apartment-dwellers. These parking stalls are not common near the center of the city, but can be seen near high-rise and low-rise apartments in many other areas of the city. A miniature version of a stall, a **parking pad** is meant for just one or two cars and are not covered. A pad consists of just a concrete or asphalt parking area. This is the least expensive form of off-street parking.

Multilevel parking garages are ones which have multiple floors to park at. The design of a multilevel parking garage can be very different. Some garages have ramps or lifts while some have robotic systems that move cars from one level to another. The floors of the parking garage can either go up, down or both.

2.2. Draw backs of Conventional Parking Techniques

The conventional parking either on-street or off-street are no longer efficient to be implemented in urban areas. The concerns raised by them are more negative in nature than their benefits. Some of the effects of conventional parking methods are listed in the following sections.

2.2.1. Issues of Off-Street Parking

Urban planners consider that the off-street parking has destroyed the urban fabric. Many old neighborhoods which were built before the invention of automobile were uninterrupted pedestrian zones. As historic buildings were renovated to accommodate parking spaces, the town centers became easier to access by car but much more difficult to walk through, as parking lots create large gaps between land uses. Large number of people therefore choose to drive, which increases parking demand and thus degrade the town's pedestrian qualities and the area becomes a less desirable place to visit, with parking supply easily accommodating parking demand, but the special qualities and uninterrupted urban fabric that comes with pedestrian orientation greatly diminished. Aerial photographs of many American cities and suburbs show that parking land area is often equal to or greater than non-parking area (streets, buildings, sidewalks, parks) (Shoup, 1997).

Off-street parking encourages car ownership and car use, thus further increasing parking demand. Increased traffic is a hazard for all non-driving street users. Parking consumes valuable land that could be otherwise used for housing units or green spaces thus reducing the tax base. Parking lots when not in use form empty spaces where no one wants to be, reduces the sense of personal safety. All residents and other consumers must bear the costs of parking facilities (as additional costs along with rents), whether they use the facilities or not. Off-street parking, limits pedestrian access to destinations (driveways to off-street parking cut through sidewalks) and are sometimes dangerous to pedestrians. Overall off-street parking facilities gives a view of an ugly car storage which is an undesirable feature of streetscape.

An oversupply of off-street parking leads to underutilizing in urban areas that are primarily walkable and transit oriented in nature. This oversupply of parking consumes more space and creates dead zones that disperse amenities and destinations, thus making the area difficult to walk through. Most importantly, free parking adds more cars to the street, compromising the safety of pedestrians and bicyclists. As the local governments usually need to provide sufficient space for parking, they have generally shown a little interest in parking design or aesthetics. This causes a significant damage to most of neighborhood vistas because parking now fills a significant proportion of the area. As Donald Shoup points out, “we not only pay for off-street parking, but we also have to look at it”. Most off-street parking results in blank walls or empty spaces, disrupting the pedestrian realm (Shoup, 1997).

A study from city of Portland based on the impacts of parking requirements on housing affordability, uses a hypothetical development and considers a number of different scenarios for providing parking to the building. Results show that there are trade-offs involved, as the method of providing parking spaces not only increases the cost, but also limits the ability of a building to fully utilize a site. For example, providing parking via an off-street surface lot is rather cheap to build, but has a high opportunity cost – that land used for parking cannot also be used for housing. The study keeps the land area and the zoning envelope constant: that is, the off-street parking must be provided on-site, and the variance for extra building height cannot be obtained. The trade-offs for this hypothetical development, are between cost (the rent charged to get a return on investment) and in utilization of the site (Block, 2012).

Increasingly regarded as one of the great planning disasters, off-street parking requirements uncovers the reason behind using a motor vehicle to make almost 90 percent of all trips in America. Because free parking spaces serve as a “cheap, convenient, direct, sedentary connection to most points in the city” and lead to a diminished street life. These spaces also provide an impetus for large-scale sprawl in most areas (Shoup, 1997).

2.2.2. Issues of On-Street Parking

On-street parking supply has affected the quality of urban life in a negative sense. The demand for parking from the residents living in properties where there is less or no provision for parking facilities have raised issues on-street. The on-street parking usually restricts the safe passage of pedestrians walking along narrow pavements because the vehicles are sometimes parked partly on the pavement. This also damages the surface footway and the services underneath.

Another problem is that as a street becomes congested with parked cars it is easier for vehicles to be abandoned unnoticed thereby restricting parking supply even more. Environmental pollution created and the time spent when searching for a vacant parking space is another effect of the limited on-street parking supply. Difficulties with parking close to one’s home can lead to disputes between neighbors. There is anecdotal evidence that there has been an increase in the number of disputes between neighbors relating to parking issues (Parking forum, 2004).

In order to accommodate the demand for parking spaces in some areas, the situation has resulted in larger vehicles such as buses, commercial and emergency vehicles having difficulty in easily travelling along these roads. Whilst the slowing of traffic can increase road safety issues, it can also impede the passage of buses thereby delaying their passengers or emergency vehicles attending an incident. Parked vehicles are also liable to damage (protruding wing mirrors, etc.). When the needs of residents’ visitors and delivery vehicles are all taken into account the demand for curb side parking spaces far exceeds supply on an increasing number of residential roads (Parking forum, 2004).

The environmental impact and safety of an area can also be adversely affected by excessive on-street parking. If remedies are not developed soon there could ultimately be parking gridlock in some suburban areas where streets and properties are not designed for parked cars. Dealing with on-street parking in residential areas is clearly a situation that will get worse as the number of vehicles increase.

Traffic capacity (number of vehicles moving along a section of roadway) is lost due to parking along a street. Parking, backing, stopping, or standing vehicles during a parking maneuver physically restricts other traffic movements. The presence of vehicle in the street, opening doors between cars also interfere with efficient traffic movement or pedestrians walking (Parking forum, 2004).

In the city of New York, local governments' minimum street-width standards may force developers to oversupply, and residents to pay excessively for on-street parking in residential neighborhoods. Such oversupply is often presumed to encourage car ownership and reduce housing affordability, although less evidence exists in this regard. Free residential street parking increases private car ownership by nearly 9%; that is, the availability of free street parking explains 1 out of 11 cars owned by households with off-street parking (Guo, 2013).

2.3. Parking Problems in Residential Areas

A comparison of residential parking with non-residential parking shows that residential parking has certain unique characteristics. Residential parking not only means providing an adequate number of parking spaces but also involves finding the proper place to park cars. New residential areas are usually developed at low density to provide desired space for parking along the street. This contrasts with non-residential areas (and with old residential areas, especially in the city center) where the intensity of development is so high that curb space is clearly inadequate and off-street parking is a necessity. Up till now, off-street parking requirements are applied specifically to new residential development. One reason for off-street parking requirements is community appearance or the desire to keep cars out of sight and to keep the environment attractive. Another reason is a concern for safety; streets cluttered with parked cars may be hazardous (obstruction for other vehicles). Since off-street parking requirements in residential areas are based mostly on community sentiment, the requirements often seem useless to the outside observer. The fact is that no standards are universally valid, each community must decide for it to what extent curb parking is acceptable and to what extent off-street parking should be required (Ornstein, 1966).

Another characteristic of residential areas is that the space required for parking is related to car ownership. In non-residential areas, however, space is provided for all customers, employees, visitors. In residential areas, the use of the cars is largely irrelevant. One important reason of this difference is that the availability of mass transit facilities in residential area although it has little impact on parking needs; a person may use accessible mass transit to get to work, but he still may own a car for other reasons. Therefore, the average number of cars per family in an area served by mass transit may differ slightly from the average in an area which has little or no such service. Another reason is that residential parking is aimed at providing the "long-term" parking demands of car owners, not the "short-term" demands of visitors and commercial vehicles. The demand in residential areas for overnight parking is indeed greater than in commercial or non-residential areas, with the peak demand that occurs between 2:30 and 5:30 a.m. often the short-term demand is completely ignored. It is expected that the visitors will find space along the curb or will pay for space in a garage or parking lot. Sometimes if there is a provision of free off-street parking in the apartment buildings, it is meant only for the residents. For commercial vehicles it is assumed that they stay for a short period of time so will find space along the curb or, if necessary, will double-park. Another dimensions of parking problem in residential areas which is not observed in non-residential areas is the concern over devoting a significant proportion of residential land to parking, this in turn raises the concern over the possibility that the area will be dominated by parking spaces both on and off the street (Ornstein, 1966).

The literature describes three important concerns that resulted in the current parking problems in residential areas. The first concern points out an increase in car ownership. For example, in the Netherlands the number of cars per household increased from 0.86 in 1995 to 1.05 in 2010 (CROW,

2006). The second concern highlights the availability of parking spaces in residential areas. The number of parking spaces is not increasing and many existing parking spaces are removed in favor of other land uses such as buildings or bus stops. This case is similar for private areas where parking space is utilized for an extension of dwelling. The third concern uncovers the spill-over demand for parking from other areas where restricted parking policies have been introduced such as central business and shopping areas. The intensity of parking problems strongly depends on the type and location of the area (Coevering & Snellen, 2008).

In Europe, problems tend to be most intense in pre-war neighborhoods where in most cases planners did not take into account the presence of cars. Parking issues in newer neighborhoods is mainly caused by an increase in car ownership rates. (Marsden, 2006) mentioned an increase of 12 million cars by 2030 in the UK. Approximately a quarter of these cars have to be parked on-street. Cities already face several parking problems in residential areas such as high occupancy rates, long walking distances between parking and dwellings, and vandalism at parking facilities. The increase of parking problems in residential areas causes different effects on residents' behavior that includes the choice of home location and various travel choices such as travel mode and parking location.

Some other studies provide evidence of relationships between residential parking and residents' preferences. In 1993, Balcombe and York investigated the effects of parking measures in residential areas in England that experienced severe parking problems. They found that residents reduce car use because they are afraid of losing a close parking place. In addition, residents fear vandalism when the car is parked at some distance from their home. Empirical evidence on the importance of distance between home parking, and security for the design of parking facilities in residential areas was also found by (Stubbs, 2002). He also investigated the effect of the layout of parking in residential areas on residents' preferences. It was found that if parking provision is not satisfactory regarding distance and security, residents are unlikely to purchase a house in the neighborhood. (Borgers et al, 2008) investigated residents' preferences for residential areas with restrained car access. In a stated choice experiment, residents were invited to evaluate hypothetical plans for residential neighborhoods. The plans were defined using different transport-related characteristics including parking. The parking situation was represented by a combined variable describing distance from home to parking facility and presence of security. They found a negative effect of parking at distance from home on the residents' preferences. The negative effect is partly compensated by the presence of security.

2.3.1. Problems Associated to Parking Demand, Supply and Utilization

Demand and supply are two major causes of problems associated with parking. The demand for parking space, car ownership per household, increased by 25 percent during the last two decades, it seems a problem in most of the residential areas because supply of parking did not develop at the same pace.

However, parking problems do not occur solely because of a lack of parking spaces. In 2007, there were 7.2 million cars and 850.000 delivery vans in the Netherlands while the total parking supply estimated at 12.5 up to 15.6 million parking spaces (IOO, 2002). In addition to a lack of parking space in certain areas, parking facilities face underutilization. This is due to the uneven spatial distribution of demand and supply of parking space, which further leads to local surpluses and shortages of available parking space (Figure 3). Compared to less urbanized regions, car ownership levels in urbanized regions are lower. Nevertheless, the number of cars per hectare is considerably higher in these areas. This reflects a trade-off between the lower car ownership levels per household and the higher concentration of households per hectare. Consequently, urbanized areas have to deal with a concentration of parking demand. At the same time, the availability of parking spaces is lower because the high densities reduce the amount of public space. This combination often leads to parking problems in the (strongly) urbanized areas.

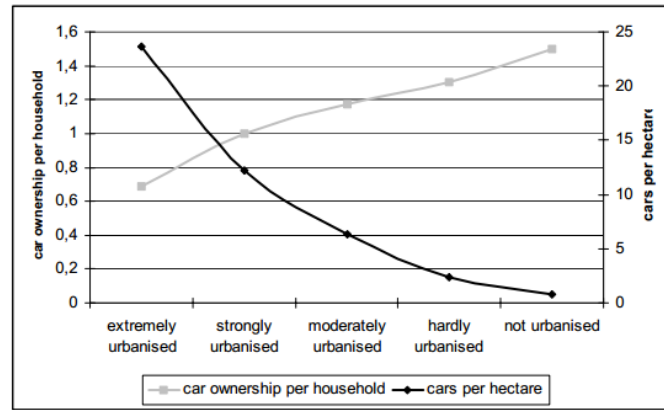


Figure 2: Household car ownership and cars per hectare by degree of urbanization of the postal area
(Source: CBS/RDW 2007)

Moreover, the low level of utilization is affected by the separation of land-uses. This produces local and temporary peaks in parking demand, during the day on work and leisure locations and during the night at residential locations. In the off-peak periods, the utilization of parking supply is very low. In areas having mixed-use development the use of parking facilities is often restricted to one user group (residents or visitors). Residents use their private parking facilities like garages, drives and carports often for other purposes and park their car in the public area. This leads to high parking pressures in public space whilst the theoretical supply of parking is sufficient. Thus the residents are not willing to walk long distances to the parking facilities. This results in illegal parking near the dwelling while there is sufficient parking space available on other locations in the neighborhood (Coevering & Snellen, 2008).

In the UK cars are usually parked either off-street in garages or on-street in residential areas. In a nation-wide survey of 500 drivers conducted in 2005 reported that 73% of cars are parked off-street at night – either in a garage (26%) or in a communal parking area (47%). Parking at older houses is usually on-street, while that at detached properties is more likely to be off-street. Even amongst single person households, who might prefer to live in areas where off-street parking is less likely to be available, 60% of cars were parked off road. Over the previous seven years, the usage of garages had reduced from 28% to 24%, despite the construction of more houses with garages, with more drivers now choosing to park their car outside. The same survey found that a parking space will increase around 8% of the value of a property, while a single garage will add a further 3%, and a double garage a further 9%. However, at the same time, people appeared unwilling to pay directly for parking. When asked what price they would pay to secure parking outside their homes per year, more than half those surveyed would not pay anything; only 2% would pay over £500 (TRL, 2010).

2.3.2. Problems Associated to Resident's Choice

The lack of parking space is a major drawback for residents specially those who live close to commercial areas. Most residents think of it as the most important source of annoyance in their neighborhood (Vereniging Eigen Huis, 2007). The increasing parking pressure also affects other aspects of live ability in neighborhoods. With increased parking pressure, the residential street loses its function as a play space for children and green areas are affected by illegally parked cars. Excessive number of parked cars reduces visibility and leads to parking search traffic. This affects traffic safety and increases traffic-induced air and noise pollution.

Parking problems vary between different types of neighborhoods. For instance, in the old mixed-use neighborhoods in the center of cities, the streets are narrow and there is a lack of parking space while there is a demand for both resident and visitor parking. This leads to high parking pressures during

day-and night time. As a solution authorities introduce paid parking and parking permits to mitigate parking problems in these areas and reserve parking space for residents. In contrast, in single-use suburbs built from 70's onwards in the Netherlands, parking problems, are mainly caused by the high levels of car ownership of households. The car was already an integral part of the urban development plans of these suburbs, still these plans could not anticipate the vast growth of car ownership during the past decades. The parking standards used are too low for the current level of car ownership. Despite the high level of annoyance, residents hardly seem to adjust their level of car ownership to the available parking space in their residential area. The benefit of owning an (additional) car seems to be larger than the burden of the collective parking problems. This becomes more apparent from questionnaires regarding the live ability in residential areas. The individual problem, lack of parking space, is regarded as the major problem. The collective problem, the profusion of parked cars and related nuisance are regarded as less important by residents. Furthermore, parking problems are rarely a reason to relocate. People change their place of residence primarily because of factors related to the type of dwelling and changes in household composition. In the extremely urbanized areas in major cities, parking pressure plays a slightly larger role in residential mobility (Coevering & Snellen, 2008).

In the early 1990s, Balcombe and York undertook two surveys and examined the views of households in a variety of residential areas and a sample of local authorities. One of the questions put forward to residents comprised of valuing a parking space. Although the answers were hypothetical, the findings reported that between 33 – 50% of car owners would be prepared to pay up to £50 annually for an on-street space. One of the conclusions from the study was that pricing mechanisms alone were unlikely to level demand. (Balcombe and York, 1993).

2.4. Parking Solutions

There are different interests and viewpoints to consider when making decisions regarding parking management. Each municipality with its unique neighborhoods have different needs so there is no single parking policy that will work for the entire region (see annex I for parking problems). (Litman, 2006) suggests that planners should use the principles of consumer choice, efficient utilization, sharing, flexibility, user information, prioritization, pricing, peak management, quality vs. quantity and comprehensive analysis when making decisions to support parking management. So that the people should have information on feasible parking and travel options. Parking facilities should serve multiple users and destinations. These facilities should be sized and managed in a way so that the spaces to be utilized properly. Parking plans should accommodate uncertainty and change. Most desirable spaces should be managed to favor higher-priority uses. As much as possible, users should pay directly for the parking facilities they use. Special efforts should be made to deal with peak-demand. Parking facility quality should be considered as important as quantity, including aesthetics, security and accessibility. All significant costs and benefits should be considered in parking planning. Local authorities are responsible for the maintenance of public space, including unallocated parking spaces. It is expected by the residents that the local authorities will handle parking problems in their communal area. A lot of difficulties are experienced by the local authorities due to increased car ownership, in managing the parking situation. There can be three policy options for the authorities:

- Discourage car ownership;
- Optimize the use of existing parking space;
- Create more parking space;

2.4.1. Discourage Car Ownership

Controlled parking zones if introduced with parking permits can reduce parking demand. By controlling the number of parking permits, parking demand can be adjusted to the total supply of

parking spaces. Parking without a permit is prohibited unless parking permits are combined with paid parking. This way, visitors can also use the available parking space which has a positive effect on utilizations. However, the concept of controlled parking zones is restricted city centers. Outside these areas, lower densities make enforcement of these schemes more labor-intensive. The lack of mixed-development reduces the amount of visitors and subsequently the potential for paid parking (Coevering & Snellen, 2008).

Another way to discourage car ownership is the provision of alternatives such as efficient public transport, proper facilities for cycling, walking and introduction of car sharing schemes. However, in general, the potential to discourage car ownership is low. There is a limited relationship between spatial and public transport characteristics and car ownership levels. Cycling and walking facilities are desirable as these slow modes server as an alternative for the private car if small distances to facilities are provided. Lower densities and single-use zoning in suburban areas makes distance to destinations long thus making slow modes less attractive. Car sharing schemes have somehow affected the private car ownership. It is most significant in old, high density neighborhoods in large cities only. The overall effect of car sharing scheme, on the parking situation has been limited so far (Coevering & Snellen, 2008).

2.4.2. Optimize the Use of Existing Parking Space

In most of the residential areas the utilization of parking space also seems to be an area of interest. Parking facilities are usually accessible for one user group; residents, employees or visitors and theses facilities cater demand only for peak hours. Residential parking demand has its peak during evening and night while parking demand from employees and visitors has its peak by day. As a result, large amount of parking space is used for a short amount of time. Opening up parking facilities for different user groups can increase utilization considerably.

The potential for mixed-use of parking facilities depends on the amount of mixed-use development in the area. This concept cannot be successful in case of single-use areas having only one user group. Increasing mixed-use development can add a significant contribution to better utilizations of parking facilities but this can only be achieved through a planned long-term strategy. The current single use lay-out in many areas is not likely to change in future, despite spatial policies directed at increasing mixed-use development, this type of development in new residential areas is limited (Snellen et al., 2005).

Furthermore, residents often under-utilized their own private parking facilities. They use the driveway and parking space in front gardens often for other purposes and park the car in public space. Local authorities should encourage residents to use these spaces as first priority. However, enforcement is hardly possible when parking in public space is not restricted with parking permits. Without additional parking schemes, the highest attainable option for local and central governments is to encourage the perception that parking in the public area is a privilege, not a right (Coevering & Snellen, 2008).

A review of existing literature revealed a lack of consensus on the factors that drive parking use and account for the variation in auto ownership. Although socio-demographic, housing and built environment variables have shown an impact on residential parking and vehicle availability, but their relative influence is still a source of debate. King County undertook a research in order to better understand the factors that contribute to variation (increase or decrease) in parking utilization for multifamily housing. More than 100 factors were developed for data collection and analysis that could be grouped in five areas:

- Parking supply and price;
- Property/development characteristics;
- Neighborhood household characteristics;

- Accessibility;
- Built form/development patterns.

These factors were developed based on data availability and possible influences on parking utilization. The independent variables included supply, average monthly parking cost to tenant, average rent, density, household income, household size, bedroom count, presence of children, age, distance to nearest transit stop, job density, proximity to schools, walk score, block size, and block density. This research directs to consider the proper provision of parking, given several land use, transit and walk factors. In some cases block size, population and job density, walk and transit access to trip destinations influence parking utilization by 50 percent (Ransford et al., 2013).

2.4.3. Create More Parking Space

Authority should create parking spaces to cater for the demand along with managing the utilization of these spaces. The authorities usually meet the demand by providing additional parking spaces on-site. Creating these spaces are relatively cheap (€1.500-2.500 per parking space). However, due to the vast growth of car ownership, these measures do not seem to be sufficient any more. The expansion of parking space conflicts with space needed for green zones and space for play area for children. This case is common in both high & low density neighborhoods. Opportunities to convert functions in public space are limited.

The lack of public spaces urges local authorities to consider more innovative measures while creating more parking spaces. More expensive alternatives for on-street parking like garage parking and mechanical and automated parking facilities (automated garages or car stackers) have to be considered. This can enhance the opportunities to provide parking both below and above ground level, creating a more efficient use of on-street parking space. These measures can also be integrated in new building plans. Most important is the reduction in the nuisance (noise, visual & environmental pollution) caused by heavy flow of traffic searching for parking. The suitability of these alternatives depends on the lay-out of an area because automated garages usually provide large number of parking spaces, these are suitable for high density mixed-use areas. The number of potential users increase with the increase in density of the area and mixed-use provides opportunities for garage to be utilized more with different user groups. In suburban, low-density neighborhoods, garages are less useful due to the lack of potential users. Small-scale car stackers are more convenient in these areas. High costs of these automated parking systems (€10.000- 40.000 per parking space) is the major issue. Local authorities cannot provide these parking spaces at low tariffs of regular on-street parking. Residents are also reluctant to pay these additional costs. Experience from residential parking garages in urban renewal areas show that higher tariffs are not easily accepted and residents try to find a 'free' parking spot in the surrounding neighborhoods. Consequently, many residential parking garages suffer from underutilization and the neighborhoods from circulating traffic. This means that parking regulation in surrounding areas is very important when new (expensive) parking spaces for residents are considered (Coevering & Snellen, 2008).

2.5. The Future of Residential Parking

The studies have revealed that household car ownership will continue to rise with 5 to 16 percent in the future (2030) (Coevering & Snellen, 2008). Highly urbanized areas in the Netherlands will have the highest growth in car ownership. It is difficult to predict which areas will have excessive parking problems, as this also depends on the policies made by the local government. The parking problems should be considered as an integral part of local transport policies.

2.5.1. Pay per Use for Residential Parking

Reluctance of residents to pay for parking is one of the major aspects that need to be considered by the local authorities while making parking policies. The reason of this reluctance is that majority of

residents do not have the idea about the costs (and returns) of residential parking and often consider 'free' parking as their right. Indeed, residents rarely pay directly for the use of parking space. The costs of residential parking are paid via local taxes and these are added in the housing price. Furthermore, the returns on parking permits do not cover the costs of enforcement and local governments use revenues from paid parking in the city centers to compensate for the parking shortage in residential areas. A relationship between the actual use of parking space and the costs is practically nonexistent because most parking spaces are unallocated. Regardless of the household car ownership level every household in a given residential area pays the same price for parking (Coevering & Snellen, 2008)

In order to meet the needs of future parking demand the principal of pay per use is necessary to be considered. This will make the residents aware of the actual costs of residential parking and these costs can affect their decisions while purchasing (additional) car. When residents are faced with the actual costs of parking, more expensive parking solutions, such as automated parking systems may become an option. To enable the pay-per-use principle, it is necessary to discern the indirect costs of parking and these costs should be divided amongst the car owners. The introduction of the 'pay-per-use' principle in residential parking will bring about a major cultural change in dealing with residential parking.

2.5.2. New Residential areas

When planning for new residential areas, realistic parking standards are necessary. These should be in accordance to the household characteristics of the area. High income households will have higher car ownership rates, regardless of the spatial features of the surrounding residential area. Especially when local authorities try to increase urban densities by building in existing urban areas, the car ownership levels of new inhabitants could be considerably higher than car ownership of the current residents.

Parking standards provide a rough estimation of the future parking demand. The household car ownership is highly dependent on economic and demographic characteristics. Local authorities can anticipate this by creating more flexible urban plans, for instance by allocating space that can be transformed to parking space in the future. The utilization of parking spaces varies with mixed use and single use areas. In case of single use areas, parking spaces should be allocated to individual dwellings (households). Allocated parking space includes spaces within the premises of a property (driveway, carport or garage) and spaces in communal areas reserved for one particular property. Unallocated on-street parking space should be limited in these areas (Coevering & Snellen, 2008).

2.6. Innovative Ways of Parking Utilization

Abandoned properties in an area that had a thriving character once are left behind as underutilized public infrastructure, these sort of buildings thus feed the cycle of disinvestment in urban areas. As the population became more dependent on automobiles, providing parking in urban areas has become a significant expense. It is necessary to reduce suburban sprawl and protect the environment by encouraging developers to invest within existing urban infrastructures. Providing parking in outlying green field areas is less difficult because of the availability of land at low cost.

An important way to reduce the demand for parking is to shift transportation behaviors in the direction of non-auto modes. This can be achieved by providing incentives for using alternative modes and reducing the availability of parking spaces. Such changes will encourage infill redevelopment and reduce vehicle miles traveled, emissions and congestion. Innovative ways are needed to better utilize the existing parking facilities e.g., in-lieu parking fees to cover costs of city garages, shared parking arrangements when users park at different times of the day, shuttle buses from centralized parking facilities and alternatives designed to reduce the demand for parking by providing incentives for non-auto modes of transportation (e.g., public transit subsidies, "cash-out" programs, trip reduction programs, bicycle amenities) (USEPA, 1999).

2.6.3. Centralized Parking

Centralized Parking are parking facilities, located in the center of the neighborhood designated to be used by the residents of the community rather than parking on street. In large neighborhoods shuttle services are used to and from the centralized parking facilities to facilitate the users. These facilities can reduce the costs of parking because large facilities are less expensive on a per space basis to build and maintain than small facilities. Centralized parking, as an alternative to on-site parking, also improves urban design and preserves the historic nature of communities. Some cities mandate centralized parking facilities and finance them through development impact fees or negotiated contributions established during the environmental review process. The concept of centralized parking facilities is good with respect to economic, environmental and urban design perspective but raises concerns for building occupants, such as lack of parking proximity. These concerns can be addressed by providing reliable and frequent shuttle services to and from the centralized parking facilities. Successful centralized parking has been accomplished in Chattanooga, Tennessee. In this case, centralized facilities are located at the periphery of the city, reducing traffic emissions in the downtown area and freeing up land in the center for redevelopment (USEPA, 1999).

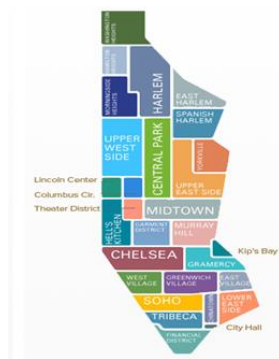


Photo 2: Centralized parking

2.6.4. Parking Freezes

After certain time limit some areas in the neighborhood are not allowed to be used for the purpose of parking specially the residential streets (e.g. parking is not allowed in the residential streets close to city center after 5pm). The amount of parking required can be directly reduced through parking freezes that cap the total number of parking spaces in a particular district. Such freezes have been implemented in various areas of the U.S. in response to non-attainment of environmental standards, traffic congestion or other urban planning considerations. Parking freezes need to be implemented in conjunction with viable public transportation options. Cities with successful parking freezes generally have strong economies and are attractive to tenants, customers and visitors. Such cities can attract businesses because the benefits of the urban location outweigh the potential drawback of limited parking and because public transit offers a viable alternative to auto use (USEPA, 1999).



Photo 3: Parking Freezes

2.6.5. Demand Reduction

The above discussed concepts such as in-lieu fees, centralized parking and shared parking not only decrease the parking requirements but also provide ways to reduce excess parking supply. Demand reduction directly targets on the reduction of parking demand by replacing parking spaces with bus stops or reserving parking spaces for carpooling, car sharing, etc. It is also possible to reduce the need for parking and the associated costs by influencing the demand for parking.



Photo 4: Demand Reduction by car pool

It can be achieved by increasing the price of parking or by promoting non-auto transport incentives. Charging users for parking is a market-based approach, if a fee sufficient to cover construction, operation and maintenance costs is charged to the users of parking facilities, it will likely cause them to seek alternative transport modes. Demand reduction programs include: subsidies for transit, cash-out programs, transit improvements, pedestrian and bicycle amenities and vehicle trip reduction programs. When employers allow telecommuting or flexible work schedules it reduces commuting, and thus the demand for parking (USEPA, 1999).

2.6.6. Smart Parking

Smart parking is a system that informs and navigates the driver about the free space available in the nearby parking area using smart sensors and smartphone apps, the resident may get a notification on his smartphone about a free space that is at some distance from his home. Currently, many municipalities rely on old-fashioned parking standards that result in an abundance of parking at the cost of community's character and vitality. Smart parking approaches can address these issues through a variety of techniques by tailoring standards, managing demand and improving parking facility design.

Marlborough is a medium-sized city located near the intersection of the Massachusetts Turnpike and Interstate 495. This strategic location near two of Massachusetts' major transportation routes makes Marlborough an attractive location for the many electronics and computer firms that currently inhabit the city. To accommodate its workforce and residential parking needs, Marlborough has enacted three zoning measures that promote a smart parking approach. The city has taken steps to decrease the oversupply of parking through provisions for shared parking, compact car spaces and temporary reserve parking (EEA, 2014). This shows that the concept of smart parking can be used in combination with the above mentioned concepts to mitigate the issues of underutilization of parking facilities (more explained by the picture below).

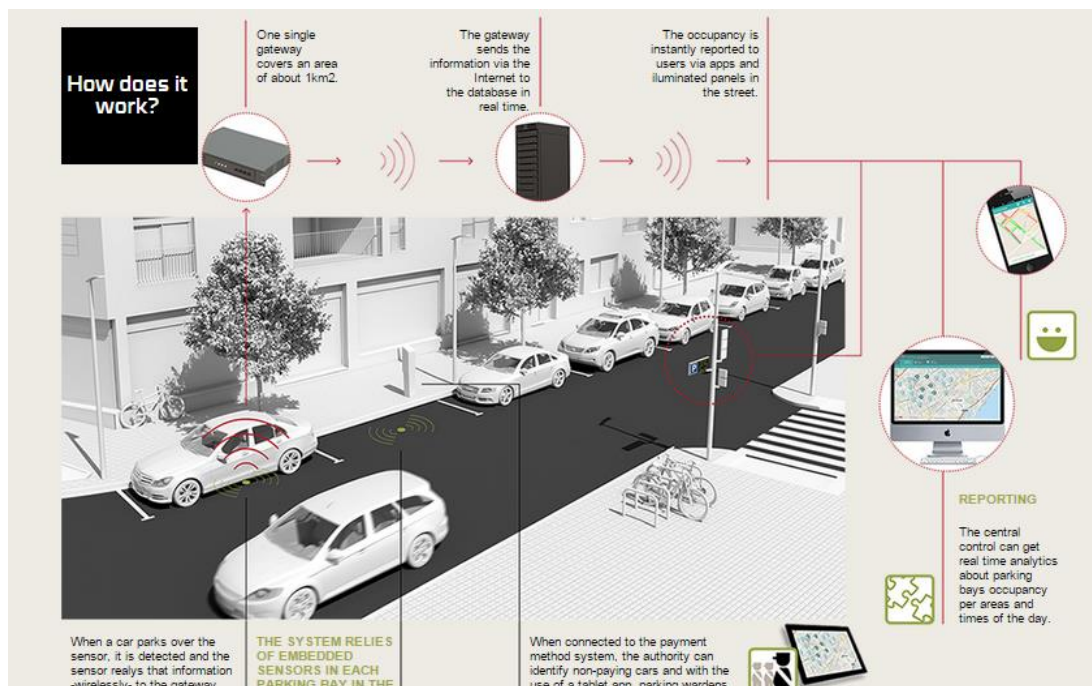


Photo 5: Smart Parking (Source: Fastprk 2012, World sending SL)

2.6.7. Private car parks

Private car parks owners list their parking spaces online via some website. Car owners easily find, book and pay for parking after reserving on the website or directly claiming the spot through the smartphone app (e.g. Carambla is an "eBay for city parking" where owners list their parking space for earning a financial return on excess capacity, benefit from increased security and embrace smart city mobility for social responsibility reasons. This is already working in Antwerp, Brussels & Ghent).

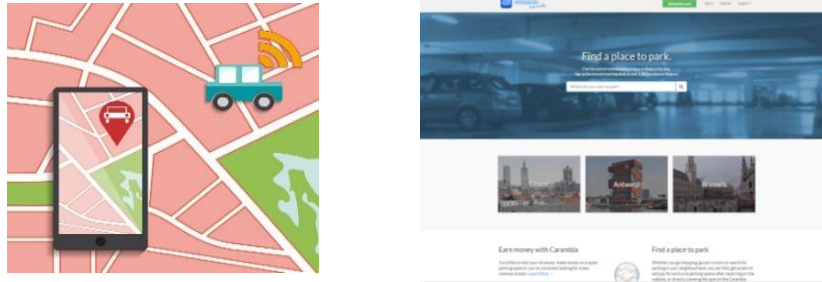


Photo 6: Private Car parks (Source: Carambla parking website)

2.7. Innovation Parking Concepts

A car is usually kept parked somewhere for 22.5 hours because a driver spends about 90 minutes a day in the car at an average. But finding a parking place in big cities and popular destinations is becoming a challenge. Planners, developers, architects and engineers are all looking for viable solutions. A parking facility should meet the functional/operational design requirement, which can supply safe and efficient passage of vehicles. Parking is sometimes provided in the form of a parking lot without human, aesthetic or integrative considerations. This has given parking a poor public perception and has frequently disrupted existing urban fabric (WBDG, 2014).

2.7.1. Automated Parking Systems

An automated parking system is a mechanical system that moves cars from the entry to an available parking space. It uses multiple levels and stacks cars vertically to use as less land as possible to park as many cars as possible. It's entirely automatic and does not require any staff. Automatic parking systems are very space efficient. The system doesn't need as much space to park as a human does. There's no need for ramps, pedestrian areas etc.

From a driver's perspective they simply park their vehicles in a parking module are guided to the correct parking position by sensors via a display sign. The drivers switch off their engines and the parking module door is closed to secure the module. Once the module is secured the vehicle is removed from the parking module and stored. When drivers return and request their vehicles, their vehicles are returned to a parking module, usually facing the correct direction, ready to be driven away. Since there is no requirement for ramps, driveways and personnel access to the parking areas, automated parking can typically park twice the number of vehicles in the same volume as conventional parking.

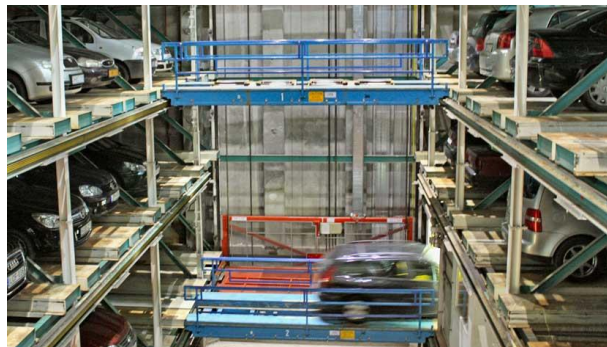


Photo 7: Automated Parking System (Rothary, 2014).

2.7.2. Semi-Automated Parking System

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

Advantages of automated parking systems is that it reduced parking search traffic and thus saves time that would be consumed in searching for parking space. It also reduces the chances of theft or damage. The automated parking also shows environmental friendliness since engine is turned off. It also offers advantages for municipalities in terms of space efficiency. Increased visual impact and public safety. Less litter, fights and accidents because there are no people inside. No need for installing signs, lighting, pedestrian areas etc. Cars inside are moved automatically, which means no need for an expensive ventilation system. No need to employ staff (except for occasional maintenance) (Rothary, 2014).

2.7.3. Working

The customer enters the parking garage and drives the car onto a platform. When the engine is turned off, the overall size and shape of the vehicle is detected by the sensors used in the system. The system analyzes where the car can be parked. Usually there is a payment terminal for the customer to pay for parking. He receives a ticket or key with a customized code. As soon as the customer leaves the parking garage, the car is moved vertically or horizontally to the available parking spot with the robotic arms and platforms. When the customer comes back to pick up his car, the system uses the code from his ticket to know which car to bring back to the platform. The customer can then enter the vehicle and leave the garage.



Photo 8: Working of automated parking system (Woehr, 2014)

2.7.4. History

Automated parking systems first appeared in Europe, Paris in 1906 and during 1920's the North America. The need to introduce automated parking systems was to maximize the value of available land by condensing parking. The 1950's the industry was at its peak in North America with a number of high profile systems built but demand for the systems fell off shortly after that time. Although demand in other parts of the world, notably Japan, Korea and parts of Europe, continued to increase for automated parking systems, since the turn of the century there have been around 15 systems installed in North America and the rate of installation is increasing. These systems are fast, efficient and environmentally sound. The technology has been refined over the last 100 years-however, the principle has remained the same: parking, simple and automatic.



Photo 9: Pigeon Hole Parking 1953
(Source: The old motor website)

2.8. Advantages of Automated Parking over Conventional Parking facilities

All automated parking systems offer several advantages and improvements compared to conventional parking facilities, these include less space requirement and less construction or building maintenance

cost. The automated parking systems provide high quality of aesthetics to the environment by its design integration and offer high returns on investment by its sustainable design features. Automated parking systems require up to 50% less volume of the parking structure to handle the same number of vehicles compared to conventional ramped parking facilities, this feature adds to the competitiveness of automated parking systems as land prices in large cities are very high.

Cost factors such as ventilation systems, pedestrian elevators, emergency staircases and fire doors are unnecessary in case of automated parking. So, the construction costs are thus comparable to average costs of conventional parking buildings. Construction of parking facilities below ground adds to the competitiveness of automated systems as less construction volume is required to handle the same amount of cars. The following table from Walker Parking Consultants indicates construction cost comparisons for a conventional garage versus an automated garage in three different configurations:

Configuration	Type	Unit Cost/SF	Efficiency SF/Stall	Building Cost per Stall	Automated Machinery Cost, \$/Stall	Total Cost per Stall
Stand-alone, Above Grade	Conventional	\$50	320	\$16,000	\$0	\$16,000
	Automated	\$45	225	\$10,125	\$16,000	\$26,125
Below building, above grade	Conventional	\$75	450	\$33,750	\$0	\$33,750
	Automated	\$65	225	\$14,625	\$16,000	\$30,625
Below building, below grade	Conventional	\$105	450	\$47,250	\$0	\$47,250
	Automated	\$85	225	\$19,125	\$16,000	\$35,125

Table 1: Construction Cost Comparisons between Conventional Ramp Garages and Automated Garages (Monahan, 2012)

Therefore, the conventional above grade garage is less costly per floor than the automated garage, unless the site is very small that results in a very poorly efficient conventional garage. Automated garage saves floor area at the high unit cost that counterbalances the cost of the automated machinery. Similarly, the unit cost is even higher for underground garage construction (see details of financial costs in annex I).

Compared to the conventional parking, computerized parking facilities require more electrical power still the management and maintenance of these parking facilities is much less labor-intensive. In addition, due to conveying technology, no polluting vehicle exhaust is emitted in the parking building. Automated parking systems guarantee highest safety standards for persons and vehicles. The transfer stations for entering and retrieving vehicles are located in well-lit, safe areas and are monitored by security cameras. Once the vehicles enter the automated parking system, they are safe from damage, dents, theft and vandalism. Exposure to vehicle exhaust in waiting lines is also avoided.

Computer controlled parking garages enable and facilitate the integration of services, such as parking space reservation systems, traffic control, carwash stations for parked vehicles and many more innovative customer services and support systems. Ramped parking structures have an unaesthetic and unfavorable existence in urban surroundings. Automated parking systems are constructed with a closed facade, thus giving city planners and architects considerable freedom of design regarding the shape and appearance of the parking facility. The investment in automated parking garages enables high returns due to the high level of space efficiency and utilization. Automated parking systems represent profitable investment opportunities for municipal authorities, parking corporations, property and business owners as well as other investors.

Automated parking systems have a number of sustainability benefits over conventional parking. The precise benefits vary with system type and project site but the general potential benefits includes

reduction in operational energy consumption because no internal lighting is required (except for maintenance), simple ventilation as only two air changes per hour are required and no requirement for other energy consuming assets including passenger lifts, amenities and barrier control systems. Reduced vehicles emissions (CO₂, NO_x, PM₁₀) as engines are switched off during parking process. Smaller building footprint reduces the need for excavation and ground works, reducing the amount of construction waste sent to landfill. High levels of recycled content through the use of steel in equipment (steel has high levels of recycled content). Nontoxic materials are used in construction (e.g. volatile organic compounds in paints). Reduced risk of accidents for pedestrians. Preferred parking for car sharing and low emission vehicles. Electric vehicle charging facilities. Increased personal security and safety especially at night. Reduced acoustic noise and spaces accessible to all users, e.g. disabled or parents with children (FATA automation, 2014).

2.9. Case Studies

There are a number of examples from different countries that have replaced conventional parking with automated parking and hence achieved a number of benefits. These case studies are explained below:

2.9.1. Automated Parking in Manhattan

An automated parking garage of 320 parking spaces was introduced in the City of Hoboken, New Jersey in January 1999. In a long series of new automated garages to be built across the country, this project was regarded as the first pilot project (World parking symposium III, 2001). The automated parking facility (APF) took a long time for its widespread recognition in North America. With the change it brought in Hoboken, another automated parking garage was installed at “One York” in Tribeca, downtown Manhattan. This project was completed in October 2008. This 32-unit condominium building houses called as the “first fully automated parking system in the USA that uses sophisticated pallet-less technology for vehicle transfer.” Residents of One York can view the mechanized, software controlled parking process through a viewing window at grade level (National Parking Association, 2009).



Photo 10: Residential renovation typified by the building at 1500 Hudson Street
(World parking symposium III, 2001)

2.9.2. Automated Parking in Munich

An awarded automated garage for residents constructed in the Donnersbergerstrasse Munich, Germany. This is a first underground automated garage for residents. Introduced by the municipality of Munich, the former car-crowded street became an attractive living space with its lost green areas recovered. Previously, the cars moved around the block searching for place to park, now the residents have their parking space in front of their door daily reduction of the searching traffic of 284 cars for parking spaces much lower level of emissions and fuel usage reduced approx. 80%.



Photo 11: Comparing before and after situations building automated parking facility (Woehr, 2014)

It only takes 137 sec on average for car retrieval. It has a capacity to carry out 100 car operations per hour. 24 hour video monitoring is done. In the underground control room, it is possible to have a look at the parking operations. 4 trained technicians are needed to carry out the operations. This parking system has been awarded as the best European parking concepts 2007. It has a 100 % degree of utilization. All 284 places are rented. The concept gained a very good acceptance since the start in May 2006. Total cost 11.5 Mio €, service cost 20 € per month and rental cost for residents 71 € (Woehr, 2014).

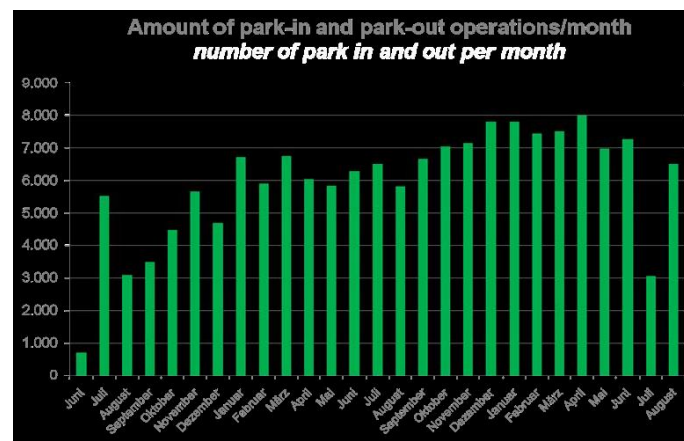


Figure 3: Amount of park in and out operations per month (Woehr, 2014)

2.9.3. Automated Parking in Toronto

Canada's largest city and a major hub for business Toronto, had an estimated population of 2.48 million people (5.5 million in the GTA - Greater Toronto Area) in 2006. It is considered the most multicultural diverse city in the world.

The city council of Toronto has restricted the number of vehicles that can be parked in a residential driveway, by passing a new by-law recently. According to the by-law, the residents are permitted to park one vehicle in their garage and one on the driveway. Residents with a double garage may park two vehicles in the garage and two on the driveway. Residents could be issued a fine of up to \$5,000, if any additional vehicles are parked. This causes the problem of limited parking space for residents. There is limited parking available on city streets, particularly in residential areas. Most of these streets have very few places to park a vehicle. Most of the urban areas in Toronto, provide limited parking time frames which sometimes cause drivers to look for parking elsewhere. In some areas, there are also safety concerns about possible theft or vandalism, particularly in the late evening or overnight.

There are many high-rise apartments and shopping malls in the greater Toronto area but there still exists a problem with limited parking space. Car parking systems facilitate the problem of limited parking and also solve other potential problems such as safety, theft and vandalism concerns. Because

of the number of advantages offered by car parking systems, they will become much more common within the next decade (Romax, 2014).

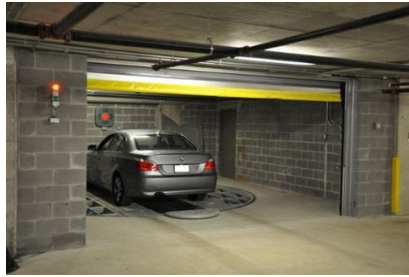


Photo 12: Car parking system in Toronto (Source: Romax parking)

CHAPTER NO. 3

RESEARCH APPROACH

This chapter describes the research methodology used to complete the report. The first task was to select the topic and find out background information to identify the true nature of problem and the focus of research regarding this problem. The literature studied, focused mainly on characteristics of residential parking and the ways in which it is done, draw backs of conventional parking techniques, better ways of parking, innovative concepts of parking and their potential benefits over conventional parking. Data collection process, analysis and conclusions are also discussed in detail.

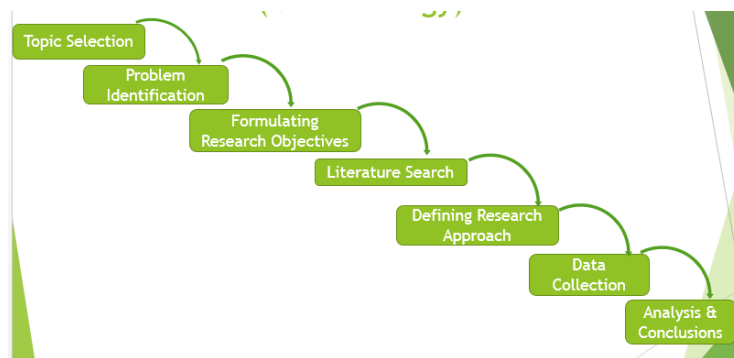


Figure 4: Research Approach

3.1. Topic Selection

A list of topics was given by the university and three topics were selected by choice. The motivation behind selecting this topic was to identify and explore new concepts that can be adopted for parking in residential area. Working out on this topic can unveil different parking strategies and ways that can be fitted in the context of residential parking. To learn and explore the parking strategies adopted by other countries and the benefits they have provided to the users and environment as a whole and appear to be potential solutions to the issues faced by the residents.

3.2. Problem Identification

The next task after topic selection was to identify the exact problem that needs to be solved using the new concepts. The problem identification is a necessary part of a scientific research as it paves the path in which the research is going to be conducted and the things that need to be kept in mind while selecting the literature and setting up research goals.

The problem that is identified in this research was that parking issues in residential areas are increasing due to the increase in car ownership rate. These issues generate concerns regarding traffic safety, environment and aesthetics of residential areas. The residential area is the place where the vehicles are placed for the longest duration. The conventional concepts of parking are not efficient enough to meet the future demand so this implies a need of some new concepts that should be introduced or reflected upon to solve the issues of conventional parking and provide an efficient way to park cars in neighborhoods.

3.3. Literature Search

The major focus of the research was on residential parking regulations and the way in which it is done (i.e. on-street and off-street parking and there types). Draw backs of conventional parking (on-street

and off-street). Efficient ways to better utilize existing parking, innovative parking systems and their advantages over conventional parking and case studies of the implemented areas.

The literature regarding the automated parking systems is taken from the developer's websites while all the other topics are taken from scientific literature. The literature primarily targets the residential parking and its management. Conventional parking methods explain the way how parking is done currently and its draw backs illustrate the parking issues that are faced by the users. Efficient ways of parking include different strategies that can be adopted to better utilize the existing parking and provide solutions to existing parking issues.

The other part of the literature diverts attention to some technical solutions such as automated and semi-automated systems that have been used for better management of parking in residential areas by most of the developed countries and their implementation benefits over conventional parking.

3.4. Defining Research Approach

A thorough desk research was the major tool to carry out this part of the research. The objectives of the research were formulated by conducting a thorough desk research and collecting required information on various non- scientific & scientific journals, website, newsletters, journals, conference proceedings and reports etc. The most relevant information was selected and reproduced in the literature review.

The next important task was to identify the research methodology for conducting the research. After discussion from the Hasselt municipality, study areas was identified and it was decided that an observation plan would be set up to identify the parking issues in that area and propose relevant parking solutions deduced from the literature. This can be done at first by preparing the inventory list of parking issues (collected through observations) and their possible solutions, and then by conducting structured interviews from the focus group working in the municipality, that which concept (solution) according to them can best fit in the study area.

3.4.1. Identification of Study area

The study area selected is Runkst, Hasselt. It is located near city center and has diverse mix of land uses. The municipality has selected this area because according to them residential parking issues are arising in that area. The boundary of the study area has been shown in the map.

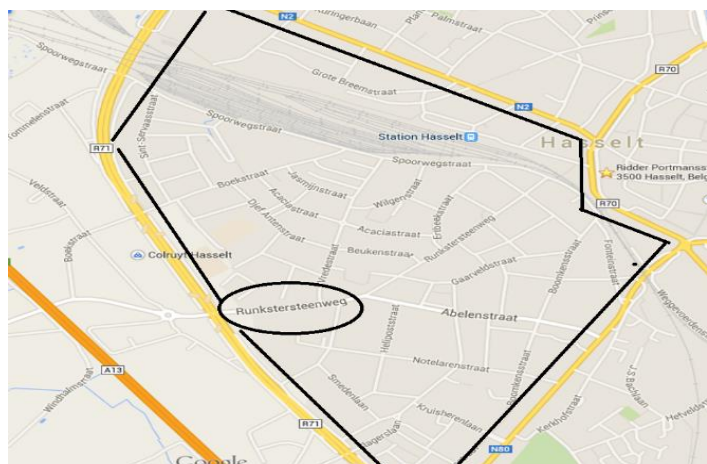


Photo 13: Study area
(Runkst, Hasselt)

3.4.2. Obtaining Maps & Performing Preliminary Survey of Area

After the selection of study area the Land use maps would be obtained in order to find out types of land uses present in the area and to what extent they are contributing in causing parking issues for the nearby residents. The land use maps can be obtained from Hasselt municipality.

3.4.3. Setting up Observation Plan

Land use maps were used to set up observation plan for finding out the parking issues prevailing in the area. Specific observation forms were designed to carry out the observations. These form contain information such as the name of street, duration of observation and type of problem observed etc. (see observation form in annex).

3.4.4. Preparing Focus Group Questionnaire

A focus group questionnaire was prepared keeping in view the issues observed from observations. The questionnaire included questions regarding the identified concepts (from literature) such as applicability, acceptability, strengths, weakness, benefits and consequences of a concept.

3.4.5. Conducting Focus Group

Focus group session was conducted as a part of data collection, it included parking experts working in Hasselt municipality. A formal presentation about the study was delivered and questionnaires were distributed among the participants. The views of the participants were obtained about the proposed concepts and their applicability in the area. And what other concepts can be applied in the context of study area. A focus group is a form of qualitative research in which a group of people are asked about their perceptions, opinions, beliefs, and attitudes towards a product, service or concept (see more detail in chapter 5).

3.4.6. Analysis & Conclusions

The information on the questionnaires was then analyzed and the identified concepts were ranked. Based on the ranking, parking concept that gains the highest score from focus group was considered as the best possible new concept that can be applied in the study area.

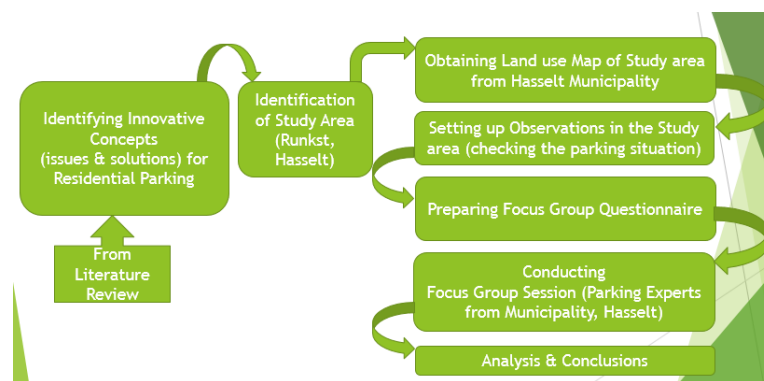


Figure 5: Data collection process

3.5. Conclusions & Recommendations

The conclusions are deduced from the analysis of focus group and articles studied. The conclusions are made by explaining the major points of the literature such as conventional parking and its draw backs and potential benefits and advantages of innovative parking over the conventional parking. The analyzed focus group questionnaires were used to explain the findings of using focus group as data collection tool. Recommendations were made keeping in view the findings from observations and focus group.

CHAPTER NO. 4

AREA PROFILE & FOCUS GROUP

This chapter discusses the profile of the study area and the methodology adopted for data collection. The qualitative data collection method of focus group along with its advantages and limitations are highlighted in this chapter. In addition to the focus group, observation plan is also discussed in this chapter.

4.1. Profile of Study Area

The area selected for study is Runkst, Hasselt. It is a district of Hasselt, located in the South-West of the city center. In 2007, it had a population of 10,726. Runkst is bounded by rail road to the city of Diest on its North, on its South it has district of Sint-Lambrechts-Herk, on its East it has railway to Sint-Truiden and on its West it has Stevoort and Kuringen. As described in the history, Runkst was a rural hamlet of Hasselt, located outside the city. The city experienced rapid expansion and caused ribbon development along the road to Sint-truiden in the beginning of 20th century. Labor class residences were usually found at the back of the station. Runkst mainly has a residential character (Wikipedia, 2015).

The total area to be observed consisted of 1332 km². The dominant land use in the area is residential. Other land uses in the area include school, graveyard, banks, café, sports playground, open parks, bakery etc. The municipality has divided the area into different parking zones. Each zones has different rules for parking. Hasselt is divided into five zones (see annex IV). According to the rules, the residents of these parking zones are entitled a free parking permit. Different land use owners have to obtain the respective parking permit (e.g. temporary parking permit, parking permit for professionals, etc.). Persons with disabilities are exempt from parking permits and fees. The cost and duration of parking is also different for different zones. For residents, the cost of parking is 200 Euros per year and the duration of this permit is two years so it is 400 Euros. After two years the residents need to renew the permit. Which is done online through the e-portal (www.hasselt.be/parkeren).

In blue zone parking is free for two hours. In Hasselt, there are a number of areas where parking is free. These are fully accessible for everyone (residents, visitors, students ...). These areas are located within walking distance or are accessible by bus from center. Name and capacity of free parking are given below:

- Parking Slachthuiskaai 500 parking spaces
- Hawaii 600 parking spaces
- Alverberg 150 parking spaces
- Parking Exit Hasselt South 200 parking spaces
- Parking Truierbrug North 70 parking spaces
- Parking Truierbrug Southern 150 parking spaces
- CCHA 320 parking spaces
- Rail Viaduct 200 parking spaces
- Colonel Dusartplein 160 parking spaces

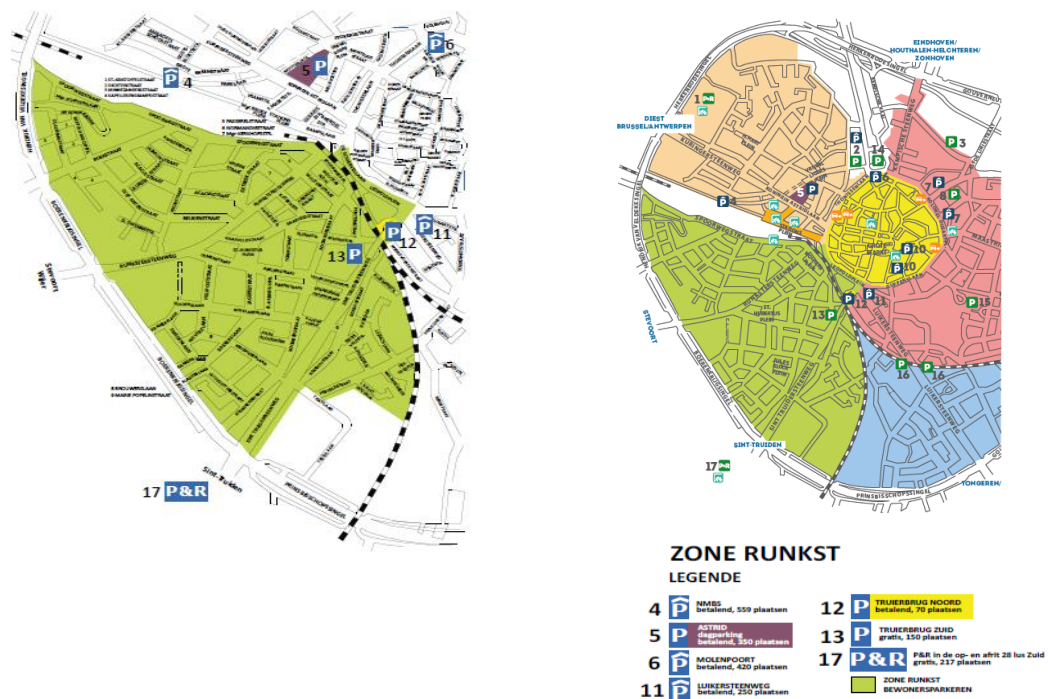


Figure 6: Map of Hasselt, Green part showing study area, Runkst. (Source: Parking in Hasselt, 2014)

4.2. Data Collection

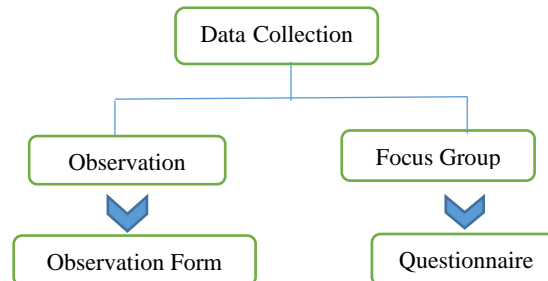
It was decided to use observation technique and focus group as a tool to collect data, these were considered the best approaches to collect data with respect to the time limitations and language issues. Observation is a fundamental way of enquiring new things. Human beings are well equipped with senses to pick up detailed information about the environment. However, as a method of data collection for research purposes, observation is more than just looking or listening. Systematic observation involves careful planning of what is needed to be observed. Secondly, what is seen or heard has to be recorded in some way to allow the information to be analyzed and interpreted.

The term 'systematic' observation is usually associated with observation undertaken from the perspective of quantitative research where the purpose is to provide reliable, quantifiable data. This usually involves the use of some kind of formal, structured observation instrument or schedule. The observation method being used will clearly identify: the variables to be observed, perhaps by means of some kind of checklist; who or what will be observed; how the observation is to be conducted; when and where the observations will take place. In qualitative research, observation can provide rich qualitative data, also called as 'thick description' (Geertz, 1973), for example, where the relevant phenomena have been carefully observed and detailed field notes have been recorded. Typically, the researcher would not approach the observation with pre-determined categories or questions in mind. Because of this openness, observation in qualitative research is often referred to as unstructured. Unstructured observation is more likely to be carried out where the focus is on understanding the meanings, participants, in the contexts observed attribute to events and actions (University of Strathclyde, 2015).

4.2.1. Observation Plan

An observation plan was set up, special observation forms were designed to investigate the parking issues prevailing in different streets of Runkst. Survey was conducted using the observation form. The sample observation sheet is placed in the annex. The observation form also consists of the map of the

area. The information to be recorded on the observation form included date and time of observation, name of street, its distance from city center in meters, number of housing units, street width, type of housing, type of parking, type of on-street parking and type of off-street parking along with the number of spaces available, parking issue other land uses in the street and any free space available in the street. The objective behind setting up the observation plan was to find out the existing situation of parking (issues, free space and type of parking) in the study area.



In order to conduct observations precisely some of the data aid was taken from the municipality, these include land use map of Runkst, map showing the parking facilities in the area, data or reports regarding vehicle registration/ownership, parking issues, type of parking facilities available, census report showing the population, income level of residents and property types/ housing units/ dwelling types/ demographic data, reports regarding parking management/ policies in Hasselt, research reports if any parking study has been conducted by the municipality. This was all included in the website given by the resource person from the Hasselt municipality (http://aps.vlaanderen.be/lokaal/cijfers_domein.htm).

The area to be observed consists of following streets:

1. Boomkensstraat
2. Woutersstraat
3. Runkstersteenweg
4. Gaarveldstraat
5. Beukenstraat
6. Acaciastraat
7. Wilgenstraat
8. Spoorwegstraat
9. Vredestraat
10. Helipoststraat
11. Jasmijnstraat
12. Djef Antenstraat
13. Smedenlaan
14. Beekstraat



Photo 14: On-street Parking

4.2.2. Focus Group

A focus group is used as a tool for gathering qualitative information from a small number of participants. It is a powerful instrument for understanding thoughts, perceptions, attitudes, and behaviors about particular issues or topics. Focus groups are an efficient means to gather “open-ended,” subjective and in-depth responses from multiple viewpoints in a safe environment. A well-conducted focus group can provide insights that are difficult to obtain through other data-gathering techniques. It is a sort of group interview of approximately six to twelve people who share similar characteristics or common interests. A facilitator guides the group based on a predetermined set of

topics. The facilitator creates an environment that encourages participants to share their perceptions and points of view. The data collected through focus group is descriptive and cannot be measured numerically (University of Strathclyde, 2015).

Participants generally are allowed to say anything they like in focus groups sessions. Focus groups therefore are considered to be naturalistic (Krueger & Casey, 2000). The researcher listens not only for the content of focus group discussions, but for emotions, ironies, contradictions and tensions that are helpful in gaining insight. Survey research, on the other hand, enables researchers to make predictions about the occurrence of a phenomenon on a large scale. Focus groups can provide trustworthy naturalistic data that also lead to important insights about human behavior, but they aren't set up to generalize in the same way as survey research (Fern, 2001). More information regarding the purpose, types, uses, characteristics, features and guidelines of conducting focus group are provided in the annex II.

4.2.3. Advantages & Disadvantages of a Focus Group

Focus group usually consists of volunteers gathered to discuss a particular product or idea. These volunteers are asked a series of questions which they answer and freely share their opinions, ideas and reactions. Focus groups usually provide immediate ideas for the improvement of particular products or concepts (Writing, 2015). Some of the advantages and limitations of focus group are discussed below.

Advantages

Focus group is quick and relatively easy to set up than other research techniques. The group dynamic can provide useful information that individual data collection does not provide. It is useful for gaining insight into a topic that may be more difficult to gather through other data collection methods. Information is provided more quickly than if people were interviewed separately. It encourages interaction between participants. The researcher can interact with the participants and ask questions that probe more deeply. When participants are stimulated to discuss, the group dynamics can generate new thinking about a topic which will result in a much more in-depth discussion. As every participant is under observation by the moderator and everybody knows that the process has been videotaped, it is easy to make participants fully engage even during non-discussion time. Results can be easier to understand than complicated statistical data. The researcher can get information from non-verbal responses, such as facial expressions or body language. In a face to face interview, moderator can keep the discussion under control and focus on the areas of interest. Free and open discussion among the respondents results in generation of new ideas which can be very useful for decision making. A focus group is not static. The moderator can bring changes in order to better facilitate the discussion during the group discussion. This dynamism allows better results. Fully equipped modern focus group facilities enables participants to observe the discussion in order to better understand the research findings and also to quality control the whole process (ICS, 2012).

Disadvantages

A major disadvantage of focus group is that it is susceptible to facilitator bias, which affects the validity and reliability of findings. The discussion is sometimes sidetracked by a few individuals. Focus groups generate lots of qualitative information, but no quantitative information from which generalizations can be made. Information can be difficult to analyze. It is difficult to encourage people to participate. Participants may feel under pressure to agree with the dominant view. Compared to individual interviews, focus groups are not as efficient in covering maximum depth on a particular issue. Compared with surveys and questionnaires, focus groups are much more expensive to execute. Usually, each participant will have to be compensated in cash or any other benefit. The moderator plays an essential role in handling the situation, but if the moderator is not experienced enough, it is

very easy for the whole discussion to be dominated by a few people. Moderators can greatly influence the outcome of a focus group discussion. They may, intentionally or unintentionally, introduce their personal biases into the participants' exchange of ideas. This can result in inaccurate results. The small sample size of participants in a focus group might not be a good representation of the larger population. Due to small sample size and heterogeneity of individuals, focus groups findings may not be adequate to make projections. On the other hand if the number of participants in the group is large, discussions can be difficult to steer and control, so time can be lost in irrelevant topics. The moderator's skill in phrasing questions along with the setting can affect responses and skew results (Temkin, 2007).

A focus group can be a very artificial set up which influence the respondents to express and act unnaturally. The findings may be far from the reality. However, focus group research is a useful tool for qualitative research in various fields of study, from marketing to engineering and from finance to public administration (ICS, 2012).

CHAPTER NO. 5

ANALYSIS OF FOCUS GROUP

This chapter discusses the existing conditions of parking in Runkst. This existing condition of parking was analyzed using observation technique. The observation was conducting using observation form on which the information such as type of on-street parking and off-street parking, type of housing, distance of parking facility from city center, capacity of parking available along with the time, date and street name was recorded. It further elaborates the way how the focus group was conducted in collaboration of municipality of Hasselt, to identify the best parking concept that can be applied in the selected study area. The detailed procedure of observations, focus group session and its analysis & findings are also highlighted in this chapter.

5.1. Existing Condition of Parking in Study Area

The existing condition of parking in the area were quite alarming as identified by setting up observations. Some of the streets close to the center had almost no space for visitor parking and the cars of the residents were parking on the pavement thus damaging the pavement condition of the road. Almost all of the streets have on-street parking for residents. Some of the streets have pavement markings but most of the streets did not even have parking space marked in front of the houses so the residents use half of the pavement space thus making obstruction in the flow of traffic on road and for other mode users as well. Most of the streets lack space for cyclists so they are forced to use the space on road thus causing hazardous situation for the cyclists. Off-street parking is only available for sports stadium and other commercial building users. The Table 10 (see annex III) explains the situation in a detailed manner with the street name. This information was recorded using special observation forms designed to carry out observation.

5.2. Findings from Observations

The observations were carried on all the major and minor streets in the study area. The observations were recorded on the observation forms (see annex IV). The information recorded on the observation contains:

- Date & Time of observation
- Name of street
- Distance from the center
- Number of housing units
- Type of housing
- Type of parking
- Character of street depending on the dominant land use available in the street
- Parking issue observed
- Capacity of off-street parking and on-street parking
- Other land uses in the street
- Number of free space available

The observations were conducted in the morning and afternoon. It was clear from the observations that the streets with more number of housing units in the form of row housing had more number of cars parked on street. This shows that parking problems are more obvious in areas with high car occupancy rates. In case of row housing the parking situation was more adverse. It was also observed

that usually people are prone to the habit of keeping their cars in front of their doors they feel more secure if the car is parked on the pavement in front of their doors. This shows that any concept which keeps the car in front of the owner's house would be accepted more than the concept of keeping cars away from owners home.

It was also observed that there is a very less significance of the distance of the street from the city center on the parking condition of the street, but if there are some other land uses such as shops, restaurants, bakeries etc. available in the street then this condition affects the parking situation in the areas and parking issues arise. The distance of the street from the center is measured using Map window software.

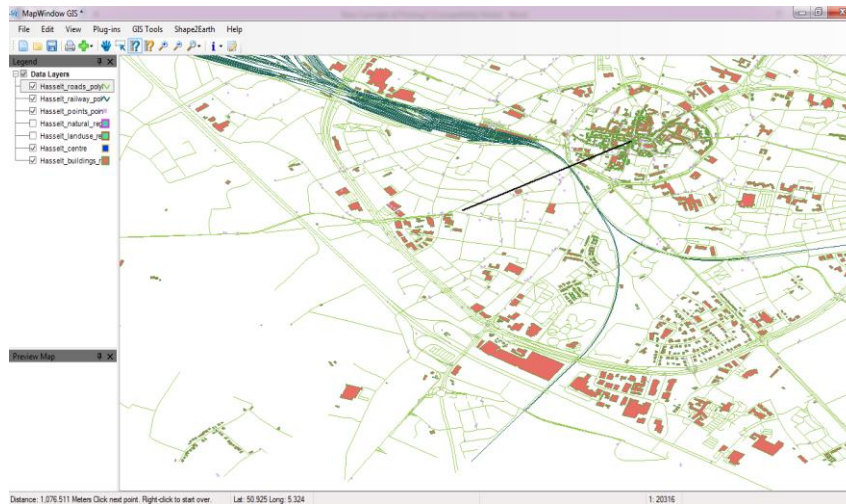


Figure 7: Measuring Distance using Map window

During the weekends the parking situations in some streets gets worst due to non-availability of space for visitors. Although there is provision for visitor parking by the municipality but that seems not to be efficient. The most prominent parking issue observed was less number of space available for parking, pavement parking that damages the pavement and illegal parking. The capacity of on-street parking is very less as compared to the demand. The street width is affected by the on-street parking that causes obstruction for cyclists and other road users thus causing road user conflicts. Most of the streets have on-street type of parking and the cars are parked back to back on the pavement. In some streets there are pavement marking for parking cars on street but most of the streets lack these markings.

There is no separate space for cyclists along the road which is dangerous for them. Off-street parking is not much used by the residents and there are almost no free spaces available in the streets that can be used for parking purposes by the residents. Streets with apartment building do not show any problem for parking as they have spaces available for cars to be parked in the space allotted by the apartment building. The parking situation can be analyzed from Photo 15 given below:



Photo 15: Parking situation observed in Runkst

5.3. Focus Group Session

The data collection was done using focus group. An interactive focus group session was arranged. Before conducting the focus group a questionnaire was designed in order to obtain the necessary information from the viewpoints of desired stakeholders regarding the parking concepts identified from the literature and ask for the acceptability of the concepts. The stakeholders include the residents and the municipality. The Agenda and the composition of the focus group was also considered and planned accordingly.

5.3.1. Focus Group Questionnaire Preparation

The aim of the focus group questionnaire was to get a notion about the acceptability of the identified new concepts of parking that can be introduced in the residential area of Runkst, Hasselt. It is considered as a source of data collection to evaluate which of the new concepts best fit in the context of Hasselt solving the current parking issues of the area and cater for future demand of parking efficiently. The concepts are defined and relevant questions are given in the questionnaire. The participants of the focus group just need to tick in the best option and fill in the space given by writing their views. It was assured that all the information would be kept confidential and used for educational purpose only. The questionnaire consisted two sections with both open and closed ended questions. Section I was about the existing conditions and section II was about the acceptability of the concepts (see for questionnaire annex IV). It had 10 questions with seven identified parking concepts. The last question was about ranking the concept, the participants need to score the concept out of 7. The best concept gets 1 and the least score is ranked as 7.

5.3.2. Location & Time

The session was conducted on 24-03-2015 at 09:30 hours in the morning, at AC Dr. Willems, Dokter Willemsstraat 34, Hasselt. The session was planned for 3 hours. It was decided to carry out the discussion in English. With the researcher as the moderator and the supervisor as the co-moderator. The session started with a presentation describing the content of the questionnaire and as a guidance to fill up the questionnaires. The presentation of the focus group is placed in the annex.

5.3.3. Composition of Focus group

The focus group consisted of 3 people in total. One of them was from the resident committee of Runkst, Hasselt and the rest were from the municipality. These include parking experts from the municipality.

5.4. Analysis

There are several methods for analyzing focus groups these include:

- Constant comparison analysis
- Classical content analysis
- Keywords-in-context

The first step in many approaches to analyze the focus group data is to have the entire interview transcribed. The most common analyses of focus group results involve a transcript of the discussion and a summary of the conclusions that can be drawn. Transcription not only facilitates further analysis, but also it establishes a permanent written record of the group discussion that can be shared with other interested parties.

Constant comparison analysis. This type of analysis has three major stages (Strauss & Corbin, 1998). In the first stage known as open coding, the data is chunked into small units. A code or descriptor is attached to each of the units by the researcher. During the second stage called as axial coding, these codes are grouped into categories. Finally, in the third and final stage of selective

coding, one or more themes are developed by the researchers that express the content of each of the groups (Strauss & Corbin, 1998). Focus group data can be analyzed via constant comparison analysis, especially when there are multiple focus groups within the same study (Anthony et al., 2009).

Classical content analysis. Similar to constant comparison analysis, classical content analysis also creates small chunks of data and a code is placed with each chunk. However, instead of creating a theme from the codes, these codes then are placed into similar groupings and counted.

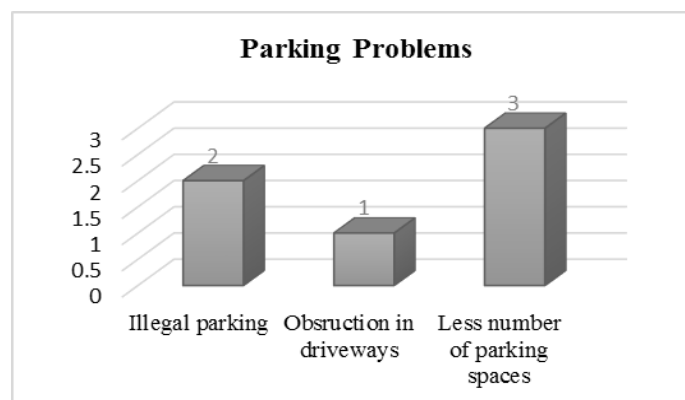
Keywords-in-context. This type of analysis is used to determine how words are used in context with other words. Keywords-in-context represents an analysis of the culture of the use of the word (Fielding & Lee, 1998). Keywords-in-context involves a contextualization of words that are fundamental for the development of themes and theory, by analyzing words that appear before and after each keyword, leading to an analysis of the culture of the use of the word (Fielding & Lee, 1998) (Anthony et al., 2009).

In this study a simple matrix (see Table 10 in annex III) is used to indicate the number of participants falling for an option, since it's a qualitative research so there is no need to indicate the frequencies in number. Only text will be used to analyze that which parking concept is ranked best among the given choices.

5.5. Findings from Focus Group

The findings from the focus groups are explained below:

Parking problems. The first question asked was about the parking problems faced by the residents. When asked about the problems experienced by the residents in Runkst. One of the participant indicated that the main problem prevailing in the area regarding parking and the major issue face by the residents in Runkst is less number of parking spaces. While the other two participants told that Illegal parking, obstruction in driveways, less number of parking spaces are the problems faced by the residents. All the participants were agreed that less number of parking spaces is a prominent issue. The graph below describes the parking problems in Runkst as explained by the participants in the focus group.



Graph 1: Parking Problems faced by the residents in Runkst

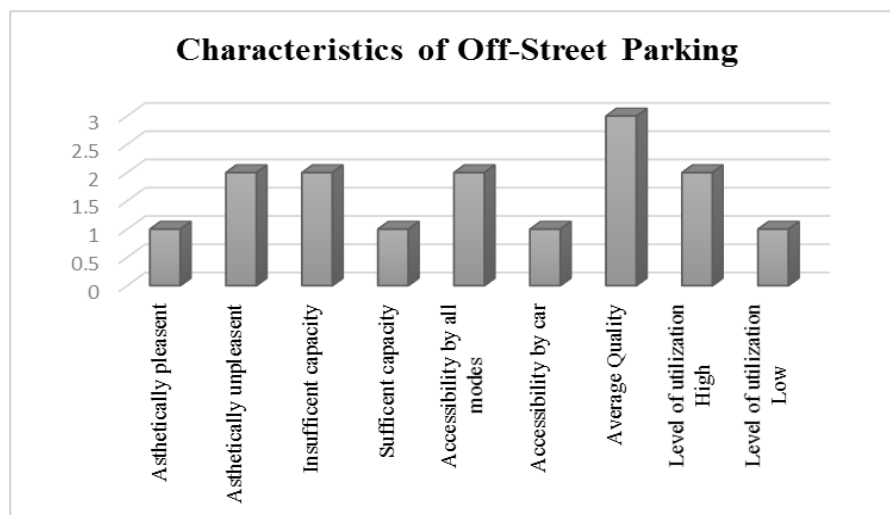
Condition of on-street & off street parking. The next question was about the characteristics of on-street and off-street parking this question was asked to identify the quality & condition of these two types of parking and are the residents satisfied by the availability of these parking types or not.

On-Street Parking. All the participants mentioned that on-street parking seems aesthetically unpleasant, capacity wise insufficient and quality of on-street parking is average. The graph below describes the characteristics of on-street parking in Runkst as explained by the participants in the focus group.



Graph 2: Characteristics of On-Street Parking in Runkst

Off-Street Parking. Participant one, mentioned that off-street parking seems aesthetically pleasant, capacity wise sufficient and quality of on-street parking is good. Although these off-street parking spaces are accessible by automobile (means far for residents) and level of utilization is medium. Other two Participants, declared that off-street parking seems aesthetically unpleasent, capacity wise insufficient and quality of on-street parking is good. These off-street parking spaces are accessible by automobile, by foot and by bicycle and level of utilization is high.



Graph 3: Characteristics of Off-Street Parking Runkst

The next section contained questions about the concepts. Section II was designed in such a way that the concepts were defined and the questions related to the concept were asked followed by the explanation. The concepts to be evaluated includes:

- Centralized Parking
- Shared Parking
- Parking freezes
- Demand Reduction
- Smart Parking
- Automated parking
- Private car parks

Applicability of Centralized Parking in Runkst. When asked if the concept of centralized parking would be applicable in Runkst. Participant one, mentioned that centralized parking is not applicable in Runkst, because people prefer to park in front of their houses and also there is no space available to

construct centralized parking facility. Other Participants, declared that centralized parking is applicable in Runkst, because it is financially feasible, partially conforms with the policy and will increase the livability and safety of the area.

Acceptability by residents. When asked if the concept of centralized parking would be accepted by the residents in Runkst. According to participant one, only 20-40% of the residents will be willing to use the centralized parking if introduced in Runkst. While other Participants, mentioned 40-60% residents will be willing to use centralized parking. This shows that this concept will also be accepted by the community.

Strengths/ Benefits

- Can create more space on street, which makes the streets aesthetically look better.
- Less search traffic
- More capacity
- Less parking pressure in street & increased spatial organization

Weakness /Consequences

- Theft & vandalism
- Increased distance, less social safety because of door to door mentality
- Illegal parking will increase and more turnover
- Due to increased walking distance people want to park the cars as close as possible

Applicability of Shared Parking in Runkst. When asked if the concept of shared parking would be applicable in Runkst. All the Participants one agreed because it is financially feasible, conforms with policy, increases livability and adds a little to increase the safety of the area.

Acceptability by residents. When asked if the concept of shared parking would be accepted by the residents in Runkst. All the Participants told that the concept will be 40-60% accepted by the residents.

Strengths/Benefits

- Better level of utilization of parking spaces.
- More space on-street better living
- Rent of private parking means financial benefits

Weakness /Consequences

- Not a good solution for off-street parking.
- Not all the citizens will have more space if they want to park at 10pm
- Agreement has to be set among the parking providers.
- More use of organization's resources time and money. People need to collaborate for public private partnership that cannot be made obligatory
- Livability of the Neighborhood will be affected
- Vandalism

Applicability of Parking Freezes in Runkst. When asked if this concept would be applicable in Runkst. Participant one agreed that the concept is applicable but it is not financially feasible neither it conforms with policy but it can increase livability and safety of the area. Participant two also agreed on the applicability of the **concept** because it is financially feasible, conforms with policy and can increase livability and safety of the area. Third Participant denied, for its applicability because of limited connection with public transport.

Acceptability by residents. When asked if this concept would be accepted by the residents in Runkst. Participant one & three, mentioned that the concept will be 20-40% accepted by the residents. Participant two, mentioned that the concept will be accepted by 80-100% people. This shows that the concept would be less acceptable by the community.

Strengths/ Benefits

- Aesthetically better less car on streets.
- More supply of parking, more comfort, less search traffic
- Due to increased walking distance people want to park the cars as close as possible
- More capacity, less parking pressure

Weakness /Consequences

- Intervention of police theft & vandalism
- Illegal parking will increase and more turnover.
- It will change policy for visitor parking & employees using the blue zone disc more than the allowed time.
- Politically not feasible, intervention of police

Applicability of Demand reduction in Runkst. When asked if this concept would be applicable in Runkst. All Participants agreed for the applicability of the concept because it is financially feasible and can increase livability and safety of the area to a great extent but it does not conform with the policy.

Acceptability by residents. When asked if this concept would be accepted by the residents in Runkst. Two participants said that, the concept will be 20-40% accepted by the residents. According to third participant, less than 20%.

Strengths/ Benefits

- Aesthetically better more space on streets
- Increased parking space
- Fits best if applied in city center

Weakness/Consequences

- Not good for short trips.
- Usually need more time to wait for buses and other public transports.
- Not a time efficient solution.
- High cost of building & maintenance
- Not applicable in residential area
- It needs renaming the streets and good enforcement that needs money

Applicability of Smart Parking in Runkst. When asked if this concept would be applicable in Runkst. All the participants were strongly agree for the applicability of the concept, because it conforms with the policy and can increase livability and safety of the area to a great extent but it is not financially feasible.

Acceptability by residents. When asked if this concept would be accepted by the residents in Runkst. Participant one, the concept will be 40-60% accepted by the residents. Second participant mentioned 80-100%, third participant mentioned less than 60-80%. This shows that the acceptability

Strengths/ Benefits

- Parking search behavior
- Less traffic more diversion of parking
- High comfort.
- Less search traffic

Weakness /Consequences

- Difficult to be understood by elderly people
- Technically complex to be implemented
- High infrastructure charges

- Residents don't have to look for space.
- More costs involved.
- Does not suit on residential roads but for city center only.
- Difficult to provide alternatives.
- If use apps that it needs to be assume that everybody has a smartphone

Applicability of Automated Parking in Runkst. When asked if this concept would be applicable in Runkst. Participant one, strongly agreed that the concept is applicable because it conforms with the policy and can increase livability and safety of the area to a great extent but it is not financially feasible. Other participants did not agree about the acceptability of the concept due to its increased walking distance and does not integrate with spatial planning and other regulations.

Acceptability by residents. When asked if this concept would be accepted by the residents in Runkst. Participant one, mentioned that the concept will be 20-40% accepted by the residents. Participant two told, 40-60%. Participant three, less than 20%. This shows that this concept would be less acceptable by the community.

Strength/ Benefits

- Less space usage quick storage of vehicles
- No theft vandalism
- Aesthetically better
- More space on street
- Compact solution

Weakness /Consequences

- If residents need to walk far way they won't prefer it.
- Residents cannot park in front of their doors.
- Require technical assistance

Applicability of Private car parks in Runkst. When asked if this concept would be applicable in Runkst. All the three participants agreed about the applicability of private car parks in the study area, because it is financially feasible, conform with the policy and can increase livability and safety of the area.

Acceptability by residents. When asked if this concept would be accepted by the residents in Runkst. Participant one indicated that, the concept will be 40-60% accepted by the residents. Participant two said, 100-80% while third participant mentioned it would only be accepted by 20-40%. This shows that there is more possibility of this concept to be accepted by the community.

Strengths/Benefits

- Aesthetically better more space on streets
- Effective & cheap solution
- More parking comfort
- Better use of space
- More capacity

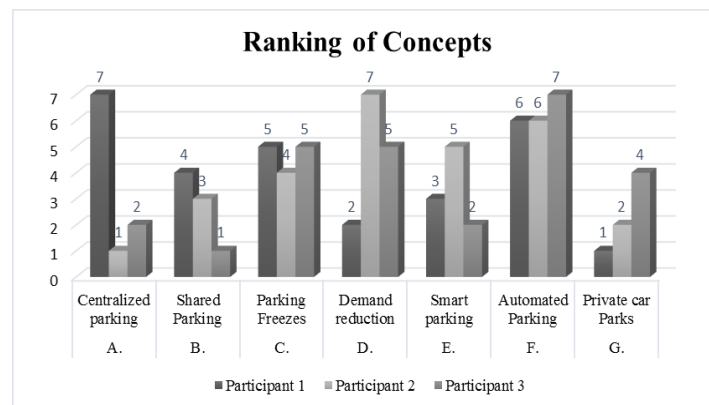
Weakness/ Consequences

- Elderly cannot use it
- Difficult to find the tariffs
- Better use of parking
- Dependent on who is providing space
- Less applicable in city center

Ranking of Concepts. The concepts are given a score on a scale of 7-1. 1 as the highest and 7 the least score. As shown in the table participant one ranked private car parks as the best concept. Participant two and three ranked centralized parking and shared parking

Sr. No.	Concept	Participant 1	Participant 2	Participant 3
A.	Centralized parking	7	1	2
B.	Shared Parking	4	3	1
C.	Parking Freezes	5	4	5
D.	Demand reduction	2	7	5
E.	Smart parking	3	5	2
F.	Automated Parking	6	6	7
G.	Private car Parks	1	2	4

Table 2: Ranking of Concepts



Graph 4: Ranking of Concepts

Reason for being the best possible concept. According to participant one, smart parking has a high cost so private car parks is the best possible solution however, a mix of concepts can be used, such as demand reduction with private car parks can solve a lot of parking problems present in Runkst and other parts of Hasselt. According to Participant two, centralized parking is the most appropriate solution. Because the municipality can implement it independently as it is relatively cheap and does not need involvement of political parties and can be integrated within the spatial structure of the city. While third participant indicated that shared parking, can prove to be the best solution for Runkst, as it can be integrated with the current policy, more efficient space usage and provides more alternatives for the residents to select space closer to their homes. The detailed analysis is given in the form of matrix placed in annex III (see Table 4). This shows that a mix of these three concepts or one of them can be applied to solve the parking issues in the area

CHAPTER NO. 6

CONCLUSIONS & RECOMMENDATIONS

This chapter discusses the conclusions and recommendations that have been deduced from a detailed study of literature. It is concluded that the car ownership rate is growing with the population so the places to reside those vehicles also need to be increased. It is a challenge for the local authorities to provide spaces and manage the demand for parking efficiently without damaging the environment and aesthetics of urban fabric. The issues with residential parking are not just limited to demand and supply of parking but also related to proper utilization of the existing parking facilities. The existing facilities can only be utilized by making efficient parking policies and their enforcement. Parking regulations such as fines or penalties for noncompliance of parking rules can help solving problems such as illegal parking, obstructive driveways or leaving abandoned vehicles on road. On-street parking, is always preferred by the residents and authorities because it is close and cheap but on the other hand it is aesthetically unpleasant to see lot of cars parking on the road. Off-street parking facilities are efficient but these raise concerns such as underutilization because very less residents are willing to pay for them. The efficiency and effectiveness of these conventional parking methods can be enhanced greatly by using parking concepts such as shared parking, centralized parking, in-lieu fees and smart parking. These concepts are helpful not only for the residents but also for the authorities because no or very less additional cost is incurred. Moreover, automated driving systems are technically very advanced and can be used as the most efficient car parking concepts. Although these are expensive but have very successfully solved all the issues regarding parking. The features of automated systems such as less fuel usage, sustainable designs, and reduced space, lighting, heating and ventilation requirements have grasped the eyes of investors. The increased acceptance of such system is creating innovation in performing parking management efficiently. From the observations and analysis of focus group it is clear that the major issue in the area is related to less available parking spaces and illegal parking. The condition of on-street parking is not of good quality and also in-sufficient for the residents, while off-street parking is somehow in better condition. Concepts such as centralized parking, shared parking and private car parks are applicable and acceptable by the community as these are financially feasible, conforms with the policy and if implemented can add a lot to the livability and safety of the area. It is concluded that a mix of these concepts if implemented in the area can reduce the issues of parking to a great extent. The study also revealed that focus group (compared to other survey, data collection techniques) can be used as an effective tool to gain insights regarding the introduction of a particular idea or technique that how much this idea would be accepted or rejected by the community.

6.1. Conclusions

Parking in residential areas is managed using on-street and off-street parking methods, these methods are becoming inefficient to cater for the future demand of parking. Large number of parking problems have been associated to these conventional parking methods with respect to residential areas. These parking problems have many perspectives such as demand, supply and utilization. Environmental, social (illegal parking, obstructive parking, parking of abandoned vehicles on road, vandalism etc.) and aesthetics are just some other dimensions of residential parking problems that are usually neglected and not taken into account.

Residential parking is managed by the local authorities or city councils. These authorities are responsible for enforcement and regulation of parking bye-laws. There are certain factors that should

be kept in mind while devising solutions to parking problems associated to residential areas, these include the resident's choice and willingness to pay for parking. This solely depends on the income level of the community. Proposing a parking concept in an area completely depends on the characteristics of that area and its inhabitants either they need that particular concept and will accept it or not. The characteristics of the community where the parking concept is going to be proposed need to be studied. Some other aspects that should be considered while proposing a parking solution in a residential area includes car ownership rate, parking supply and price, affordability, accessibility, property characteristics (apartments or semi-detached), neighborhood household characteristics and development patterns, average monthly parking cost to tenant, average rent, density, household income, household size, bedroom count, presence of children, age, distance to nearest transit stop, job density, proximity to schools, walk score, block size, and block density.

The parking solutions may not always be of physical nature that is in terms of infrastructural reforms but these can also be in terms of promoting other modes of transit and providing incentives for non-auto modes of transport that discourage car ownership. The use of existing parking facilities or spaces can also be optimized by providing subsidized parking schemes and reducing overall parking costs. If in any residential area the issue is related to less parking space the authority should create more parking space. The authority can also solve parking issues using the innovative ways of parking utilization (e.g., in-lieu parking fees to cover costs of city garages, shared parking arrangements when users park at different times of the day, shuttle buses from centralized parking facilities). Smart Parking is also used nowadays as a tool to properly utilize the existing parking facilities. Automate parking systems can also be a solution in densely populated areas. The case studies have indicated that although these systems gained acceptance after a long time and are highly expensive to be proposed as a solution to residential parking problems but are highly efficient in space requirements, design, sustainability and security as compared to the conventional parking concepts.

The literature defines parking problems and their solutions in the perspectives given below:

- Inadequate information for motorists on parking availability and price. The solution could be to improve use information.
- Inadequate user options. The solution could be to improve parking options, such as letting residents choose between convenient, priced parking and less convenient, free/inexpensive parking.
- Inconvenient parking pricing methods, such as mechanical meters that require users to predict how long they will be parked and only accept certain coins. The solution could be to improve pricing systems.
- Inefficient use of existing parking capacity. The solution could be to use parking management strategies that result in more efficient use of parking facilities.
- Excessive automobile use. The solution could be to reduce automobile dependency and encourage transportation alternatives.
- Concerns over spillover parking congestion in nearby areas if parking supply is inadequate or priced. The solution could be to provide parking management and enforcement in impacted areas.
- Economic, environmental and aesthetic impacts of parking facilities. The solution could be to reduce parking supply and improve parking facility design.

Keeping in view the findings from the observations, it is concluded that less parking space and illegal parking are major problems prevailing in study area (Runkst). The capacity of on-street parking is very less as compared to the demand. Parking problems are more obvious in streets with high car occupancy rates. In case of row housing the parking situation was more adverse. People are prone to

the habit of keeping their cars in front of their doors they feel more secure if the car is parked on the pavement in front of their doors so the off-street parking is not much used by the residents. Obstruction in driveways for other road users was also observed with creates safety issues especially for pedestrians and cyclists. Visitor parking is not efficiently managed by the municipality. The presence of other land uses such as shops, restaurants, bakeries etc. in the street affects the parking situation in the areas and gives rise to parking issues.

The findings from the focus group show that financial feasibility and integration with the parking policy are two important aspects that should be fulfilled for the applicability of the concept. Concepts such as centralized parking, shared parking and private car parks are applicable and acceptable by the community as these are financially feasible, conforms with the policy and if implemented can add a lot to the livability and safety of the area. Also the municipality can implement these independently, does not need involvement of political parties and can be integrated within the spatial structure of the city. It is concluded that a mix of these concepts if implemented in the area can reduce the issues of parking to a great extent.

6.2. Recommendations

Residential parking problems have various perspectives and dimensions, which can be solved by implementing combination of parking management strategies or innovative parking systems depending on the level of acceptance, affordability and ease of usage by the community.

It is recommended that combination of parking strategies should be explored such as combining residential parking permits and time limits. Residential parking permits coupled with 2 or 4-hour time limits can protect neighborhoods from long-term commuter parking spillover. The policy of double use of parking can also be adopted. The municipality should pursue the use of public lots for smart parking. This new technology uses real-time information for making people aware of availability of parking space. A successful parking strategy requires extensive on-going coordination and planning for increased parking demand. The authorities should survey the parking situation annually to identify problems and seek solutions. Certain strategies should be introduced that can result in a reduced demand for parking, such as transit incentive programs, car sharing, shuttles and shared parking that prove to be beneficial in the context of residential areas.

The residents and municipality are the key stakeholders for parking concerns in a community. So, it is recommended that the municipality should make parking policies with the aim to discourage car use and optimize existing parking space instead of creating more space for parking. Residents are the key players for the well-being of a community. To mitigate the issues related to parking, residents need to understand the importance of parking policies and concepts. These parking concepts are introduced to meet the future parking needs of the area and for the overall betterment of the community. If the residents need the environment near their homes to be safe and aesthetically pleasant, they need to change their habit of keeping car in front of their door and abide by the changing need of parking management. Moreover, all the concepts mentioned in the study are valuable, but their application varies depending on the situation and conditions of the parking issues of the area for which they are proposed. The research also paves the way for future research related to the current topic such as carrying out the assessment of financial feasibility of the identified innovative concepts using cost benefit analysis. This piece of research serves the basis for evaluating which concept would be financially acceptable by the municipality.

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Annex I: Parking Problems and Financial Costs for Parking Facilities

Perspective	Problem Definition	Potential Solutions
Supply-oriented	Inadequate supply, excessive price.	Governments, businesses and residents should increase parking supply. Increase minimum parking standards.
Information Oriented	Inadequate user information.	Create signs, brochures and other information resources indicating parking availability and price.
Choice-Oriented	Inadequate consumer options.	Increase the range of parking convenience and price levels available to consumers.
Pricing Convenience	Pricing is inconvenient.	Develop more convenient payment and time options.
Efficiency-oriented	Inefficient use of existing parking capacity.	Share parking facilities. Implement transport and parking demand management. Price parking. Provide shuttle services to parking facilities.
Demand-oriented	Excessive automobile use.	Improve access and transport choice. Transport and parking demand management programs.
Spillover Impacts	Inadequate parking causes problems in other locations.	Use management strategies to respond to spillover problems. Improve enforcement of parking regulations.
External Impacts	Parking facilities impose external costs.	Reduce parking minimums. Price parking. Improve parking facility design. Implement TDM programs.

Table 3: Different perspectives for viewing parking problems (Litman, 2006)

Building Type	Unit	Spaces
Single Family Housing	Dwelling Unit	2.0
Multi-Family Housing	Dwelling Unit	1.8
Apartments	Dwelling Unit	1.5
Neighborhood Commercial	100 sq. m. GLA	4.7
Community Commercial	100 sq. m. GLA	5.3
Regional Commercial	100 sq. m. GLA	5.8
Office Building	100 sq. m. GFA	3.2
Fast-Food Restaurant	Seats	0.85
Church	Seats	0.5
Hospital	Beds	2.6
Light Industry	100 sq. m. GFA	2.2

GLA = Gross Leasable Area GFA = Gross Floor Area

Table 4: Typical Off-Street Parking Requirements (ITE, 1999)

	Small Site (30,000 sf)	Medium Site (60,000 sf)	Large Site (90,000 sf)
Area Per Space	350 sf	325 sf	315 sf
Surface Parking	\$1,838	\$1,706	\$1,654
Ground + 1 level	\$7,258	\$6,143	\$5,705
Ground + 2 level	\$8,085	\$6,767	\$6,284
Ground + 3 level	\$8,407	\$6,996	\$6,491
Ground + 4 level	\$8,747	\$7,269	\$6,747
Ground + 5level	\$8,973	\$7,451	\$6,918
Ground + 6 level	\$9,135	\$7,581	\$7,040
Ground + 7 level	\$9,256	\$7,678	\$7,132
Ground + 8 level	\$9,351	\$7,754	\$7,203

Table 5: Typical Parking Construction Costs (PT, May 2000, p. 28)

Type of Facility	Land Costs	Land Costs	Construction Costs	O & M Costs	Total Cost	Daily Cost
	<i>Per Acre</i>	<i>Per Space</i>	<i>Per Space</i>	<i>Annual, Per Space</i>	<i>Annual, Per Space</i>	<i>Per Space</i>
Suburban, On-Street	\$50,000	\$200	\$2,000	\$200	\$408	\$1.36
Suburban, Surface, Free Land	\$0	\$0	\$2,000	\$200	\$389	\$1.62
Suburban, Surface	\$50,000	\$455	\$2,000	\$200	\$432	\$1.80
Suburban, 2-Level Structure	\$50,000	\$227	\$10,000	\$300	\$1,265	\$5.27
Urban, On-Street	\$250,000	\$1,000	\$3,000	\$200	\$578	\$1.93
Urban, Surface	\$250,000	\$2,083	\$3,000	\$300	\$780	\$3.25
Urban, 3-Level Structure	\$250,000	\$694	\$12,000	\$400	\$1,598	\$6.66
Urban, Underground	\$250,000	\$0	\$20,000	\$400	\$2,288	\$9.53
CBD, On-Street	\$2,000,000	\$8,000	\$3,000	\$300	\$1,338	\$4.46
CBD, Surface	\$2,000,000	\$15,385	\$3,000	\$300	\$2,035	\$6.78
CBD, 4-Level Structure	\$2,000,000	\$3,846	\$15,000	\$400	\$2,179	\$7.26
CBD, Underground	\$2,000,000	\$0	\$25,000	\$500	\$2,645	\$8.82

Table 6: Typical Parking Facility Financial Costs

This Table 7 illustrates the financial costs of providing parking facilities under various conditions. (CBD = Central Business District)

	Spaces Per Vehicle	Annual Cost Per Space	Paid Directly By Users	User-Paid Costs	External Costs	Total Costs
Residential	1	\$600	100%	\$600	0	\$600
Off-street	2	\$800	5%	\$80	\$1,520	\$1,600
On-street	2	\$400	5%	\$40	\$760	\$800
<i>Totals</i>	<i>5</i>			<i>\$720 (24%)</i>	<i>\$2280 (76%)</i>	<i>\$3,000 (100%)</i>

Table 7: Typical Parking Facility Financial Costs (Litman, 2006)

This Table 8 shows an estimate of total parking costs per vehicle and their distribution. It indicates that users only pay directly for about a quarter of total parking costs. The rest are borne indirectly through taxes, reduced wages, and additional costs for goods and services.

Annex II: Additional Information on Focus Group

Purpose of Focus Group

The purpose of the focus group is to collect data related to inquiry question in a setting that allows for interaction and encourages deep thinking about important issues. The group environment compels participants to think about other people's responses in relation to their own, and encourages them to formulate and express their own impressions. In listening and responding to others, participants can correct misinformation and provide alternative perspectives. However, a focus group is not a problem solving session or a way to reach consensus on a decision. There are other group processes to use for those purposes. A focus group is an appropriate means for obtaining a diversity of perspectives, opinions, and experiences. Focus groups are useful for gathering subjective perspectives from key stakeholders.

Mixed methods approaches are used to increase validity of evaluation findings by using a variety of data collection techniques. Because focus groups are one of the few methods in which data is gathered from a group, it is useful as part of a mixed method approach (Grudens et al., 2004).

Characteristics of Focus Group

Focus group has some specific characteristics. Without these characteristics it is not possible to conduct the focus group.

These include

- Moderator
- Environment
- Participants
- Analysis & Reporting

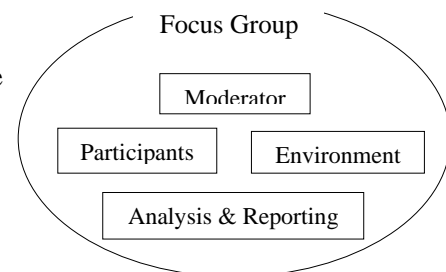


Figure 8: Focus group characteristics

Moderator. Moderator is a person who conducts the session, a good moderator should be highly skillful with respect to group discussion. The moderator should use predetermined questions and it's the responsibility of moderator to establish permissive environment.

Environment. The environment of the place where the focus group is going to be conducted should be comfortable and it is preferred that the participants should be seated in circular arrangement and if possible the session should be recorded.

Participants. The participants for conducting the focus group should be selected very carefully, because their opinions will reflect other people's responses in relation to their own. There should be about 5-10 people, 6-8 are preferred. The group should contain people from similar category or work field.

Analysis & Reporting. Appropriate analysis technique should be selected for analyzing focus group so that the results clearly describe the mutual response of the focus group. Systematic analysis and special verifiable procedures should be used for analyzing focus group and appropriate reporting procedure should be adopted.

Features of focus groups

In qualitative research, focus groups have some differences from other survey methodologies.

- **Insight not Rules** Focus group allows all participants to say anything they would like in front of the whole group, this can provide trustworthy naturalistic data that also lead to important insights about human behaviors. Meanwhile, researchers listen not only for the content of discussions but observe something beyond talking, such as tone and emotions which help them to learn or confirm not just the facts but the meaning behind the facts.
- **Social not Individual** In a focus group session, conversation among participants results in discussion data. In this way, focus groups produce information that paints a portrait of combined local perspectives because the research may seek ways to fit all together.

- **Homogenous not Diverse** Focus group researchers select and invite 20-25 people with similar characteristics to a single session. The goal is to fill the room with a minimum of 10-12 participants that are similar which is supposed to increase the quality of the data (Krueger and Casey, 2000).
- **Flexible not standardized** During the course of a two-hour session, a natural conversation will be produced because individuals are allowed to laugh, tell personal stories, revisit earlier questions, disagree with other research, the moderator only needs to lead the conversation on track by applying his prepared interview guide. Actually, a well-designed guide encourages group members to relax, open up, think deeply and consider alternatives.
- **Words not Numbers** Focus groups rely upon words spoken by participants. A report based on focus groups will feature patterns formed by words, called themes or perspectives. Numerical analysis is not a preferred technique. In fact, it is inappropriate to report a result of focus groups by percentage (Brown, 2014).

Uses of focus group

Focus groups may be used:

- To explore new research areas (sensitive topics, topic that is difficult to observe (not easy to gain access) & does not lend itself to observational techniques (e.g. attitudes and decision-making)
- To collect a concentrated set of observations in a short time span
- To ascertain perspectives and experiences from people on a topic, particularly when these are people who might otherwise be marginalized
- In combination with other methods, focus groups might be used to:
 - gather preliminary data
 - aid in the development of surveys and interview guides
 - clarify research findings from another method

Methods of conducting Focus group

There are different ways of conducting focus group, some of them are given below:

- **Focus groups can be conducted in person or via teleconference.** It is ideal to conduct a focus group in person, it is possible to conduct a focus group by phone. Web conferencing is an additional technology that can be used for focus groups. When conducting focus groups by phone or web conference, the facilitator has to work to ensure that everyone participates in the discussion.
- **Playing a game.** The moderator contacts the potential participants and arranges the room for conducting the session. At the start of the session the moderator explains the objective of the focus group. The moderator uses power point presentation projector to elaborate the questions. The participants are given the cards where they write their desired answer and reason why they selected that choice. The cards are then placed on the board and pictures are taken.
- **Conducting focus group using questionnaire.** Before the session the moderator makes a list of potential participants and contacts them. A separate room to conduct the session should be arranged where the focus group session is to be conducted. The moderator describes the objective of the focus group, records the designation of the participants & explains the questionnaires. The group of people are provided with the questionnaires to be filled in by the respondents. The data collected is then analyzed using SPSS and the best parking concept is identified.

Types of Focus groups

Depending upon the research questions. The focus group varies in its types. Different types of focus groups can be used for exploring new research topics e.g.

- **Two-way focus group** one focus group watches another focus group and discusses the observed interactions and conclusion.
- **Dual moderator focus group** one moderator ensures the session progresses smoothly, while another ensures that all the topics are covered
- **Dueling moderator focus group (fencing- moderator)** two moderators deliberately take opposite sides on the issue under discussion
- **Respondent moderator focus group** one and only one of the respondents is asked to act as the moderator temporarily
- **Client participant focus groups** one or more client representatives participate in the discussion, either covertly or overtly
- **Mini focus groups** groups are composed of four or five members rather than 6 to 12
- **Teleconference focus groups** telephone network is used
- **Online focus groups** computers connected via the internet are used

Guidelines for Conducting Focus Groups

Focus group is a good method to get people involved in the decision making process and to get their input regarding the topic. The purpose of this section is to provide a general overview of the focus group process based upon the experience of the focus groups conducted during this study.

- Preparation
- Selection of participants
- Session logistics
- Moderating the session
- Analysis of Information

Preparing for the Focus Group Discussion

When preparing for the focus group discussions there are several considerations including what questions will be asked, who will participate, where will the discussions be held, and who will conduct the sessions. The first step is to develop a discussion guide.

- **Developing the Discussion Guide.** The discussion guide contains the questions which will be asked to participants during the discussion sessions. Approximately 10 to 15 questions should be used for the discussion. It is avoided to spend too much time on background information and concentrate on the important issues necessary to cover. There are two elements which should be considered when drafting the guide. First, it is necessary to identify who you want to obtain information from and second, what type of information is needed (Beimborn, 2015).
- **Reserve a Time and Place.** Reserving a time and place to conduct the discussion should be done well in advance to the actual date of the discussion sessions. Finding a location quickly will give time to contact potential participants with the necessary information regarding the time and location of the sessions. Another option for conducting the focus group is to hold the sessions at a focus group discussion facility. Marketing firms often have special facilities in which they conduct focus group discussions. Using these facilities will add to the cost of the project. When selecting a location, try to find the most convenient and accessible location as possible.
- **Provide an Incentive for Participation.** Individuals taking part in a discussion session should be compensated for their participation. When contacting potential participants use an incentive to encourage or persuade an individual to take part in a discussion session. Various

forms of compensation can be used with the most common being a cash payment, lunch or dinner. Snacks and beverages may also be provided at the discussion.

- **Determine the Equipment needed.** The researcher must determine how detailed information is needed to be obtained from the discussion. This will determine whether to audio tape, videotape, or simply take notes. The advantage of videotaping is that it allows the research team to easily make note of the important quotes and comments made during the discussion. This will allow the person reviewing the tape to quickly locate these comments and record the exact information. If the sessions will be videotaped, it is necessary to reserve the equipment well in advance of the sessions. Equipment which is needed includes:
 - A video recorder.
 - A microphone which should be placed at the discussion table.
 - A videotape per session (Note: One videotape will hold approximately two hours of time).

It is recommended to videotape the sessions. If notes are taken by the research team during the session, this will also facilitate the development of a report for the focus group.

Selection of Focus Group Discussion Participants

When developing the discussion guide it is necessary to identify who will participate in the discussion sessions. This will provide an indication of the number of participants who will formulate the discussion group. A good size for a discussion group is between 8 to 10 participants. However, the discussion can still take place if fewer than 8 participants show up. It is difficult to assure all participants will show up for the discussion as some individuals may forget, run into a scheduling conflict, or just decide not to take part. For this reason, it is recommended approximately 12 participants to be selected to take part in the discussion session. After making a list of potential participants, the individuals should be contacted by telephone with information regarding the discussion session. When making initial contact with the potential participant, provide the date, time and location of the session. Be sure to mention the incentive for taking part in the discussion as this could influence some individuals to take part.

A follow-up letter should be mailed to individuals who agreed to take part approximately a week to ten days prior to the discussion session. The follow-up letter should briefly describe the purpose of the focus group and include information which clearly identifies the date, time and place of the discussion. Finally, participants should be asked to contact the research team if they are unable to attend so that it an alternate participant can be contacted in time (Beimborn, 2015).

Preparation for the Discussion Sessions (Session logistics)

The discussion room should be setup and ready for the discussion when participants arrive. Participants should be seated around a table with the moderators back to the video recorder. The video recorder should be positioned to provide the widest angle possible and a microphone should be placed on the table. One of the challenges in recording focus group data is knowing who is speaking at any particular time, since often multiple people speak in overlap that's why it is necessary to consider audio-or video-recording focus group sessions. Video will be helpful for identifying who is speaking. Recordings also provide the ability to replay sessions during analysis.

There should be at least 2-3 researchers (in addition to the moderator) to attend the focus group and take notes. The focus of each researcher's note-taking efforts might be different (e.g. non-verbal behavior, group dynamics, emergent themes). Note taking is important to capture non-verbal data. Even if one is video-recording a group, some non-verbal behavior will be lost that might be recorded by a note-taker. If the sessions will be videotaped it is necessary to arrive well in advance to the start of the discussion to setup the equipment. Other items which need to be considered include name tags,

consent forms and payment to participants. Name tags will allow the moderator to address questions to specific individuals during the discussion (Beimborn, 2015).

Moderating the sessions

It is recommended that an experienced focus group moderator conducts the sessions. Moderating the discussion is a difficult process and someone with experience has the ability to draw information out of the participants. The moderator should try to keep the discussion as informal as possible and should encourage all participants to speak whatever is in their mind. The moderator is in charge of the discussion and it is his/her duty to draw information out from the participants.

The discussion session should last approximately 1 and 1/2 hours. One of the benefits of having an outside person moderate the discussion is that the person can be neutral. Some people may not like the topic being discussed and should be allowed to voice their opinion (Beimborn, 2015).

Analysis of the Results

In the analysis stage, survey research requires transformation of numbers with statistics (at minimum, it requires the calculation of percentages). The end result is a report featuring graphs and tables. Focus groups, on the other hand, rely upon words spoken by participants. The focus on language earns focus group methodology the label, qualitative (Creswell, 1998). A report based on focus groups will feature patterns formed by words, called themes or perspectives. Numerical analysis is not a preferred technique. In fact, it is inappropriate to report the results of focus groups by percentage (e.g., among the five focus groups, an average of 56 percent of participants mentioned their frustration with the procedures for applying for public assistance). A report of results from focus groups should not present major findings via frequencies or statistics because 'counting' leads readers to believe that percentages or frequencies are true for a much wider population (which they are not) (Beimborn, 2015).

Quantitative survey researchers go to great lengths to design a study so that numerical data generalize to a wider population with mathematical precision. Focus groups method isn't meant to create generalizations (Fern, 2001). Qualitative approaches, such as participatory action research, share control even more vigorously. In participatory research, the entire topic can change based on the interests of participants (Greenwood and Levin, 1998). This would not occur with focus group technique. Personal interviews also share some control. The amount, sequence and phrasing of talk, as well as specific topics, are managed as much by the interviewee as by the researcher (Creswell, 1998).

Annex III: Analysis tables

Focus Group Questions	Participant 1	Participant 2	Participant 3
1. Parking Problem	Less space for parking	Illegal, Less space for parking, obstruction in driveways	Illegal, Less space for parking
1 (a). On-street parking	Aesthetically pleasant, quality wise average and capacity wise sufficient	Aesthetically pleasant, quality wise average and capacity insufficient	
1 (b). Off-street parking	Aesthetically pleasant, capacity wise sufficient and quality of on-street parking is good.	Aesthetically unpleasant, capacity wise sufficient and quality of on-street parking is good	
Centralized Parking			
2 (a). Applicability	Not applicable	Applicable because it is financially feasible, partially conforms with the policy, increase the livability & safety.	
2 (b). Acceptability	20-40%	40-60%	
2 (c). Strength/Weakness	Can create more space on street, which makes the streets aesthetically look better. People prefer to park cars in front of their houses due to the issues of theft and vandalism.	More supply of parking, more comfort, less search traffic Due to increased walking distance people want to park the cars as close as possible	Less parking pressure in street & increased spatial organization Increased distance, less social safety because of door to door mentality
2 (d). Benefits/Consequences	more space on-street better living Theft & vandalism	More space on street. It will change policy for visitor parking & employees using the blue zone disc more than the allowed time.	More capacity , less parking pressure Illegal parking will increase and more turnover.
Shared Parking			
3 (a). Applicability	yes, because it is financially feasible, conforms with policy, increases livability and adds a little to increase the safety of the area	yes and strongly agreed that this concept is financially feasible, conforms with policy, increases livability and adds a little to increase the safety of the area	
3 (b). Acceptability	20-40%		
3 (c). Strength/Weakness	Better level of utilization of parking spaces. Not a good solution for off-street parking	Efficient use of space More use of organization's resources time and money. People need to collaborate for public private partnership that cannot be made obligatory	Less parking pressure, better use of capacity Agreement has to be set.
3 (d). Benefits/Consequences	More space on-street better living Not all the citizens will have more space if they want to park at 10pm	Rent of private parking means financial benefits Vandalism	Occupancy rate and turnover will increase. Livability of the NH will be affected.

Parking Freezes			
4 (a). Applicability	Yes, but it is not financially feasible neither it conforms with policy but it can increase livability and safety of the area.	Yes, because it is financially feasible, conforms with policy and can increase livability and safety of the area.	No, limited connection with public transport
4 (b). Acceptability	20-40%	>20%	20-40%
4 (c). Strength/Weakness	Aesthetically better less car on streets. Politically not feasible, intervention of police	More space No space for visitors	It can be fully integrated to make people enthusiastic. Difficult to integrate politically sensitive
4 (d). Benefits/Consequences	Aesthetically better Intervention of police heft & vandalism	Comfortable No alternatives for visitor parking	Increased liability, less pollution ecofriendly Less attractive,
Demand Reduction			
5 (a). Applicability	Yes, because it is financially feasible and can increase livability and safety of the area to a great extent but it does not conform with the policy.	No	
5 (b). Acceptability	20-40%	>20%	
5 (c). Strength/Weakness	Aesthetically better more space on streets. Not good for short trips.	Increased parking space High cost of building & maintenance	Fits best if applied in city centre. Not applicable in residential area
5 (d). Benefits/Consequences	Aesthetically better Usually need more time to wait for buses and other public transports. Not a time efficient solution.	It needs renaming the streets and good enforcement that needs money	No
Smart Parking			
6 (a). Applicability	Yes, because it conforms with the policy and can increase livability and safety of the area to a great extent but it is not financially feasible.		
6 (b). Acceptability	40-60%	100-80%	60-80%
6 (c). Strength/Weakness	Parking search behavior, less traffic more diversion of parking. Difficult to be understood by elderly people, more costs involved.	High comfort Technically complex to be implemented	Less search traffic. Does not suit on residential roads but for city centre only. Difficult to provide alternatives. If use apps that it needs to be assume that everybody has a smart fone
6 (d). Benefits/Consequences	Less search traffic Difficult to be understood by elderly people.	High infrastructure charges	Residents don't have to look for space .Only one NH is not sufficient, not a consistent solution
Automated Parking			
7 (a). Applicability	yes, because it conforms with the policy and can increase livability and safety	No, increased walking distance and does not integrate with spatial planning and other regulations	

	of the area to a great extent but it is not financially feasible.		
7 (b). Acceptability	20-40%	40-60%	> 20%
7 (c). Strength/Weakness	Less space quick storage of vehicles, no theft vandalism. if residents need to walk far way they won't prefer it.	More space on-street. Require technical assistance	No
7 (d). Benefits/Consequences	Aesthetically better, more space on street. Residents cannot park in front of their doors.	More space available, compact solution.	No
Private car Parks			
8 (a). Applicability	yes, because it is financially feasible, conform with the policy and can increase livability and safety of the area		
8 (b). Acceptability	40-60%	100-80%	20-40%
8 (c). Strength/Weakness	Aesthetically better more space on streets.	Effective & cheap solution	Better use of space More capacity Difficult to find the tariffs
8 (d). Benefits/Consequences	Save space on streets. Elderly cannot use it.	More parking comfort	Better use of parking Dependent on who is providing space less applicable in centre
Ranking			
9 (a). Centralized Parking	7	1	2
9 (b). Shared Parking	4	3	1
9 (c). Parking Freezes	5	4	5
9 (d). Demand Reduction	2	7	5
9 (e). Smart Parking	3	5	2
9 (f). Automated Parking	6	6	7
9 (g). Private car Parks	1	2	4
10. Reasons	Private car parks is the best possible solution however, a mix of concepts such as demand reduction with private car parks can be used	Centralized parking, City can implement it independently. Relatively cheap, no need to change individual streets.	Shared parking, it can be integrated with the current policy, more efficient space usage, more alternatives for the residents to select space closer to their homes.

Table 8: Analysis of Matrix

S r. N o.	Street names	Street Characteristics									
		Road type	Distan ce from Centre (m)	Number of housing units	Type of Housing	Type of Parking	On-street Parking type + capacity	Off- street Parkin g type+ capacit y	Parking issue	Other land uses	Free space availabl e
1.	Abele nstraat	R	900	34	Row houses	On- street	Back to Back road marking 10-15 cars	No	Parking on pavement, no place for cyclists so hindrance, no space for visitor parking	Baker y, coffee shop, Bank, barber , spar	Open space provided for cars to be parked in angled parking
2.	Boom kensst raaat	R	720	301	Row housing	On- street	Road marked for on-street parking 15-20 cars	Some houses have own place for cars within house	No space for visitor parking	Dalton, clinic, Hasan ia Barber, for stars	No
3.	Woute rsstraat	R	540	48	Apartme nt+ Row housing	On- street	Back to Back road marking 10-15 cars	No	Illegal Parking	clinic	No
4.	Runks terste enweg	R	530	243	Apartme nt + Row housing	On- street	Back to Back Pavement parking 10-15 cars	Parking lot Parking for ALdi	Parking on pavement	Aldi, Gamma, JBC, Krefel Butch er, clinic	No
5.	Gaarv eldstra at	R	860	132	Apartme nt + Row housing	On- street	Back to Back Pavement parking 10-15 cars	Parking lot	Parking on pavement	cemet ery	No
6.	Beuke nstraat	R	820	57	Apartme nt + Row housing	On- street	Back to Back Pavement parking 10-15 cars	No	Parking on pavement	No	No
7.	Spoor wegst	R	450	147	Apartme nt	On- street	Back to Back	No	Parking on	No	No

	raat				+ Row housing		Pavement parking 10-15 cars		pavement		
8.	Vrede straat	R	1026	120	Apartme nt + Row housing	On-street	Back to Back Pavement parking 10-15 cars	No	Parking on pavement	No	No
9.	Helipoststraat	R	1163	48	Row houses	On-street	Back to Back parking on special paved surface	No	Parking on pavement	No	No
10.	Beekstraat	R	1180	130	Apartme nt + Row houses	On-street	Back to Back Pavement parking	No	Parking on pavement	Football	No
11.	Acacia straat	R	1243	125	Apartme nt + Row houses	On-street	Back to Back Pavement parking	No	Illegal parking	No	No
12.	Djef Anten straat	R	1343	86	Apartme nt + Row houses	On-street	Back to Back Pavement parking	No	Parking on pavement	No	No
13.	Fonteinstraat	R	449	83	Apartme nt + Row houses	On-street	Back to Back Pavement parking	Parking lot	Parking on pavement	Dalton, clinic, Barber	No
14.	Schoolstraat	R	613	39	Apartme nt + Row houses	On-street	Back to Back Pavement parking	Parking lot	Parking on pavement	Baker y, school	No

Table 9: Observation Table

Annex IV: Observation form, Maps, Focus group Questionnaire & Presentation

New Concepts of Parking in Residential areas**(Observation Form)****Objective**

To find out the existing situation of parking (issues, free space, type of parking) in the study area.

Date _____

Time _____

- Name of Street

- Distance from center

Less than 50m 100m 200m 300m 400m more than 400m

- Number of housing units (within the street)

Less than 10 10 20 30 more than 30

- Type of housing

Detached Semi Detached Row Housing Apartment

- Character of street

Residential Commercial Mix use

- Type of Parking

On-street Off-street

If on-street then

Parallel Back to back Angled

Number of spaces available _____

If off-street then

Garage Parking Lot

Number of spaces available _____

- Parking issue

Illegal parking Obstruction in driveways Fight among residents Vandalism

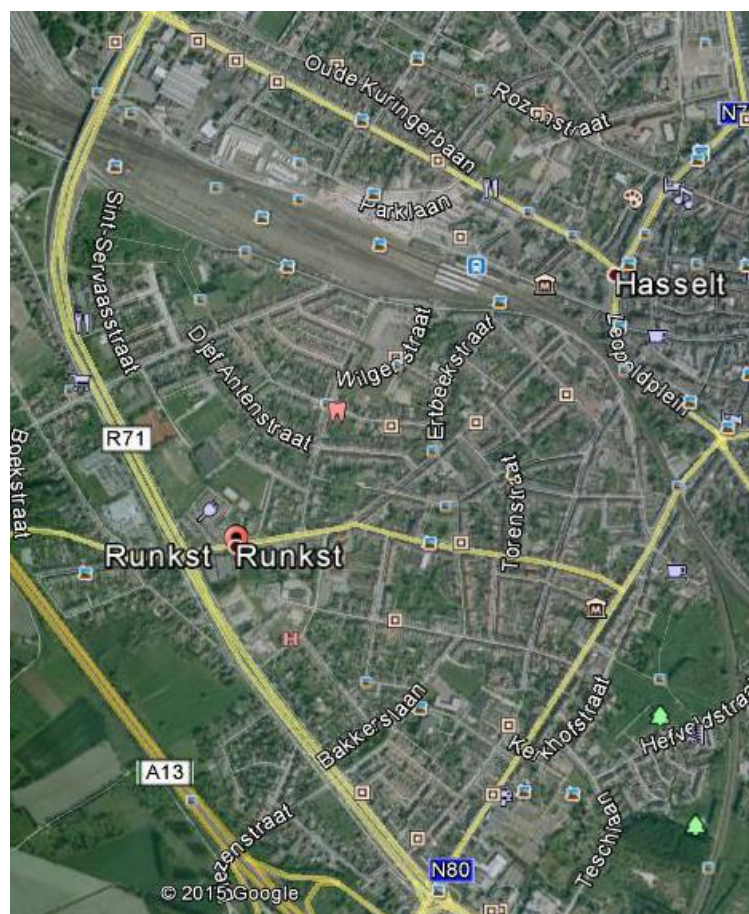
Less number of parking spaces available

- Other land use in street

Shop Restaurant Office Education Sport Other

- Number of free spaces available that can be used for parking in the street _____

Types of parking	Problems identified
On-street parking	<ul style="list-style-type: none"> • Vandalism • Aesthetically unpleasant • Obstruction in driveways hindrance in the flow of emergency vehicles • Illegal parking • Decreases roadway capacity • Impedes traffic flow and increases crash potential • Affects livability
Off-street parking	<ul style="list-style-type: none"> • Under Utilized • Residents Not Willing To Pay • More Space Requirement • Less Personal Safety • Dead Zones • Limits Pedestrian Access • Car Storage Seems Ugly and Undesirable Streetscape Feature • Encourages Car Use



New Concepts of Parking in Residential areas

(Focus Group Questionnaire)

Objective

The aim of this focus group questionnaire is to get a notion about the acceptability of the identified new concepts of parking that can be introduced in the residential area of Runkst, Hasselt. It is considered as a source of data collection to evaluate which of the new concepts best fit in the context of Hasselt solving the current parking issues of the area and cater for future demand of parking efficiently. The concepts are defined and relevant questions are given. You just need to tick in the best option and fill in the space given by writing your views. All the information would be kept confidential and used for educational purpose only.

(SECTION I)

Date _____

Time _____

Name _____

Designation _____

Q1. What problems are experienced by the residents in Runkst regarding parking?

- Illegal parking
- Obstruction in driveways
- Less number of parking spaces available
- Vandalism
- Any other, please specify _____

Q1. (a). On-Street Parking

- A. Quality Good Average Poor
- B. Capacity Sufficient Insufficient
- C. Aesthetically Pleasant Unpleasant

Q1. (b). Off-Street Parking

- Quality Good Average Poor
- Capacity Sufficient Insufficient
- Aesthetically Pleasant Unpleasant
- Accessibility By foot Bicycle Automobile
- Level of Utilization High Low

(SECTION II)

A. Centralized Parking are parking facilities, located in the center of the neighborhood designated to be used by the residents of the community rather than parking on street. Centralized parking, as an alternative to on-site parking, also improves urban design and preserves the historic nature of communities. In large neighborhoods shuttle services are used to and from the centralized parking facilities to facilitate the users.

Q2. Do you think that ‘centralized parking’ is applicable in Runkst?

Yes No, Why _____

Q2. (a). If yes then do you think it is/will?

- Financially feasible Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Conforms with current policy feasible
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Increase the livability
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Increase safety
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree

Q2. (b). How much do you think the residents be willing to accept this concept

100-80 % 80-60% 60-40% 40-20% less than 20%

Q2. (c).What Strengths/weakness do you think the concept has?

Strengths _____

Weaknesses _____

Q2. (d).What benefits/ consequences this concept can bring if introduced in the current situation (in your opinion)?

Benefits _____

Consequences _____

D. Shared Parking means same parking space to be used by different types of land uses depending on the peak hour’s e.g. same space to be used by an office from 9-5pm and later in the evening to

be used by residents. By encouraging shared parking, planners can decrease the total number of spaces required for mixed-use developments or single use developments in mixed-use areas.

Q3. Do you think that ‘shared parking’ is applicable in Runkst?

Yes No, Why _____

Q3. (a). If yes then do you think it is/will?

- Financially feasible Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Conforms with current policy feasible
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Increase the livability
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Increase safety
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree

Q3. (b).How much do you think the residents be willing to accept this concept

100-80 % 80-60% 60-40% 40-20% less than 20%

Q3. (c).What Strengths/weakness do you think the concept has?

Strenghts _____

Weaknesses _____

Q3. (d).What benefits/ consequences this concept can bring if introduced in the current situation (in your opinion)?

Benefits _____

Consequences _____

E. Parking Freezes after certain time limit some areas in the neighborhood are not allowed to be used for the purpose of parking specially the residential streets (e.g. parking is not allowed in the residential streets close to city center after 5pm). Parking freezes need to be implemented in conjunction with viable public transportation options. The amount of parking required can be

directly reduced through parking freezes that cap the total number of parking spaces in a particular district.

Q4. Do you think that the concept of ‘parking freezes’ is applicable in Runkst?

Yes No, Why _____

Q4. (a). If yes then do you think it is?

- Financially feasible Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Conforms with current policy feasible
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Increase the livability
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Increase safety
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree

Q4. (b). How much do you think the residents be willing to accept this concept

100-80 % 80-60% 60-40% 40-20% less than 20%

Q4. (c). What Strengths/weakness do you think the concept has?

Strenghts _____

Weaknesses _____

Q4. (d).What benefits/ consequences this concept can bring if introduced in the current situation (in your opinion)?

Benefits _____

Consequences _____

F. Demand reduction directly targets on the reduction of parking demand by replacing parking spaces with bus stops or reserving parking spaces for carpooling, car sharing, etc. Demand reduction can also be achieved by increasing the price of parking or by introducing non-auto transport incentives.

Q5. Do you think that the concept of ‘demand reduction’ is applicable in Runkst?

Yes No, Why _____

Q5. (a). If yes then do you think it is/will?

- Financially feasible Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Conforms with current policy feasible
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Increase the livability
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Increase safety
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree

Q5. (b). How much do you think the residents be willing to accept this concept.

100-80 % 80-60% 60-40% 40-20% less than 20%

Q5. (c). What Strengths/weakness do you think the concept has?

Strengths _____

Weaknesses _____

Q5. (d).What benefits/ consequences this concept can bring if introduced in the current situation (in your opinion)?

Benefits _____

Consequences _____

G. Smart Parking a system that informs and navigates the driver about the free space available in the nearby parking area using smart sensors and smartphone apps, the resident may get a notification on his smartphone about a free space that is at some distance from his home (more explained by the picture below).

Q6. Do you think that smart parking is applicable in Runkst?

Yes No, Why _____

Q6. (a). If yes then do you think it is/will?

- Financially feasible Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Conforms with current policy feasible
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Increase the livability
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree
- Increase safety
 Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree

Q6. (b). How much do you think the residents be willing to accept this concept

- 100-80 % 80-60% 60-40% 40-20% less than 20%

Q6. (c). What Strengths/weakness do you think the concept has?

Strengths_____

Weaknesses_____

Q6. (d).What benefits/ consequences this concept can bring if introduced in the current situation (in your opinion)?

Benefits_____

Consequences_____

F. Automated Parking a type of fully controlled robotic car storage uses various mechanical operations to take the car to the vacant space inside it, easy retrieval and requires less space as compared to conventional garages (might be expensive for both residents and municipality).

Q7. Do you think that automated parking is applicable in Runkst?

- Yes No, Why_____

Q7. (a).If yes then do you think it is?

- Financially feasible Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree

- Conforms with current policy feasible

Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree

- Increase the livability

Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree

- Increase safety

Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree

Q7. (b).How much do you think the residents be willing to accept this concept.

100-80 % 80-60% 60-40% 40-20% less than 20%

Q7. (c). What Strengths/weakness do you think the concept has?

Strengths_____

Weaknesses_____

Q7. (d).What benefits/ consequences this concept can bring if introduced in the current situation (in your opinion)?

Benefits_____

Consequences_____

G. Private car parks owners list their parking spaces online via some website. Car owners easily find, book and pay for parking after reserving on the website, or directly claiming the spot through the smartphone app (e.g. Carambla is an "eBay for city parking" where owners list there parking space for earning a financial return on excess capacity, benefit from increased security and embrace smart city mobility for social responsibility reasons. This is already working in Antwerp, Brussels & Ghent).

Q8. Do you think that Private car parks is applicable in Runkst?

Yes No, Why_____

Q8. (a).If yes then do you think it is?

- Financially feasible Strongly Agree Agree Partially Agree
 Strongly Disagree Disagree Partially Disagree

- Conforms with current policy feasible

<input type="checkbox"/> Strongly Agree	<input type="checkbox"/> Agree	<input type="checkbox"/> Partially Agree
<input type="checkbox"/> Strongly Disagree	<input type="checkbox"/> Disagree	<input type="checkbox"/> Partially Disagree

- Increase the livability

<input type="checkbox"/> Strongly Agree	<input type="checkbox"/> Agree	<input type="checkbox"/> Partially Agree
<input type="checkbox"/> Strongly Disagree	<input type="checkbox"/> Disagree	<input type="checkbox"/> Partially Disagree

- Increase safety

<input type="checkbox"/> Strongly Agree	<input type="checkbox"/> Agree	<input type="checkbox"/> Partially Agree
<input type="checkbox"/> Strongly Disagree	<input type="checkbox"/> Disagree	<input type="checkbox"/> Partially Disagree

Q8. (b). How much do you think the residents be willing to accept this concept

100-80 % 80-60% 60-40% 40-20% less than 20%

Q8. (c). What Strengths/weakness do you think the concept has?

Strengths_____

Weaknesses_____

Q8. (d).What benefits/ consequences this concept can bring if introduced in the current situation (in your opinion)?

Benefits_____

Consequences_____

Q9. Rank the above mentioned concepts on a scale of 1-5. Give the highest score (i.e. 1) to the concept which best fits in Runkst and other accordingly.

A. Centralized Parking	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
B. Shared Parking	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
C. Parking Freezes	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
D. Demand Reduction	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
E. Smart Parking	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7

F. Automated Parking

1	2	3	4	5	6	7
---	---	---	---	---	---	---

G. Private car parks

1	2	3	4	5	6	7
---	---	---	---	---	---	---

Q10. Why do you think this is the best option to be used in Runkst? Reason.

(Thank you)

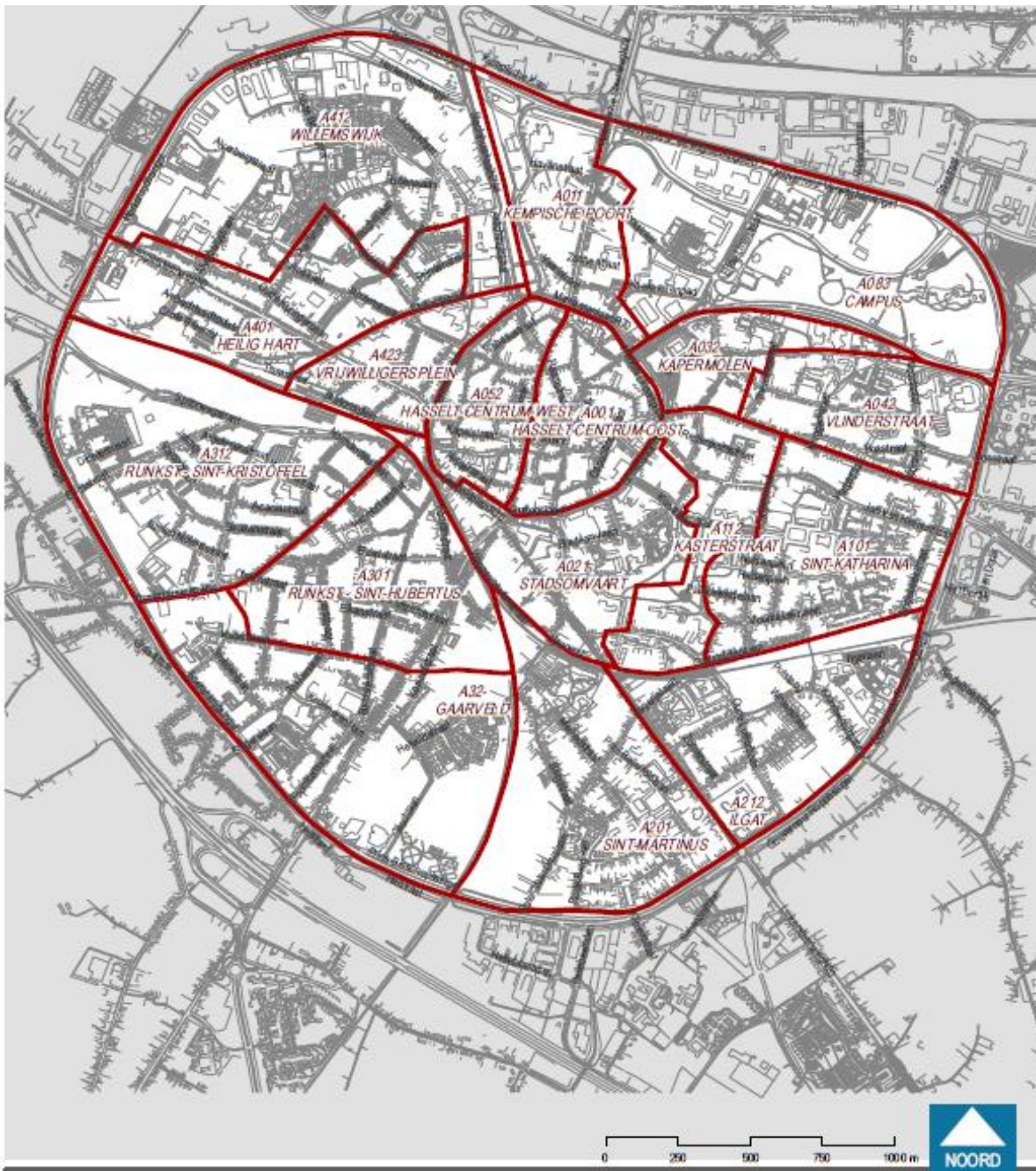


Figure 9: Division of Hasselt for parking study by municipality (Source: Municipality Hasselt)

New Concepts of Parking in Residential areas

Interactive Focus Group Session

universiteit Hasselt
KNOWLEDGE IN ACTION

Date : 24-03-2015
Time : 9.30 hours
Location: AC Dr. Willems, Dokter Willemsstraat 34, Hasselt.
Duration: 3 hours
Moderator: Annum Khaliq
Supervisor/ Co-moderator: Peter van de Wander

Objective

- To get a notion about the **acceptability of new concepts of parking** successfully implemented in different countries (Canada, Germany, U.S) if introduced in Runkst, Hasselt.
- This **session is a source of data collection** to evaluate which of the new concepts best fit in the context of Hasselt solving the current parking issues of the area and cater for future demand of parking efficiently.
- The concepts are defined and relevant questions are given. You just need to **tick in the best option** and fill in the space given by writing your views. All the information would be kept confidential and used for educational purpose only.

Agenda

- Welcome note Peter, introduction of participants (Peter)
- A brief explanation of all the concepts would be presented (Annum)
- A questionnaire would be presented to all the participants
- Questionnaire has two sections,
 - Section I** deals with the existing condition of the area, to investigate parking issues
 - Section II** discusses the concepts
- Group Discussion (Concept ranking)

SECTION I

Evaluation of Existing Condition of Parking

Q1. Select the parking problems that you think are faced by residents of Runkst, given in the options or if not in options you can specify in the space given below

Q1. What problems are experienced by the residents in Runkst regarding parking?

- Illegal parking
- Obstruction in driveways
- Less number of parking spaces available
- Vandalism
- Any other, please specify _____

Q.1 (a) & (b) Characteristics of onstreet & off-street parking

- Quality (are there special provisions for on-street parking e.g. pavement markings, other arrangements)
- Capacity (Parking spaces)
- Aesthetics (Does the parking procedure fits in the design features of the area)
- Accessibility (In case of off-street parking is it accessible to residents)
- Level of utilization (off-street parking is utilized properly or seems a dead zone in the neighborhood)

SECTION II

Evaluation of New Concepts

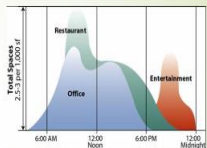
A. Centralized Parking

- Located in the **center of the neighborhood** designated to be used by the residents of the community, as an alternative to on-street parking
- Improves urban design and preserves the historic nature of communities.
- In large neighborhoods, **shuttle services** are used to and from the centralized parking facilities to facilitate the users.



B. Shared Parking


- Same parking space to be used by different types of land uses depending on the peak hour's e.g. same space to be used by an office from 9-5pm and later in the evening to be used by residents.
- By encouraging shared parking, **planners can decrease the total number of spaces required for mixed-use developments** or single use developments in mixed-use areas.



Function	with	Function
RESIDENTIAL		RESIDENTIAL
LODGING		LODGING
OFFICE		OFFICE
RETAIL		RETAIL

C. Parking Freezes

- After certain time limit some areas in the neighborhood are not allowed to be used for the purpose of parking specially the residential streets
- Need to be implemented in conjunction with viable public transportation options.



D. Demand Reduction

- Directly targets on the **reduction of parking demand by replacing parking spaces with bus stops or reserving parking spaces for carpooling, car sharing, etc.** This can also be achieved by increasing the price of parking or by **introducing non-auto transport incentives.**



BREAK

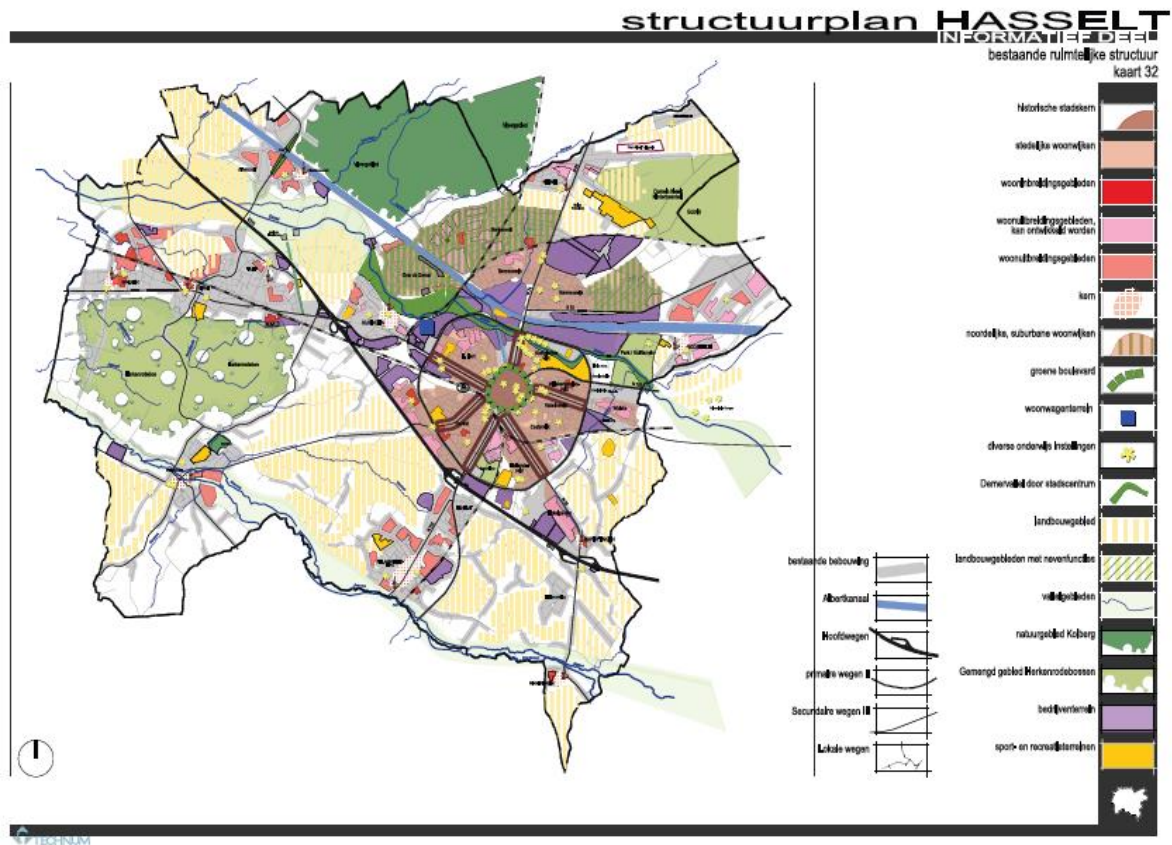


Photo 17: Structure Plan Hasselt (Source: Municipality Hasselt)

Auteursrechtelijke overeenkomst

Ik/wij verlenen het wereldwijde auteursrecht voor de ingediende eindverhandeling:
New concepts for parking in residential areas

Richting: **Master of Transportation Sciences-Mobility Management**

Jaar: **2015**

in alle mogelijke mediaformaten, - bestaande en in de toekomst te ontwikkelen - , aan de Universiteit Hasselt.

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Voor akkoord,

Khaliq, Annum

Datum: **8/06/2015**