Traffic safety and shared space in the urban environment

The case of the Municipality of Kalamaria in Thessaloniki, Greece

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Master thesis

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"When you treat people like idiots,
they'll behave like idiots"

-- Hans Monderman

Summary

Traffic safety refers to the safe movement of road users in a road network and the prevention of any kind of harm caused to them, by reducing the risk of them being injured or killed and it is measured by the numbers of traffic accidents and victims and their severity. Ever since the major commercial explosion in automobiles in the 1960s, high rates in car ownership and their constantly increasing presence on the roads led to the design of a car-based street network. Inevitably, this led to the recognition of car drivers as the dominant users of the road in the urban environment and the consideration that the car is the safest mode of transport, since the majority of fatalities and victims severely injured in traffic accidents belong to the vulnerable users of the road network (pedestrians, cyclists).

The recent calls for sustainability in mobility have put traffic safety into the center of attention, making the reduction of traffic accidents and victims a priority. In order to enhance means of transport alternative to the car, the safety of their use must be ensured so that the vulnerable users are more protected and their involvement in traffic accidents limited. The measures taken to deal with this issue are going to be looked at from the scope of street design. Not longer than a decade ago, shared space was created, a radical street design that put all road users together to share the same space, controlled with limited regulations, and turned upside down the belief that the conventional street design that separates the different types of traffic is the safe and only way. Starting from the Netherlands, shared space schemes began, rather timidly, to pop up all over the globe having nothing but positive results in their traffic accident numbers.

The present master thesis is divided in two main parts, the theoretical part and the empirical part, while the empirical part consists of two major chapters: the examination of case studies in European cities and the case study of the Municipality of Kalamaria in Greece.

In more detail, in the theoretical chapter the definitions of sustainable development and sustainable mobility are introduced and afterwards, a literature overview is conducted on traffic safety, separation and integration of types of traffic. A conceptual model is also developed to serve as a basis to analyze the empirical case studies that follow in the next chapters.

The case studies analysis that follows in the empirical part refers at first in chapter 3 to the different case studies of shared space throughout Europe and their results in road users' perception, their behavior and performance, traffic speed and spatial quality. The shared space paragraph focuses on a more in depth analysis of two important case studies in the Netherlands, the Laweiplein intersection in Drachten and the Rijksstraatweg in Haren. Questionnaires are collected from pedestrians in the two

locations to gain a deeper understanding of the vulnerable road users' point of view. Next, a reflection from the perspective of development of traffic safety in general is made for cities that have the street design that keeps road users separated. The chapter closes with a critical review of all the cases examined, along with the formation of the table of advantages and disadvantages of both street designs.

Chapter 4 focuses on Greece and the Municipality of Kalamaria. It begins with a brief description of the city of Thessaloniki and then the mobility in the Municipality of Kalamaria, which belongs to the greater Thessaloniki area, is analyzed concerning the evolution in its traffic safety numbers, the Local Town Plans it had through the last two decades, the measures taken and their results. Having started in the Netherlands, shared space is examined for a possible implementation in the Municipality of Kalamaria in Greece, since changes are currently being done to the Municipality towards sustainability and traffic safety improvement. The implementation barriers from one country to the other are explored and at the end, the suggestion of a shared space scheme is formed for Kalamaria.

The thesis finishes with the formation of general conclusions in chapter 5, emphasizing on the most important points made throughout the research, explaining how the research objective has been met and the research questions posed in the beginning answered. A reflection is also made on the process and outcomes of the research and recommendations are provided.

Preface

Traffic safety and the means to improve it in harmony with sustainability in the urban environment, is an unsettling issue in our times and within this context, the topic of the present thesis was chosen, examining the street design of shared space and its effects. The present research will be useful to those seeking insight on shared space, its origins and its connection to traffic safety. It contains a collection of the most important shared space cases in Europe and their results, along with a reflection on traffic safety development in cities that follow the street design of separating road users. The objective of the thesis is to examine whether traffic safety can be improved with the integration or separation of different types of traffic and under which conditions. On top of that, the case of the Municipality of Kalamaria in Greece is studied, exploring the possibility of a shared space implementation in it.

Passion about transportation and sustainable mobility made the elaboration of the thesis exciting. In addition, the subject's usefulness and relation to real life problems and situations further enhanced the enthusiasm of covering it. The organization of the thesis is rather linear, starting with an introduction, followed by a theoretical context, then the analysis of the empirical part and conclusions at the end. Graphs and tables are used as visual aids to illustrate the numerical data obtained through the research, while pictures provide a great contribution to the understanding of the case studies.

Finally, the completion of the thesis wouldn't be possible without the guidance of my supervisor, Dr. Femke Niekerk, for which I am very thankful.

Maria Kosma Groningen, August 2012

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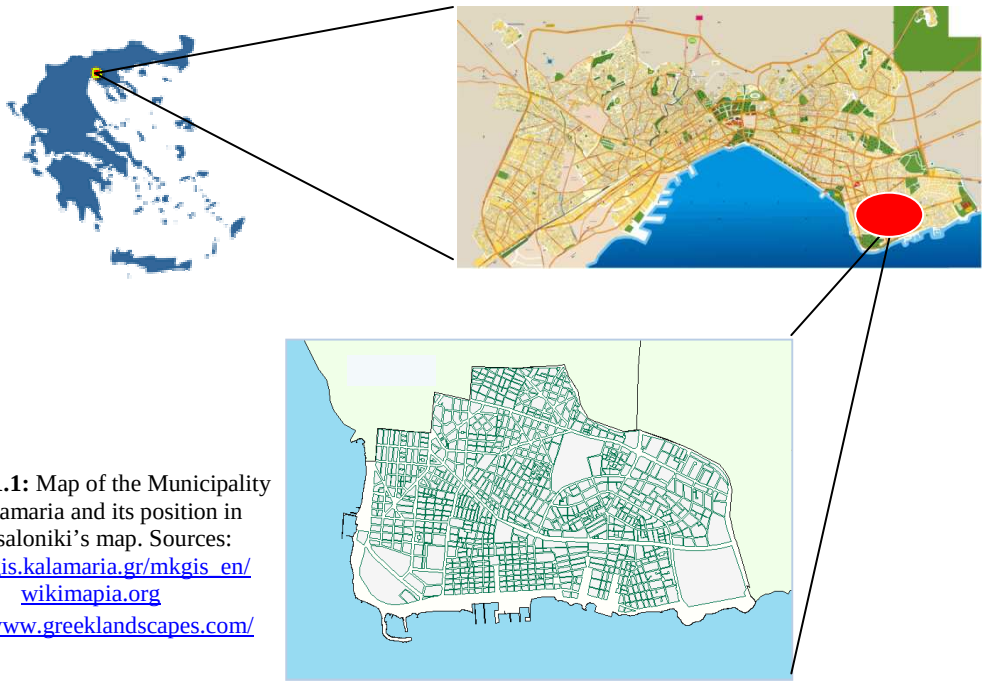
Chapter 1: Introduction

1.1 Problem description

Transportation is a common right; everyone has the right to move and road transportation has become the main factor that facilitates the movement of people and goods (World Health Organization, 2009). But at the same time, the increase of road transportation brought a series of impacts on human health, with traffic accidents being one of the most serious ones. In the urban environment, the principle was to separate the movement of every different mode user, keeping their interaction limited by building fences, barriers, under- or overpasses and using traffic control signs in order to keep them as safe as possible (US Department of Transportation, Institute of Transportation Engineers, 2004). But lately, no more than a decade ago, a new approach to road safety emerged, which incorporates the integration of different types of traffic and annuls every means of controlling them, under the name of 'shared space' (Hamilton-Baillie, 2008).

The city of Thessaloniki in Greece is dominated by cars. In this city of more than 1,000,000 inhabitants, where priority is always given to cars and they uncontrollably move and occupy sidewalks, pedestrian streets and squares, threatening the safety of pedestrians, cyclists and the vulnerable users of the roads (i.e. elderly, people with disabilities, children) (Aggelidis, 2010), there is one Municipality among 13 in total, that tries to make a difference. Kalamaria (*Picture 1.1*) is the second largest Municipality of Thessaloniki's Urban Area in northern Greece, with a population of approximately 87,000 and covering an area of 29 Km^2 (Municipality of Kalamaria,



Picture 1.1: Map of the Municipality of Kalamaria and its position in Thessaloniki's map. Sources: http://gis.kalamaria.gr/mkgis_en/ wikimapia.org http://www.greeklandscapes.com/

2007). The number of fatalities in the municipality due to traffic accidents has always been limited, but traffic injuries have gradually started decreasing after a peak of almost 150 in 1994, not the numbers of pedestrian victims though (AUTH, Municipality of Kalamaria, 2003). During the last years, the Municipality started to organize tangible initiatives to promote sustainable mobility to its residents and increase their safety, by introducing traffic calming measures and proceeding to the pedestrianization of a few of its streets.

What the present research will attempt to do is examine whether integration or separation of traffic streams is more efficient in terms of traffic safety on the local level, based on the observation of cases of both sides in European cities. Emphasis is going to be put on the Netherlands, since this is where shared space began. After that, a closer look at the Municipality of Kalamaria and the policies it has followed thus far to enhance its road safety, without involving any kind of shared space plan, will unravel if shared space is suitable for it and if and where it could be implemented. Urban mobility is crucially embedded in the daily life of EU citizens and while the debate of segregation versus integration goes on, one thing is clear; sustainability is the key word that is involved in the solutions to problems concerning road safety and other challenges like road traffic congestion and environmental impacts (European Parliament, 2010). Therefore, it is worth exploring the issue of traffic safety and the actions that are being taken to cope with it in problematic areas, while keeping in mind that everything happens in the name of sustainable mobility.

1.2 Research objective and research questions

Based on all of the above, the objective of this research is to analyze if road safety can be improved with the integration or separation of different types of traffic in general and in the urban area of Kalamaria in particular and under which conditions this improvement will be reached. This will be achieved by exploring and comparing different cases of cities and the policies they followed over the years to achieve road safety, through shared space or not, and then by looking into the case of Kalamaria and providing suggestions of alternations, reflected from the cases analyzed, that would improve its road safety.

The questions whose answers will be sought in the research are the following:

- *What are the advantages and disadvantages of integration and separation of different types of traffic in terms of traffic safety?*

This question will be answered after the examination of the findings from both types of cases in the literature. There are supporters of both sides, each with their own arguments and evidence to justify their decision and based on that, tables will be formulated displaying the advantages and disadvantages of the two street designs.

– *To what extend shared space can contribute to traffic safety and spatial quality?*

An analysis of cases of shared space in different European cities and studies that have been carried out on them are expected to show the level of its contribution to traffic safety and spatial quality improvement. Shared space can prove to be a very useful tool or a major hindrance to the safe and smooth movement of all the types of road users and the livability of the surrounding environment, when applied.

– *What are the experiences in other countries with both street designs?*

Probing into case studies of European cities will provide an overview of the methods that they used and an evaluation will be made concerning the effects they had on traffic safety. The focus will be set on cities in the Netherlands, which will be examined in more detail.

– *Can there be a shared space policy transfer from the Netherlands to Greece and what are the implementation barriers?*

The exploration of examples of shared space in the Netherlands, the analysis of the mobility situation in the Municipality of Kalamaria and a comparison between them is expected to shed some light on whether a shared space policy transfer from one country to another is applicable or not and under which restrictions.

1.3 Research methodology

The methodology that is followed is first a literature overview of available academic material, reports, articles and other publications to explore the topics related to traffic safety, separation and integration of traffic streams, mainly in Europe. The goal of this review is first to explain and clearly define the above mentioned concepts and then formulate a conceptual model whose elements will be used in the analysis of the empirical part.

Afterwards, data collection takes place for the examination of a series of case studies in Europe, including the number of accidents, injuries, vehicles' speed and traffic volumes, found in a number of surveys in both cases of shared space and of the conventional street design of separation. Case studies has proven to be a useful research method to examine contemporary real-life situations (Soy, 1997) and in this case, they will help in better understanding the complex issue of traffic safety in the domain of street design. The cases are selected depending on the data that were available, in accordance to the elements needed to be collected based on the conceptual model and the importance of the cases for each country.

In addition, another method used for a further deepening of the cases of the Netherlands is the collection of questionnaires to pedestrians in the two locations of shared space there: the Laweiplein intersection in Drachten and the main shopping

street, Rijksstraatweg, in Haren. This method is used to approach shared space from the point of view of pedestrians, who belong in the category of the vulnerable road users and how they perceive traffic safety in such a street design. It was pointed out by researchers (i.e. Moody & Melia, 2011), that there is lack of available surveys on pedestrians and that the emphasis was put on drivers after the implementation of shared space projects. For this reason, the questionnaire research to pedestrians by a personal visit to these two locations was decided as a more holistic way to examine the selected two cases in the Netherlands.

After that, the initial idea was to compare the case studies from the two different street designs in order to draw conclusions, but a full comparison couldn't be possible. All the data collected for the shared space cases refer to the specific location where the scheme was implemented, while such data could not be obtained for the cases of separation. Data were available only for whole cities, so these are the ones used and at the end, a critical review and a general comparison of all the case studies is made to define the advantages and disadvantages of shared space and the street design of separation of different types of traffic.

Data are also collected for the case of the Municipality of Kalamaria from available sources concerning its traffic safety condition; Local Town Plans executed in the Municipality, surveys and researches, including statistics and future plans. For this purpose, the Municipality's official website is of great help, due to the access to all information related to projects, actions and interventions in crucial areas that are being available to the public, along with the provision of already elaborated GIS maps.

Finally, suggestions for the case of Kalamaria are formed, accompanied with AutoCAD designs for a visual representation. The AutoCAD background of the Municipality is obtained from a research conducted by the author in 2010 in the area and more information from the same research are used for the analysis of the case study as well.

1.4 Structure of the thesis

The thesis has the following structure:

Chapter 1. Introduction
Chapter 2. Theoretical context
Chapter 3. Case studies in European cities
Chapter 4. The Municipality of Kalamaria in Greece
Chapter 5. General conclusions, reflection and recommendations

The *first chapter* is the current one, which includes the problem description, the objective of the research, the research questions that are called to be answered and the methods that will be carried out for the completion of the thesis, including a research

framework. So basically it's a general introduction to the topic of the thesis, the explanation for its choice and the expectations the reader should have from it.

In *chapter 2* a general introduction explaining the reasons why sustainable mobility and a proper management of the existing infrastructure are necessary is made in the beginning. Afterwards, the concept of traffic safety, with the provision of some theory and statistics is explored, followed by the street designs developed to achieve it in the urban environment, divided in the two categories of separation and integration of traffic streams. Both categories are analyzed and an explanation of the term of shared space is established, how it was first created and what are the views of other people of it.

Chapter 3 contains a presentation of examples of cities throughout Europe where shared space was implemented, which are examined in practical terms, including before and after photos, empirical researches and statistics to show their results in terms of traffic safety. After, the Laweiplein intersection in Drachten and Rijksstraatweg, the main shopping street in Haren, Groningen are analyzed in more detail, with the collection of further information from questionnaires, concerning how local people react and adjust to the street design that is provided to them. A comparison of the cities mentioned in the chapter to others, where a shared space policy is not followed is also made to help answer the aforementioned research questions raised. The information that is used to make this comparison belongs to researches and data of cases found in the literature. At the end, two tables are formulated displaying the advantages and disadvantages of separation and integration of the different types of traffic, based on the findings of the cases studied.

Afterwards, in *chapter 4* the case of the Municipality of Kalamaria is described by examining its current land use and mobility situation and providing information and results of relevant researches concerning its traffic elements. Next in the chapter, an investigation of the area takes place by spotting problematic points in the area that require attention for improvement concerning traffic safety. Inspired by the Dutch cases studied before and after comparing them to the Municipality, it is verified whether a policy transfer of shared space from the Netherlands is applicable to Greece and Kalamaria in particular and under which conditions. Finally, a suggestion of a shared space scheme for Kalamaria is presented.

Chapter 5 concludes by highlighting the most important points made throughout the whole research and analytically explains how the research objective has been met and the research questions raised in the very beginning have been answered. A critical reflection on the research process is also made and recommendations are provided.

A visual representation of the thesis' structure is shown in *figure 1.1* along with the connections between its elements with arrows. The research framework that reveals the process of the research and how knowledge will be developed is presented in *figure 1.2*.

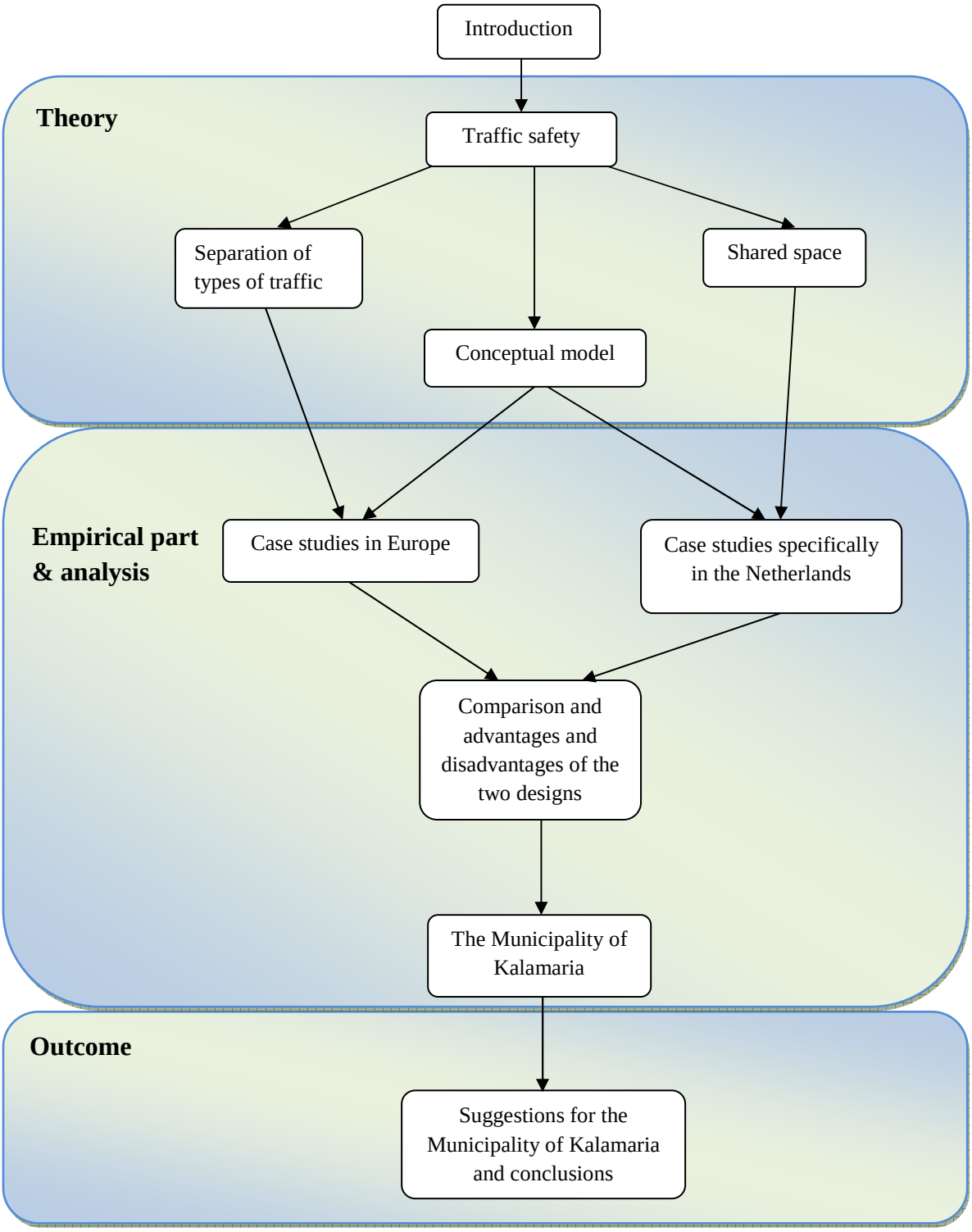


Figure 1.1: Structure of the thesis

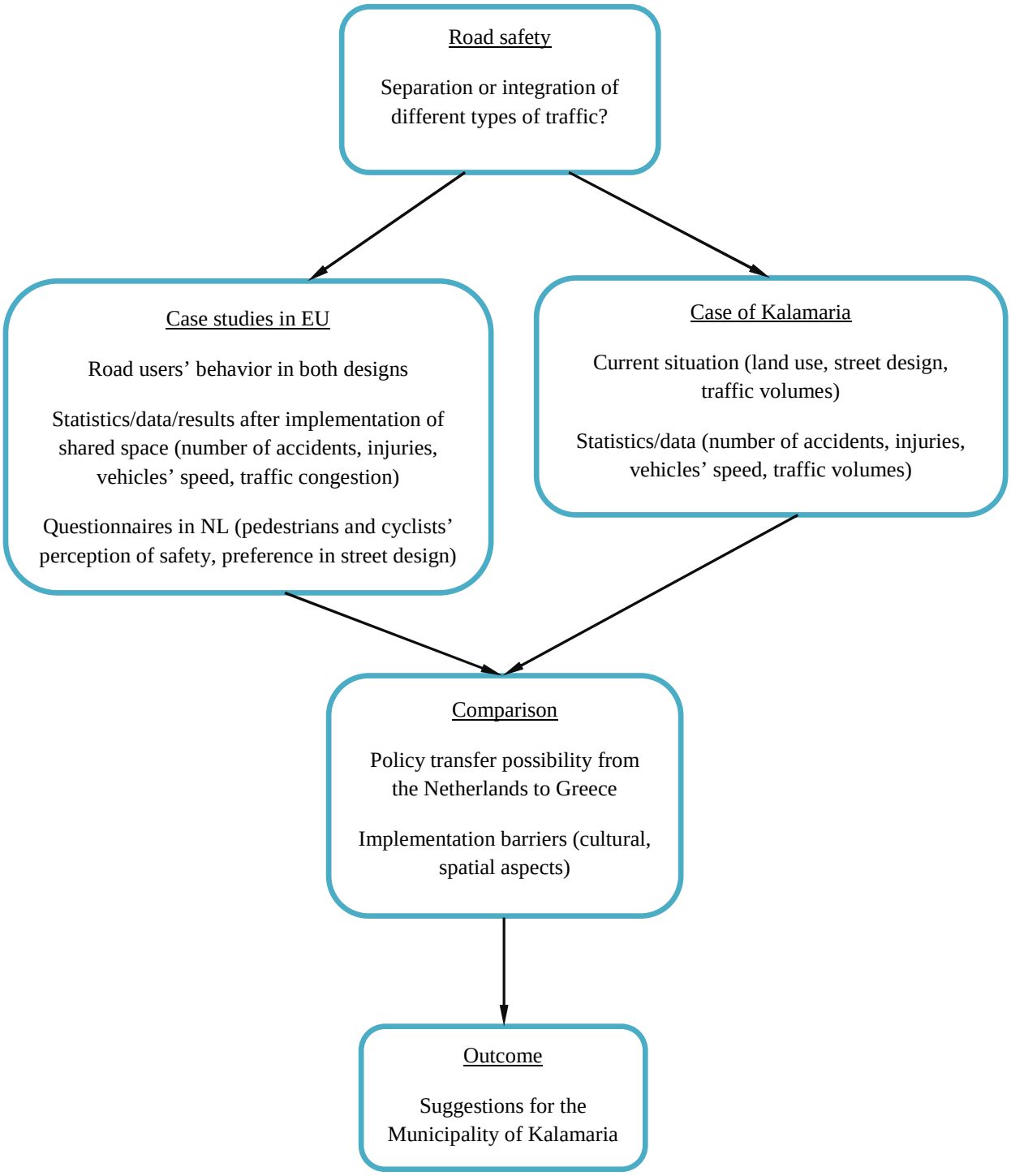


Figure 1.2: Research framework

Chapter 2: Theoretical context

In the present chapter, elements of the literature are gathered concerning traffic safety and separation and integration of traffic modes. First, an introduction is made to the definitions of sustainable development, sustainable mobility and mobility management, which are all connected to traffic safety and then, the concepts of separation and integration of types of traffic are analyzed, including the views of both their proponents and opponents. In the end, a conceptual model is developed to serve as a basis to analyze the empirical case studies that follow in the next chapters.

2.1 Sustainable mobility

The term of *sustainable development* was first introduced in 1987, in the Brundtland report 'Our common future' written by the World Commission on Environment and Development (WCED, 1987):

> *"Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*

The most prevalent way of presenting sustainable development (SD) in the literature is the one of the three overlapping circles, separately representing the economy, society and the environment (Connelly, 2007) shown in *figure 2.1* below.

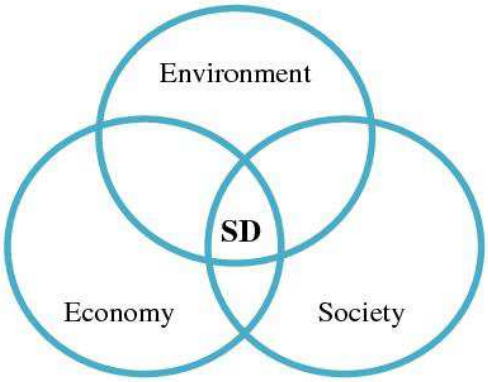


Figure 2.1: The three circles of sustainable development (SD)
Source: Connelly 2007

Sustainable transportation or *sustainable mobility* can be viewed as an expression of sustainable development in the transportation sector and can be defined as "the provision of safe, effective and efficient access and mobility into the future while considering the economic, social and environmental needs of society." (Poor & Lindquist, 2009).

According to data of the European Union (EU), half of Europe's population (490 million) owns a car, while the proportion of trips made to and from metropolitan centers by car, reaches 75% (European Commission, 2011). It is generally accepted

that problems arising from the increasing use of private cars (congestion, noise pollution, environmental impacts) cannot be solved by increasing the infrastructure. The increase of supply results to an additional increase of demand, having as a consequence the inability to achieve a balance between them. As stated by the European Economic and Social Committee, a thorough renewal of the transport system and the adoption of a different conception of mobility are required. The need to solve these problems has become even more crucial in order to maintain a high quality urban mobility for the EU citizens. This was shown in a survey conducted by Eurobarometer in 2007, in which 90% of Europeans believed that the traffic situation in their area should be improved (European Parliament, 2010). Taking into account all of the above, coupled with the lack of space, they substantially raise the need for better management of the existing infrastructure and the creation of sustainable patterns of mobility.

The main obstacle to sustainable mobility thus far is that the car is considered the safest mode of transport in the urban environment. People are concerned about safety aspects which may prevent them from using sustainable travel modes and efforts to motivate people to use sustainable travel modes have put traffic safety in the center of attention (Dziekan et al., 2011). In a research conducted in UK, it was shown that drivers consider themselves the dominant users of the road, while cyclists and pedestrians also enhanced this fact by seeing themselves as vulnerable (Musselwhite et al., 2011). Furthermore, all the participants viewed the road space as “competitive space” along with a “survival of the fittest” approach (Musselwhite et al., 2011). So when people behave according to such a mindset, their choice of the car as their travel mode is justified. The conclusion is that there is a strong relation between sustainable mobility and traffic safety and a joint strategy of travel mode choice and road safety is needed to motivate people to change their travel behavior (Dziekan et al., 2011).

2.2 Traffic safety

Traffic safety is measured by the number of traffic accidents and their severity, which is rather a reactive approach because a significant number of accidents must happen before there is a traffic safety problem identified at a location (Archer, 2005). Archer, 2005, emphasizes on the random and sparse nature of traffic accidents and the complex course of events that have to happen for an accident to occur, which hindrance safety analyses and the gathering of qualitative information on understanding the causes of accidents and provide solutions to them. He supports the argument that there are many indirect safety indicators, such as the number of near-accidents, enforcement and traffic related legislation or exposure to road traffic, which together with the number of people killed or injured in traffic accidents paint the complete picture of an area’s traffic safety situation. However, since the reliability and validity of the measurement of these indicators have been questioned, the number

of accidents remains as the predominant way of measuring traffic safety among countries (Archer, 2005).

It has been estimated that annually one million people die in road traffic accidents in the world (Ozkan et al., 2006). For Europe this number reaches approximately an average of 110,000 persons killed and about 2.5 million persons are injured annually in more than 1.8 million road accidents (Economic Commission for Europe, 2011). It should be mentioned that even though the European road network keeps expanding in a fast increasing trend (see *figure 2.2*), there is no relation between the length of motorways and the number of accidents. On the contrary, the number of road fatalities between 1990 and 2009 was decreased by 54.2%, while the equivalent number for accidents involving personal injuries decreased by 20% (European Commission, 2011). Even though these figures are optimistic, accidents do still happen and in the urban environment, the victims of road accidents are usually the vulnerable road users, pedestrians, motorcyclists, bicyclists and non-motorized vehicle occupants (Lacroix & Silcock, 2004). Consequently, the development of a sustainable transport policy framework with measures aimed at improving the traffic safety of all road users is required for every city.

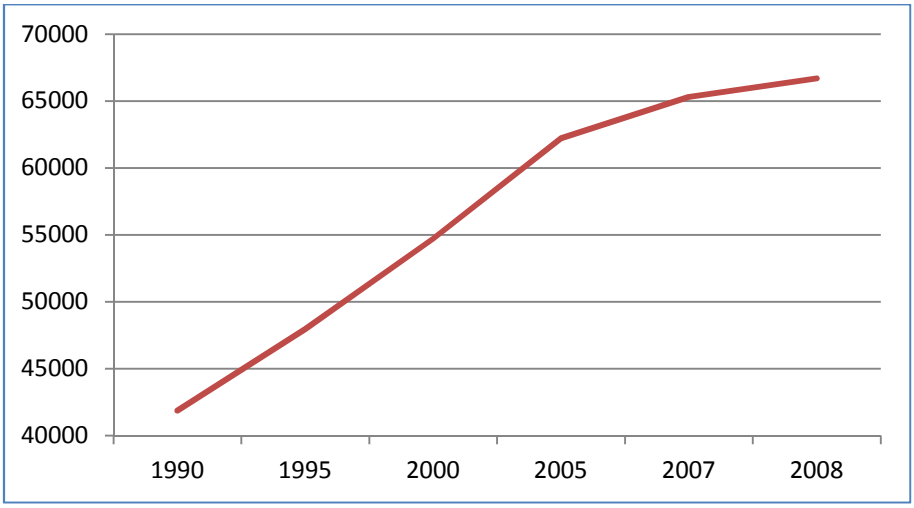


Figure 2.2: Length of motorways in Europe in Km
Source: European Commission, 2011

The Victoria Transport Policy Institute, an independent, Canadian research organization dedicated to developing innovative and practical solutions to transportation problems, suggests a set of traffic safety strategies, divided in two major categories, the one of *Engineering*, which involves safer vehicles and roadways and the one of *Behavior Changes*, which includes mobility management (changes in travel mode, route, destination, frequency and speed), more cautious driving and actions by vehicle occupants such as using seat belts, child restraints and helmets. The relationships among these various strategies are illustrated in *figure 2.3* below.

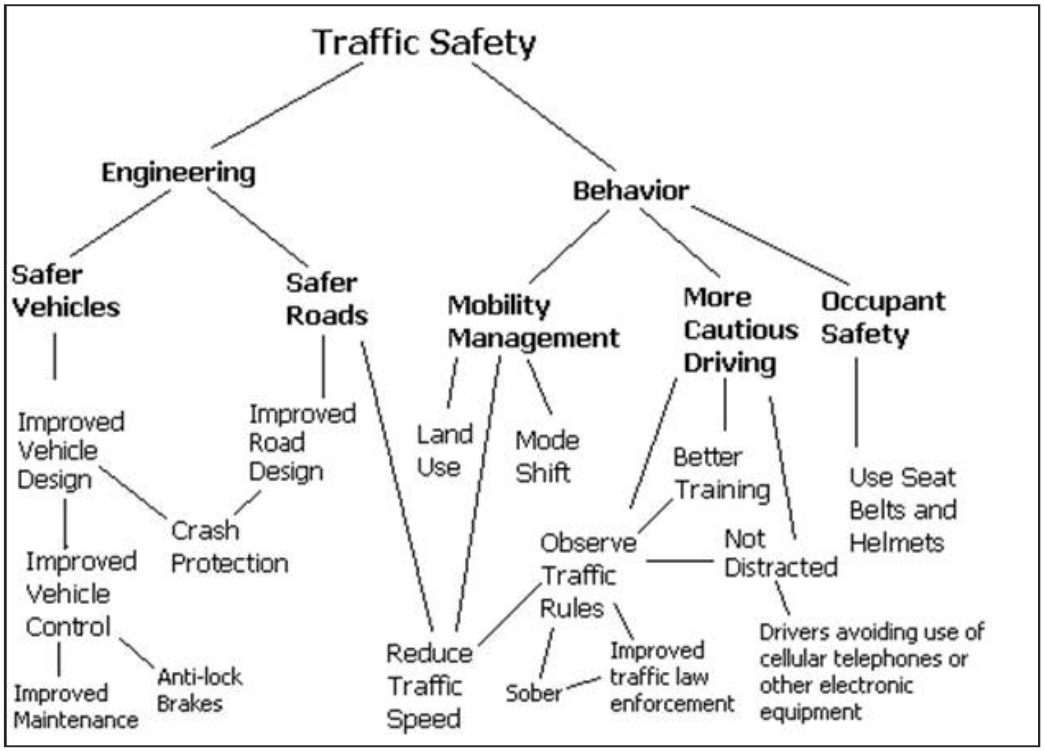


Figure 2.3: Traffic safety strategies
Source: Victoria Transport Policy Institute, 2011

It is clear that traffic safety is well-connected to human behavior and although much is known about the rules implemented to improve safety in traffic, there is still more to learn about their effects on driver behavior, which is far from safe (Aberg, 1998). It is well known among drivers that having the seat belt on or wearing a helmet as a motorcycle driver, decreases the injuries in case of an accident. But everyone has a different perception of risk and this is where rules step in to control the behavior of road users and provide equal terms of safety to everyone. We all change our behavior in response to changes in our environment; safety measures change our environment, so we may change our behavior in response to them (Hedlund, 2000). All action produces risk and as society and as individuals, people constantly balance performance and risk (Hedlund, 2000).

As a final point, it is in human nature to make mistakes and misjudgments in their behavior as road users and in general as well, so even if the safest conditions are created in a road network, accidents might still happen. What is important is to keep this number limited. Countries are constantly concerned with the matter of traffic safety and while the number of road traffic injuries doesn't seem to be decreasing everywhere (Lacroix & Silcock, 2004), new efforts through urban planning with changes in the road infrastructure, try to provide solutions to the situation. Meanwhile, the debate of segregation versus integration of different types of traffic goes on in transport policies and there are mixed opinions in countries on which is the best way that will lead to an enhanced traffic safety and sustainable development.

2.3 Separation

After the massive growth in car ownership in the 1960s, the street designs were altered to hold the constantly increasing volumes of traffic and started being controlled by traffic signs and other traffic management techniques, all in favor of the car with no regard towards the environment or other transport modes. This is the traditional approach to street design that led to the concept of segregation which focuses on the differentiation of the types of traffic in the road network (Nielsen, 2006).

An explanation of the classification of the roads in urban areas will be useful at this point. They are classified into four major categories and each one of them is serving a purpose (Federal Highway Administration, 1989):

- principal arterials
- minor arterial roads
- major and minor collector roads
- local roads

As illustrated in *figure 2.4*, arterials emphasize a high level of mobility, local facilities emphasize the land access function, while collectors offer a compromise between both functions.

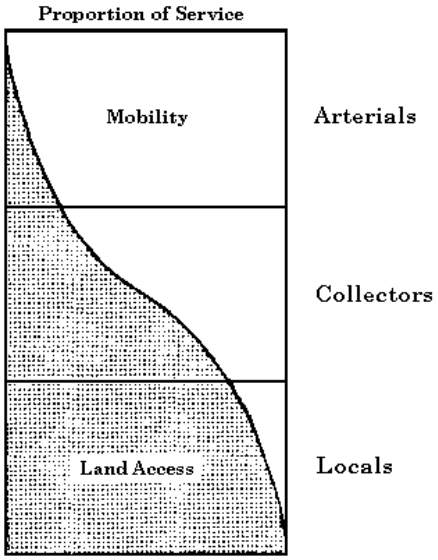


Figure 2.4: Relationship of functionally classified systems in serving traffic mobility and land access
Source: Federal Highway Administration, 1989

So, as Nielsen (2006) states it, "*a fundamental idea behind the traditional approach to traffic separation and road classification is to determine which roads can take larger volumes and higher speed levels than others*." Highways and collectors will always be needed, as well as high speed public transport links and separated high quality bicycle routes, and the necessity of separation between large volumes of high-

speed traffic and other modes or in densely populated neighborhoods is supported by indicators of environmental factors such as barriers, noise and air pollution, and from statistics on traffic accidents (Nielsen, 2006). The mix of traffic participants with large differences in speed and mass, using the same space will inevitably lead to accidents (Godthelp & Wasemann, 2010) and in sustainable road safety terms, on traffic arteries, priority has to be regulated either by traffic signs or by portal entry constructions (Methorst, 2007). Therefore, integration of different types of traffic is applicable only to local roads which serve purposes of land access within the road network (see *figure 2.4*), where car speeds are limited and the street design does not allow them to accelerate either way, while separation is not only logical, but essential on main arterials with high traffic volumes. Consequently, when talking about separation from now on in the thesis, it is meant only for local roads.

In the urban environment, the road network accommodates a mixture of heavy and light car traffic, pedestrians, cyclists and public transport with large variations in travel speed and stopping patterns (Nielsen, 2007). Basically, what segregation suggests it to maintain the street design of keeping the different road users separated from each other, but give priority to public transport, cyclists and pedestrians to discourage car use. Furthermore, the priorities between users should affect the overall design of the road and street network, traffic signals and other traffic regulations, for example giving cyclists extra space and priority time at traffic junctions (Nielsen, 2006). Hamilton-Baillie argues that separation arises from the notion of the state as a controller, regulator and responsible for order and safety and then refers to Moran (2006), who researched the development of segregation in street design, stating that there is widespread, popular faith in the effectiveness of the measures (Hamilton-Baillie, 2008). However, this traditional approach fails more and more to correspond to the desired sustainable mobility for cities or the needs of the road users (Nielsen, 2007).

The "Fietsbond", the Dutch cyclists' union admits that cycling is more comfortable when the need for alertness is decreased, but they also recognize that no real segregation exists at intersections, which may lead to more accidents, so in the end they prefer segregation to be applied only where reduction of fast driving cars' speed is not possible or desirable (Godefrooij, 1993). Back in 1998, Aberg, chair in traffic psychology at Uppsala University, believed that "*the traffic system should be seen as a social system where drivers are interacting with other drivers and road users. Rules and regulations are important to help the actors of the system to function in a safe and effective way*." But what happens when every traffic light, every sign and every kind of "rule" on the public space that defines traffic behavior is ripped out?

2.4 Integration – Shared space

"*Under the label of 'shared space', a radically different approach to street design, traffic flow and road safety is rapidly emerging*" (Hamilton-Baillie, 2008). The whole

context of the shared space policy lies in the idea of raising traffic safety by putting all the users together to share the road, or, as Hamilton-Baillie expresses it, integrating traffic into the public realm. A single definition has not been agreed, but the one that will be used here is of Moody and Melia, 2011, which describes as "shared space" the streets designed to minimize demarcations between vehicles and pedestrians. The shared space policy could be placed in the 'improved road design' category of *figure 2.3*, but it is not just about engineering interventions in public space; a major part of it lies in the behavioral changes of the people who will use it. It should be noted that shared space equals with integration of different types of traffic, but integration does not equal with shared space; in the literature the concept of traffic integration can be found for example explained just as the implementation of traffic calming measures with no mention of shared space (Nielsen, 2006). However shared space is the concept under examination in this thesis, therefore it will be the only one addressed as integration.

Shared space is a radical innovation in street design, introduced by the late Dutch traffic engineer Hans Monderman (1945-2008) who came to change the whole meaning of road safety. It all started in 1982 when he was appointed as a traffic safety officer in the town of Oudehaske in the Netherlands (PPS, 2012). This was his first experiment, when he removed everything that could be considered as a safety feature, meaning road signs, barriers and separations between the road and the pavement (Cairns, 2009). The results were surprisingly encouraging, with the speed of vehicles reducing to more than half within two weeks. More small-scale projects like that followed that had positive outcomes until 2003, when the first big challenge of shared space rose. All traffic lights and signs were taken out of the city center of Drachten, resulting not only in a number of zero accidents per year, but the elimination of traffic jams as well (Cairns, 2009). After Drachten, shared space was embraced by more people and many shared space projects were set up all over the world, which will be examined in more detail in chapter 3.

Of great interest are Monderman's points made in his presentation for Urban Design London, in 2007, that people can organize their own behavior, without any street signs to define it. He claims that what traffic engineers have been doing all along was objectifying subjects. He mentions the, what he calls, *liminal circles* in the interaction between public and private space, which are the different circles around people that allow them to open up the information to each other or block it. This way people are aware again of one another and they can communicate through eye contact and body language. Isolation and building fences is not the answer. But first people need to realize that they are responsible for their own problems, they should change their behavior and not put the responsibility on others, such as traffic engineers. He is also touching the issue of time saying that time is not linear and everyone's perception of time varies, therefore gaining some 15 minutes on a trip by reaching faster a destination through speeding is pointless. He advises to take the past into account,

when people before the automobile were not ever in a hurry to travel. The comparison between traffic and social behavior he made is illustrated in *figure 2.5* below.

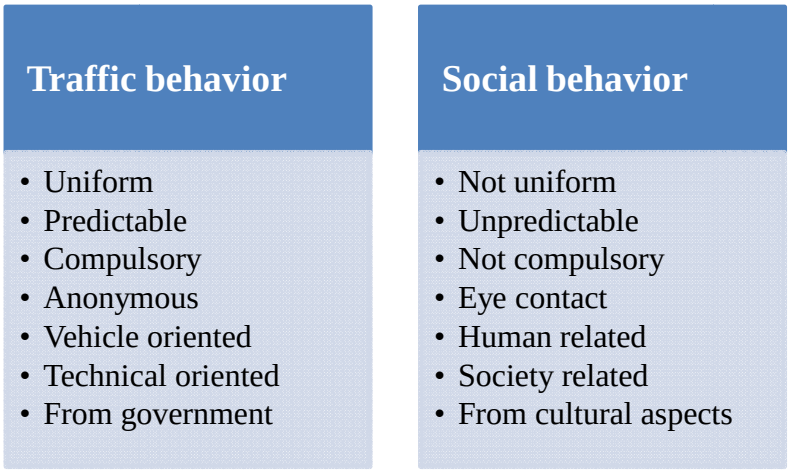


Figure 2.5: Behavior and space
Source: Monderman, 2007

In the literature there are people clearly in favor of shared space, highlighting the benefits of such a street design, such as the reduction of accidents and the improvement of traffic flows. Author Warwick Cairns, in his book 'How to live dangerously' dedicates a whole chapter to the brilliance of Monderman's work, explaining the principles of risk compensation and the paradoxes of safety. He claims that "*the safest course of action, much of the time, is the one that appears, on the face of it, the most dangerous*" (Cairns, 2009). Journalist and author Simon Jenkins writes in the British newspaper 'the Guardian' to "*rip out the traffic lights and railing. Our streets are better without them*", condemning traffic engineers who still insist to separate drivers from pedestrians and arguing that even zebra crossings can be dangerous when drivers are so used to paying attention only to traffic lights (Jenkins, 2008).

One thing many authors, traffic engineers or transportation planners in the literature agree upon, is that it is relatively early to draw conclusions on whether shared space has accomplished to increase traffic safety or not, but there are many cases of shared space implemented and through their observation, answers will be given to this question. Architect and urban design specialist Ben Hamilton-Baillie in his earlier publications couldn't decide if Monderman was "*a madman or a genius*" (Hamilton-Baillie, 2005), but later, after observation and empirical research, he gradually came to recognizing that shared space projects have generally improved pedestrian safety, but "*important implications for the definition and response to safety and risk*" didn't cease to exist (Hamilton-Baillie, 2010). Transport planner Simon Moody and Dr Steeve Melia, senior lecturer in the centre for Transport and Society of the University of the West of England, in their research, they critically examined the shared space scheme in Ashford, Kent in UK. They claim that most of the evidence collected so far in the 'official study' is focused on drivers, neglecting the pedestrians' point of view.

By using video observations and a street survey of pedestrians, they reveal that most pedestrians diverted away from their desire lines, gave way to vehicles in most cases and felt safer under the original road layout. This study casts doubt on some aspects of the methodology. The authors conclude that some claims made for shared space have been exaggerated and that "*reducing demarcations between vehicles and pedestrians is not, in itself, a sustainable transport measure. In some circumstances, shared space combined with one or more sustainable transport measures, may be the most appropriate solution*." (Moody & Melia, 2011).

In the end, it all comes down to human behavior which in all its complexity, makes explaining it a very difficult task (Ajzen, 1991). Professor of psychology Icek Ajzen developed the theory of planned behavior which has proven to be a useful framework for understanding, predicting and changing human social behavior over the past 30 years (Ajzen 2012). In the theory of planned behavior the individual's intention to perform a given behavior plays a central role and to the extent that a person has the required opportunities and resources (e.g. time, money, skills, cooperation of others) and intends to perform the behavior, he or she should succeed in doing so (Ajzen, 1991). In the case of shared space, the most relevant opportunities and resources for road users seem to be the time they need to adjust to the street design and the cooperation of others, so that everyone will come to agreement with each other and benefit from shared space in a way that will increase their safety. The theory of planned behavior also suggests three conceptually independent determinants of intention (Ajken 1991):

- *the attitude toward the behavior;* it refers to the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question
- *the social factor termed subjective norm;* it refers to the perceived social pressure to perform or not to perform the behavior
- *the degree of perceived behavioral control;* it refers to the perceived ease or difficulty of performing the behavior

In shared space schemes, as with any kind of change in a street design, the expected or desired behavior of road users in it is the one that will lead to their smooth and effective co-existence in a safe way. The place of shared space among the above determinants of intention can be revealed through empirical research, which in general has proven to well support the theory of planned behavior (Ajzen, 1991).

2.5 Conceptual model

Based on all of the above, a conceptual model was constructed in *figure 2.6*, which is going to be used as a base line for the empirical cases further on. The model illustrates the fundamental elements that are part of the traffic safety system and that they all co-exist, interact with each other and influence the system. By linking the interactions

between the model's elements, an approach to traffic safety is established that will be followed to critically examine the case studies of integration and separation of different types of traffic and provide answers to the research questions posed in the first chapter.

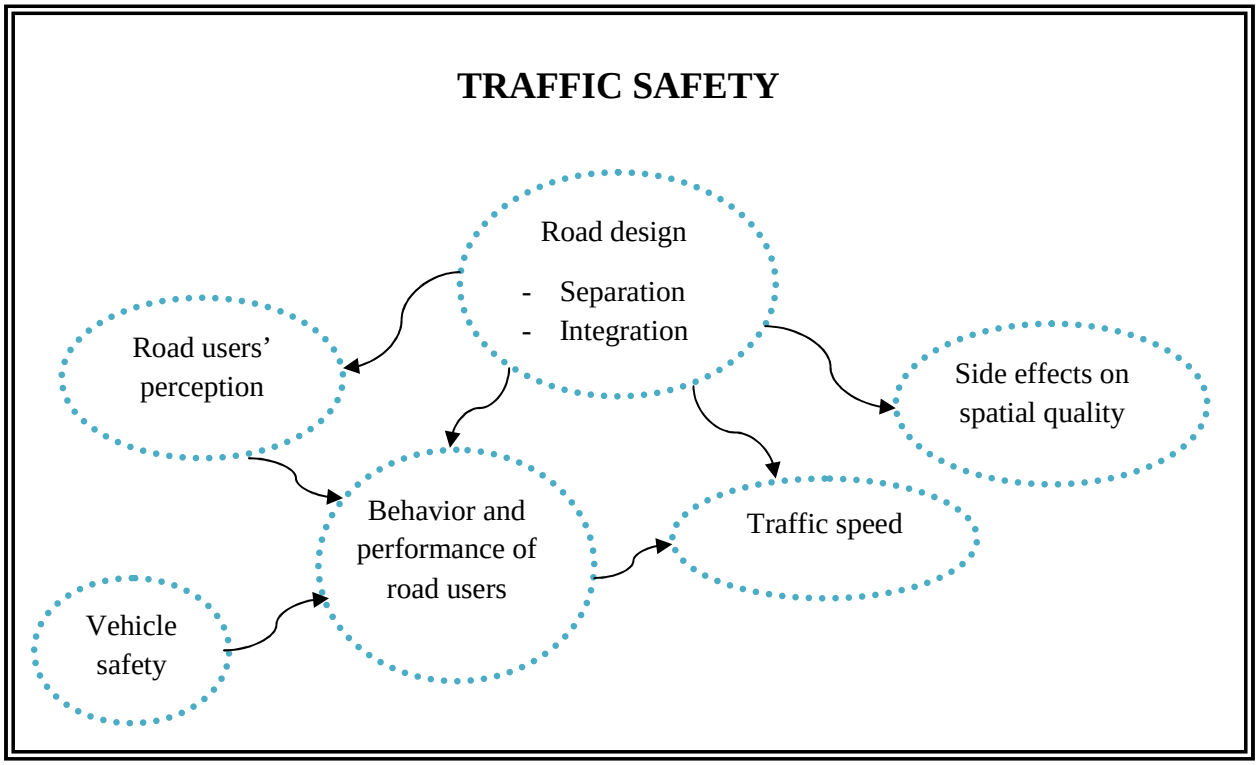


Figure 2.6: Conceptual model

Chapter 3: Case studies in European cities

In the current chapter the different case studies of shared space and separation of types of traffic are described of several countries. The shared space paragraph contains a further analysis of the two case studies in the Netherlands, the Laweiplein intersection in Drachten and the Rijksstraatweg in Haren and the collection of questionnaires in them. A critical review of all the cases follows, along with the formation of the table of advantages and disadvantages of both street designs.

3.1 Methodology

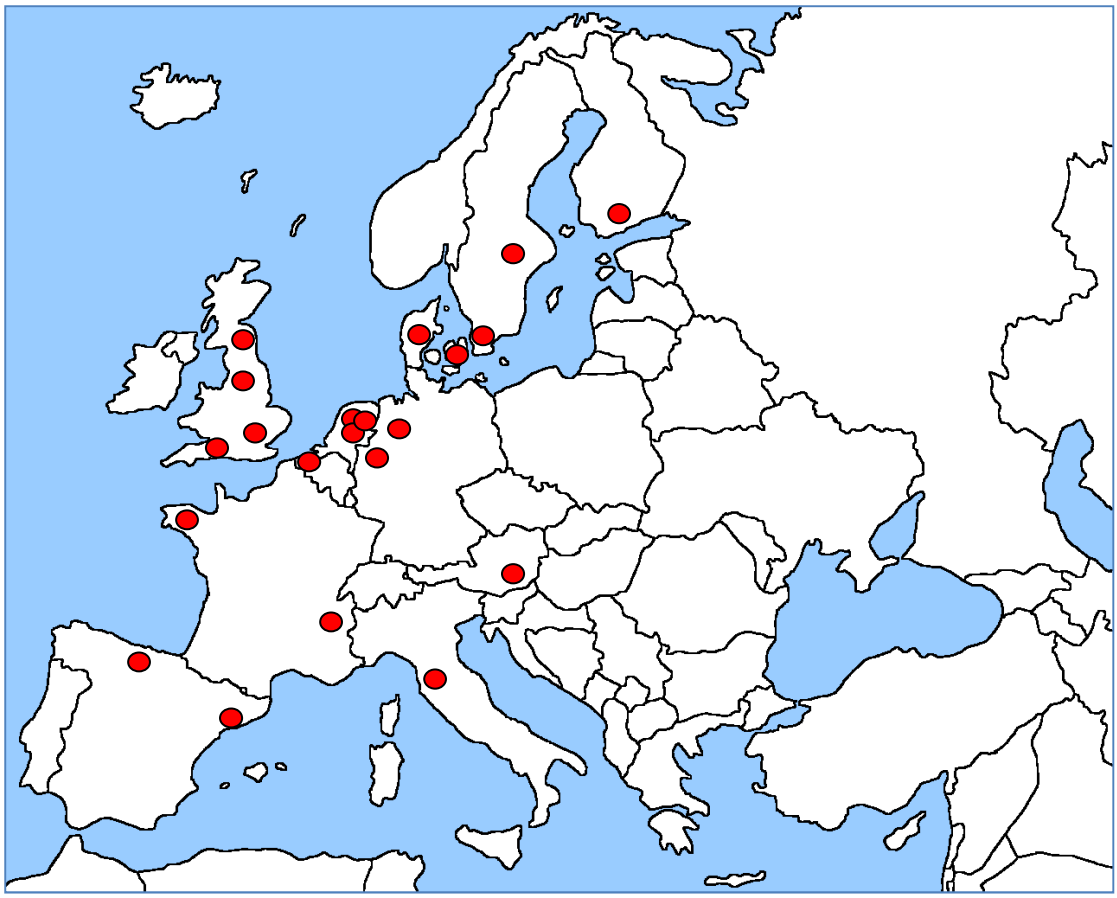
The methodology followed for the elaboration of the current chapter is the collection of data from available sources on case studies in Europe of the two different street designs. Examples of shared space can be found in the literature in countries such as Germany, Denmark, Sweden and the UK (Hamilton-Baillie, 2008, Hickman & Carson, 2006), the emphasis though will be put on cities in the Netherlands. The Laweiplein intersection in Drachten and the main shopping street, Rijksstraatweg, in Haren are the two locations of interest; the first, because it was the very first case of a shared space policy implementation and the second, because it is another important case of shared space in the Netherlands. A personal visit to these two locations for further observation of the movement in them and the collection of questionnaires from pedestrians was conducted, in order to unravel more information on the way the situation about shared space and traffic safety is perceived by local people.

After this, case studies of separation of different types of traffic are analyzed in order to be compared with the cases of shared space. An unfortunate turn of events was that in the case studies of separation of types of traffic, no data directly comparable to the case studies of shared space could be found. This means that although in a case of shared space there is a list of the numbers of traffic accidents on the specific location before and after the scheme's implementation, there aren't any data available for traffic accidents in another location which has a design of separation in the same city. This kind of numbers would be easily put next to each other and reveal right away information about a city's traffic safety situation, but since they couldn't be obtained, a general reflection will be made from the perspective of development of traffic safety for whole cities in the countries where shared space was also implemented. Depending on this information, the tables of advantages and disadvantages of the two street designs are formed.

It should be noted that the case studies were selected and analyzed depending firstly, on the data availability that cover most elements of the conceptual model and secondly, on the importance of the cases. Usually, they are the first cases of shared space in each country that encouraged more cities to consider a shared space policy, therefore they are worth mentioning in the chapter.

3.2 Case studies of shared space in Europe

The implementation of shared space during the last decade has started getting more and more popular in cities in Europe. Some examples can also be found in the US but the focus here is on Europe so they won't be mentioned. *Picture 3.1* shows the locations of the European cities that have a shared space policy, some of which are analyzed later on.



Picture 3.1: Shared space in Europe

3.2.1 Sweden and Denmark

Sweden and Denmark are the countries that developed the practice further than most countries (after the Netherlands), and shared space is now a widely accepted urban design principle in much of Scandinavia (Hamilton-Baillie, 2008).

Norrköpping is a medium size town of around 125,000 inhabitants near Stockholm. Skvallertorget (Gossip Square) is a square in the town centre with a traffic volume of 13,500 vehicles per day, many cyclists and at peak moments as many as 1700 pedestrians a day (Swales, 2009). In 2004 zebra crossings and traffic signs were removed and a spacious fountain, benches and other street furniture were installed instead (Hamilton-Baillie, 2008). Three years after its operation there have been no

accidents, mean traffic speeds have significantly decreased from 21 to 16 kilometers per hour, while road safety and livability have increased (Swales, 2009). Pedestrian volumes have greatly increased, as has economic activity around the square too and there was a decline in delays and congestion (Hamilton-Baillie, 2008). Surveys of drivers, cyclists and pedestrians indicated that satisfaction and confidence with the new arrangements is increasing although these still concerned are some older citizens and blind and partially-sighted people (Hamilton – Baillie 2008).

Picture 3.2: Skvallertorget, Norrköping, Sweden
Source: http://sverigesradio.se/sida/gruppsida.aspx?programid=2034&grupp=12146

The small town of **Ejby** in Denmark with a population of around 2,000 is centered around the intersection of a busy railway with a county road, and trade and commerce built up around this important interface (Friesland Province, 2008). In the 20th century there was a decline of railway towns and the construction of a road bridge and dark and unattractive pedestrian underpass caused major damage to the spatial quality and economic welfare of Ejby (Friesland Province, 2008). Accident records along with reports of high vehicle speeds, created difficulties for pedestrians and cyclists highlighting a severe safety problem and when the project was first implemented, initial surveys and assessments indicated a high degree of local satisfaction with the outcomes (Friesland Province, 2008). Two locations of the town were remodeled, removing intrusive highway elements and upgrading the centre's spatial quality (Toth, 2009).

The town of Ejby is also an example of the importance of land use to support a shared space design. In *picture 3.3a* there is the less successful area of shared space in the town, where due to the large open space, cars didn't seem to slow down, while in *picture 3.3b*, the setting was created more effectively (Toth, 2009).

Pictures 3.3a (left) and 3.3b (right): Ejby, Denmark
Source: Toth, 2009

3.2.2 France

The principles of shared space have already started being implemented in the city of **Chambéry** in south-east France since the 1980s by Michel Deronzier. Of course then he didn't call it shared space, but following the patterns of Hans Moderman, as described in chapter 2, he was using the term 'pedestrian priority' based on the statement that public space belongs to pedestrians and that car drivers are just invited in the city centre (Faure, 2010). Chambéry is a very dense city, around 61,000 residents in an area of 20,99 km² and therefore there is little space, so one of the objectives of the policy was to save space and the space had to be shared because it was not available (Deronzier, 2010).

Picture 3.4: Shared space in Chambéry
Source: Deronzier, 2010

In 2004, the whole city center became a 30 Km/h zone and every sign was taken down. The numbers of accidents and victims have been constantly and dramatically decreasing since the beginning in the 1980s resulting, from 245 accidents and 332 victims in 1989, to 32 and 38 respectively in 2006 (Deronzier, 2010). Compared to

the statistics in the rest of France, Chambéry is twice as safe as the average city of the same size in France (Deronzier, 2010).

3.2.3 United Kingdom

Traffic engineering and urban planning in the UK has generally adopted the model of segregation between traffic and pedestrians, offering separate infrastructure to serve each mode and only in recent years there has been a move away from it (Hamilton-Baillie & Jones, 2005). The first step was in 1999, when the UK government began to encourage experimentation with ideas such as pedestrian movements, children's play and social activities to be combined with traffic movements influencing each other through a pilot 'Home Zones' program, resulting in the transformation of 60 existing areas to Home Zones by the end of 2005 (Hamilton-Baillie & Jones, 2005).

In **Brighton** city of 156,000 inhabitants, the New Road was transformed into a fully shared space in 2007, with the route for vehicles along the whole road being shown only through the location of street furniture, such as public seating and street lights (Hamilton-Baillie, 2010). This design has led to a 93% reduction in motor vehicle trips, meaning 12,000 fewer per day and lower speeds around 10 mph ≈16 Km/h, alongside an increase in cyclist and pedestrian usage, 22% and 162% respectively (Cycling England, 2007). After that, the New Road has become the city's fourth most popular visitor attraction.

Picture 3.5: Brighton before and after
Source: http://www.nbr.co.nz/article/auckland-new-copenhagen-102761

In spring 2008, shared space was introduced in **Ashford**, Kent with a population of 59,000 people. The award-winning scheme, replaced in Elwick square a section of Ashford's former four lane ring road with two-way streets on which drivers, cyclists and pedestrians have equal priority (Royal Town Planning Institute, 2010). Unnecessary street furniture, road markings and traffic lights have been removed from the square which accommodates today traffic flows of approximately 11,000

movements per day and up to 850 movements per hour (Moody and Melia, 2011) and within the first 15 months of operation, the speed limit cut to 21 mph ≈33 Km/h (Hamilton-Baillie, 2010). The scheme has also greatly improved safety records since it opened. Between November 2008 and January 2011, there have been four road casualties in the six reported accidents there (Scott, 2010).

Picture 3.6: Ashford Elwick square
Source: Hamilton-Baillie, 2010

The success of shared space in Elwick square was severely criticized by Moody and Melia, who proved in their research that pedestrians avoid crossing freely the square and feel that they have less priority over vehicles (Moody & Melia, 2011). Hamilton-Baillie's response to this, who is responsible for the scheme, was that there was a 75% drop in serious accidents and although this fact *"doesn't necessarily translate into how people feel when they cross the street, the reduction in speed has been the most important single element in transforming what was an unattractive concrete collar surrounding Ashford into a civilized part of the town centre itself"*(BBC, 2011).

3.2.4 Germany

The town of **Bohmte** introduced a shared space road system in September 2007, with the project's main goal being the improvement of its road safety. In an area used by 13,500 cars every day with an average of one traffic accident per week, all traffic controls, traffic lights and stop signs were removed (Bosley, 2007). Only two rules remained, that drivers cannot go above 30 mph (≈48 Km/h), the German speed limit for city driving, and everyone has to yield to the right, regardless of whether it is a car, a bike or a pedestrian (Hall, 2008).

Picture 3.7: Shared space in Bohmte, Germany
Source: Hall, 2008

Four weeks after the scheme was implemented, there has been no accident, declaring the scheme a huge success and the area is now characterized as an accident-free zone (Hall, 2008). This was the first shared space project in Germany, covered by an EU grant and inspired by Moderman and his projects in the Netherlands (Bosley, 2007), bringing also an unexpected bonus of more than 6,000 euros per month savings from replacing and repairing signs damaged through normal wear and tear or by vandals (Hall, 2008).

3.3 Case studies of shared space in the Netherlands

The Netherlands was where the whole concept of shared space was initiated and it has set the example and encouraged more countries to try out this innovative design. There are more than 100 areas of shared space in the Netherlands today, mostly just single junctions in the centers of villages and small towns (Hamilton-Baillie, 2010, Hembrow, 2012). The two cases that will be investigated are Drachten and Haren, both important in the country and both continuously criticized.

3.3.1 Drachten

The transformation of the Laweiplein intersection in Drachten, a town of almost 45,000 inhabitants in the province of Friesland, is the most famous case of shared space. In 2003 all traffic lights, signs and bicycle lanes were removed from what was a major signal controlled intersection (*Picture 3.8*), converting it into a “squareabout”, meaning a roundabout as an integral part of a square, with bicycles and pedestrians sharing the whole of the public square with no formal segregation (Noordelijke Hogeschool Leeuwarden, 2007). The only thing that remained was some road markings, with two of the four zebra crossings being moved further back away from the roundabout (*Picture 3.9*) (Noordelijke Hogeschool Leeuwarden, 2007).

Picture 3.8: The former design in Laweiplein
Source: Noordelijke Hogeschool Leeuwarden, 2007

Picture 3.9: The new design in Laweiplein
Source: Noordelijke Hogeschool Leeuwarden, 2007

Between 2000 and 2005 the total volume of passing cyclists has remain roughly unchanged, while traffic volumes have increased at the intersection by around 30%, an increase from 1407 to 1854 vehicles per hour. At the same time, the number of accidents, as shown in *figure 1*, has reduced from an average of eight per year to one per year (Noordelijke Hogeschool Leeuwarden, 2007).

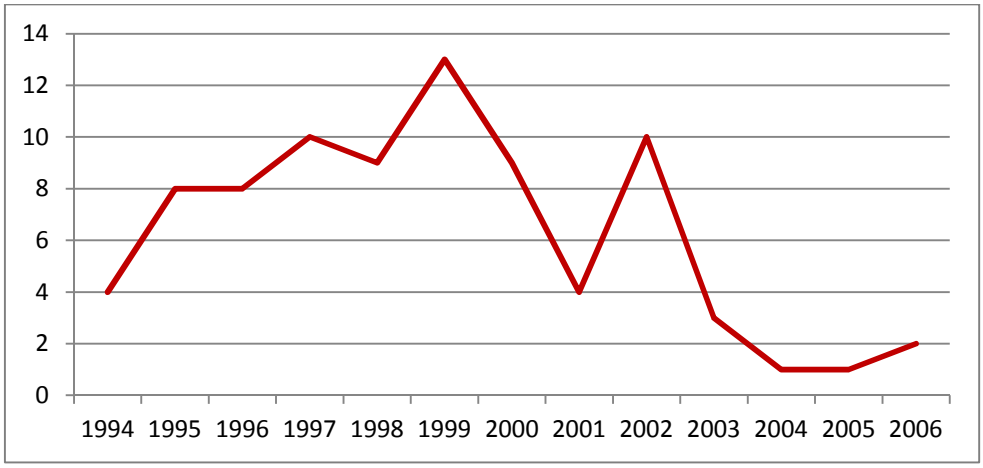


Figure 3.1: Number of traffic accidents in Laweiplein, Drachten
Sources: Noordelijke Hogeschool Leeuwarden, 2007, MVA Consultancy, 2009

3.3.2 Haren

The 800 meter shopping street in Haren in the province of Groningen, Rijksstraatweg, is accommodating an average of 8,500 vehicles per day for its 23,000 inhabitants (Hamilton-Baillie, 2008). In 2003 the street's former centre-line road markings, traffic signals, separate bicycle lanes and high kerbs, as shown in *picture 3.10*, were all removed, transforming it into a shared space street, shown in *picture 3.11* (Hamilton-Baillie, 2008). The pavement now is at the same level as the sidewalks and the only things lying on the street are trees, lampposts and some fences, while the intersection areas are open and no indication for bicycle and pedestrian space is given, except for a brick line marking the bicycle lane (Methorst, 2007).

Picture 3.10: Rijksstraatweg in Haren before 2003
Source: http://flickeflu.com/groups/341924@N25

Despite traffic speeds falling by just around 5 km/h reaching an average speed of 38 Km/h after shared space was implemented (Hamilton-Baillie, 2008), the accidents significantly reduced from 3 injuries and 32 damage only during 3 years before the scheme's implementation to 0 injuries and 17 damage only accidents during the 3 years after (Edquist & Corben, 2012). A more broad view of the number of all accidents is presented in *figure 3.2*.

Picture 3.11: Rijksstraatweg in Haren after 2003
Source: http://www.streetsblog.org/

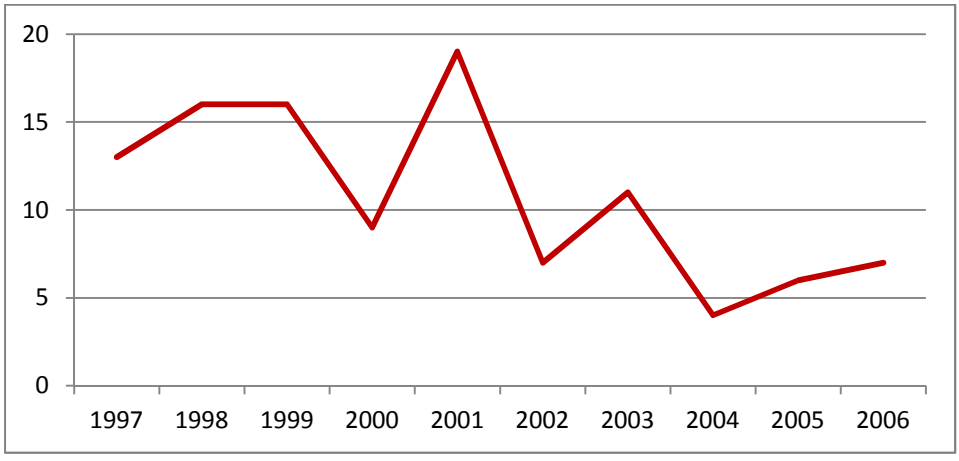


Figure 3.2: Number of traffic accidents in Rijksstraatweg, Haren
Source: MVA Consultancy, 2009

3.4 Questionnaire research

As it was also explained in the introduction, surveys on pedestrians in shared space schemes were usually neglected, a fact strongly criticized by Moody and Melia, 2011, who questioned the improvement shared space brings to pedestrians in the scheme in

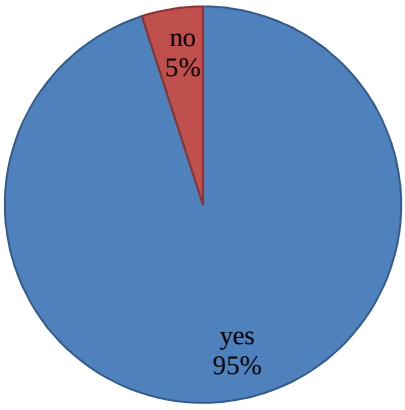
Ashford, stating that the focus is only on accident statistics and traffic flows. Therefore, the further analysis of the two Dutch shared space cases under examination from a pedestrian point of view was decided. Inspired by questionnaire research conducted in other shared space locations and also in a way that meets the research objective in accordance to the conceptual model, the questions chosen to be asked to the pedestrians in Drachten and in Haren are:

1) Do you feel safe here in this part of Drachten/Haren and why?
2) Do you feel you have equal, more or less priority over other road users (cars, bicycles)?
3) Are you satisfied by the speed of vehicles and why/why not?
4) What do you think of this street design, do you like or dislike it? Do you have suggestions for improvement?

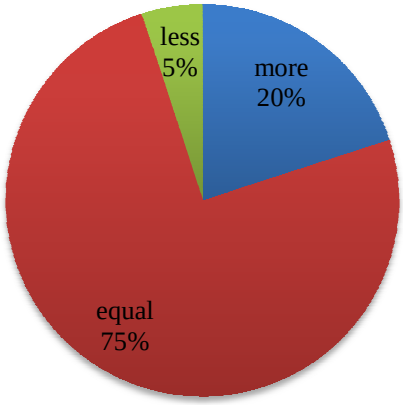
Given the fact that the willingness of the pedestrians to respond to the questions asked to them in English is uncertain, the questionnaire was designed really short but with open questions addressing to the pedestrians' perception of safety, ease of use and their preferences. The sample decided appropriate for the formation of conclusions is 40, 20 in each location. The research took place on July 12, 2012 between 3 pm and 7 pm in both locations on a Thursday when the working hours generally last until 9 pm for shops. The number of questionnaires collected was 20 in Drachten and 21 in Haren, from which the results are presented below.

3.4.1 Laweiplein, Drachten

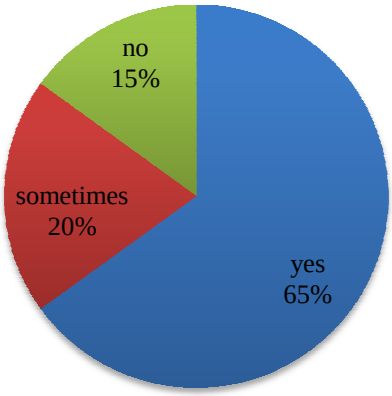
1. Do you feel safe here in this part of Drachten?



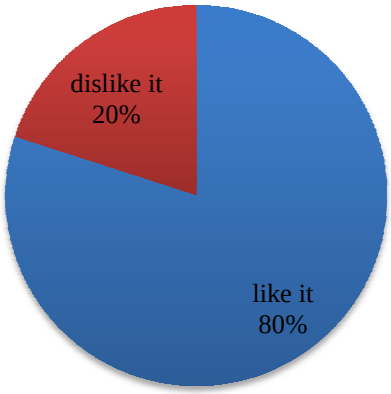
2. Do you feel you have equal, more or less priority over other road users?



3. Are you satisfied with the speed of vehicles?



4. What do you think of this street design, do you like or dislike it?



It is evident from the above chart pies that pedestrians have a positive reflection on shared space in the Laweiplein intersection in Drachten. The vast majority feels safe, they believe they have equal priority with the rest of the road users, they think the cars' speed is acceptable and they are satisfied by this particular street design. Concerning the first question, when the answer was positive, people justified it by saying that nothing has ever happened to them or that it is well-lighted during the night so all users can easily spot each other. The one person that gave a negative answer said that there is a lot of traffic and pedestrians don't use the zebra crossings to cross the street. For the second question, most of the people said they have no problem with the cars and that they usually let them go first. For the third question, pedestrians who are not satisfied by the vehicles' speed said that they drive too fast and they don't slow down, while when the answer was "sometimes", it is because the people were in between the two answers claiming that sometimes the speed is fine, but some other times the cars go too fast. Concerning the last question, a popular answer for people who like the design is that they are used to it, as for suggestions for improvement mostly from people who dislike it, but from a few who like it as well, are to move the zebra crossings closer to the roundabout, put more green and flowers there, while there were also some comments on the red art on the ground, calling it ugly and ridiculous (see *picture 3.12*). Surprisingly enough, no one commented on the little fountains placed all around the roundabout that make both pedestrians and cyclist pass through them.

An incident that occurred during the collection of the questionnaires was a minor coalition between a cyclist and a pedestrian, because the pedestrian was distracted talking to other people while crossing the road, but the cyclist was going slow so the matter was immediately solved.

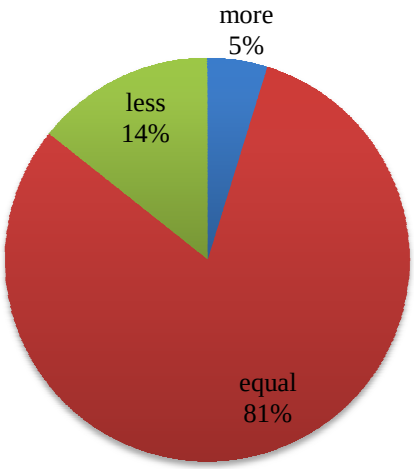
Picture 3.12: The red art on the ground of Laweiplein

As a personal observation, the Laweiplein intersection is busy and no true shared space is implemented as it is known by definition. It is very clear which space belongs to which user by the different paving used indicating the road for the cars and the cycle paths. As shown in *picture 3.13* and visible in *picture 3.9* too, after the pedestrian crossing, the cycle path continues to exist by the red bricks used, different from the rest of the road and a line pointing out the demarcation between cars and bikes. The intersection has land markings everywhere for the cars to give priority to cyclists and the zebra crossings too, suggesting where pedestrians should cross and car drivers are obligated to stop. The impression that was obtained by interviewing the pedestrians is that most of them are not even aware that this is a shared space, they just think it is inconvenient for the zebra crossings to be so far from the roundabout so they are using the cycle paths to cross the street. So in this sense, cyclists and pedestrians do share the space in Laweiplein, but car drivers have a certain route to follow.

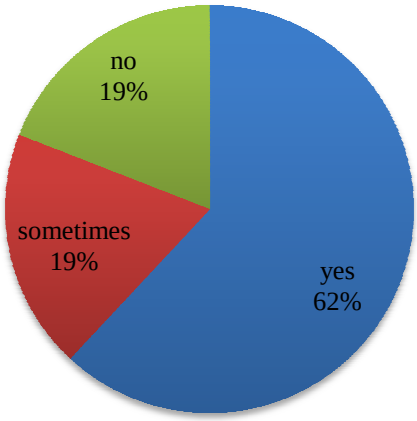
Picture 3.13: One of the four entrances to the Laweiplein

3.4.2 Rijksstraatweg, Haren

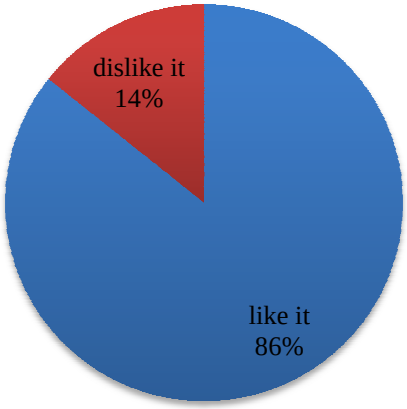
2. Do you feel you have equal, more or less priority over other road users?



3. Are you satisfied with the speed of vehicles?



4. What do you think of this street design, do you like or dislike it?



A chart for the first question is not provided because 100% of the answers were positive, people feel safe in Rijksstraatweg because they say it is not too busy, it is well-lighted during the night and one person living for years in the area said that since the street changed to shared space, accidents don't happen anymore. Concerning the second question, pedestrians generally feel they have equal priority with the rest of the road users, stating that they are not bothered by anyone, while the few people that disagree claim that sometimes the cars drive too fast and they don't seem willing to stop and give way to them. The satisfaction with the speed of the vehicles is on a good level in general, while 38% of the people recognize that the cars go too fast sometimes or most of the times and they are not entirely happy with it. Regarding the last question, pedestrians like this street design, some especially in comparison to the old one, they think it is easy to walk there because of the trees strategically placed that

give them space and don't allow the cars to go to the side of the road, while there were only two people stating that they definitely don't like sharing the road. Suggestions for improvement were the placement of more trees or flowers or speed bumps to control the speed of the cars and force them to slow down because at some parts of the road the space is wider encouraging them to speed up. Enforcement was also suggested to ensure car speeds will stay low, while one person proposed for the whole street to become a car-free zone so people can enjoy more shopping. It is important to mention that one of the interviewees was a handicapped person on a wheelchair and was very satisfied with shared space because it provides more freedom of movement and much easier access to the shops.

From the experience in Haren, same as Drachten, not a complete shared space design is applied. Only one part of the road, the one shown in *picture 3.14*, has the same kind of paving everywhere and just trees and benches suggest the way to the cars, but the rest has asphalt paving for the cars in the middle. In fact, there are street signs indicating that the two sides of the road are for pedestrians (see *picture 3.15*), while cyclists were spotted using both these sides and the road in the middle. Zebra crossings exist at some parts and being a two-way street, it is hard for pedestrians to cross at any other part of the street. Only if they are confident enough and take a step forward, car drivers will slow down and give way to them. A way to solve this issue would be the placement of warning signs for the cars that they enter a shared space zone and that everyone has equal priority.

Picture 3.14: The part of true shared space in Rijksstraatweg

Picture 3.15: Different paving and street sign in Rijksstraatweg

3.5 Cases of separation in Europe

Everywhere in the urban environment the design principle that prevails is the one of separation of types of traffic. It is the way street networks were operating since the mass expansion of the motor vehicles and the way planners and engineers trust will ensure the safest movement of road users. There is great disbelief in shared space, even among countries with successful shared space implementation and a large part of the population is against it. The cases that follow are some examples of situations like this, but it should be noted though, that they refer to whole cities and the data presented inevitably include collectors and arterial roads in their results, apart from local roads (see *figure 2.4*). This fact makes a full comparison to the data collected from the shared space cases impossible, therefore the following cases will be viewed from the perspective of general developments in terms of traffic safety for the selected cities.

3.5.1 Denmark

The city of **Copenhagen** doesn't have shared space anywhere, but in order to upgrade the quality of its public space has turned its efforts to discouraging car use by creating pedestrian zones and by promoting cycling, turning it into a world-famous bicycle city (Chen, 2010). By 2000 the city's pedestrian areas have increased by six times and bicycle traffic increased by 65% within 1978 – 2003 (Chen, 2010).

Picture 3.16: Intersection in Copenhagen
Source: http://nerdyplanner.blogspot.nl/

In 1998, 569 people were killed or seriously injured in traffic accidents. In 2005 this number was more than halved, which was achieved by redesigning a number of the city's biggest intersections and road sections. Accidents in which pedestrians are seriously injured comprise more than 25% of all injuries in Copenhagen. They also constitute the second largest category of deaths or serious injuries in comparison to the other categories (City of Copenhagen, 2007).

A study on traffic safety on bicycle paths concluded that bicycle paths impair traffic safety and this is mainly due to more accidents at intersections (Agerholm et al., 2008), justifying the shared space proponents' view that separated road users are so used to obeying only to signs and traffic lights that more accidents are caused at intersections, where no real separation exists.

3.5.2 United Kingdom

Conventional priorities remain in force in the UK, like in *picture 3.13* in **Holsworthy**, where this safety barrier placed to separate pedestrians from the traffic encourages motorists to speed up, causing accidents (Hamilton-Baillie & Jones, 2005). What is interesting is the observation of the effect the removal of safety infrastructure has on casualties, where implemented (Hamilton-Baillie & Jones, 2005).

Concerning cycling collisions generally in the UK, data recorded by the police indicate that the rate of fatality increases with speed limit of the road (Stone & Broughton, 2003) and that two out of three cyclists' accidents in the urban road network happen at intersections (Tan, 1996). In order to restrain driving speeds, speed cameras have been placed and 20 mph (≈32 Km/h) zones were created (Hill, 2010).

Picture 3.17: Pedestrian barrier in Holsworty, Devon, UK
Source: Hamilton – Baillie & Jones, 2005

Data show that car occupants are by far the majority of road users involved in traffic accidents, but when it comes to the death rate, pedestrians and cyclists are at the greatest risk (Hill, 2010). Between 2002 and 2010, the casualties in vulnerable road users were constantly increasing, reaching an peak in 2009, when 140 of the 184 victims who died in traffic accidents in **London** were vulnerable road users, while cyclists' casualties increased by 15% the same year and by 9% in 2010 (Transport for London, 2011). The type of vehicle that causes these casualties in the great majority of accidents is the car; in 2007, 67% of pedestrian casualties were injured by a car (Transport for London, 2009). These high numbers lead to the conclusion that the fact that accidents and casualties, especially of vulnerable users, are reducing where shared space is implemented is of great significance for the UK.

Picture 3.18: Conventional intersection in London
Source: http://cycling.access-legal.co.uk/legal/page/2/

3.5.3 Germany

The town of **Fuerstenberg/Havel**, north of Berlin with a population of approximately 6,500 inhabitants, despite doubts expressed by Berlin's Technical Traffic Institute, was considering implementing shared space since 2007 inspired by the successful case of Drachten (Bosley, 2007), but held on to its design of separation as shown in *picture 3.12*.

Picture 3.19: The town of Fuerstenberg/Havel
Source: http://www.panoramio.com/photo/6024253

Concerning cycling in Germany, even since the 1980's there have been negative conclusions about cycle tracks. In 1987 the Berlin police conducted a study about bicycle crashes on streets with and without sidepaths, which results show that bicycle crashes within 1981-1986 kept increasing on streets with sidepaths, while they were reduced on streets without them (Bracher, 1987). It has been a declared political goal in **Berlin** since 1978 to build sidepaths in order to make bicycling safer. However, these sidepaths turned a lot of bicyclists against them, because according to the same study, "*sidepaths lead to crashes and are difficult to ride on"* (Bracher, 1987). Between 1990 and 2007, the share of trips made by bicycle increased from 5% to 10% and between 1992 and 2006, the number of serious bicycle injuries declined by 38% (Pucher & Buehler, 2007). The German Cycling Federation at the 1990 Vélo Secur conference on cycling, compared the cycling on sidepaths to "Russian roulette" and claimed that the separation of different types of traffic by means of sidepaths behind curbs makes excessive demands on users and leads to crashes, therefore sidepaths should not be used and other solutions are being increasingly recommended for channeling bicycle traffic (German Cycling Federation ADFC, 1992). The cycle tracks however, were not removed and Berlin continues to have an extensive network of 620 Km of separate bike paths, as measured in 2004 (Pucher & Buehler, 2007).

Picture 3.20: Separated street design in Berlin
Source: http://www.streetsblog.org/

3.5.4 Netherlands

Groningen is an example of a city with high level of traffic safety under the design of separation. With almost 200,000 inhabitants, it has the highest bike share of travel of any Dutch city, reaching a 59% for the local trips, while cyclists and pedestrians have absolute priority in the city center (Pucher & Buehler, 2007). The number of bicyclist injuries fell from 202 in 1997 to 101 in 2005, although the total number of bike trips has greatly increased (Pucher & Buehler, 2007). To improve cycling safety, Groningen followed a strategy of the provision of extensive bike lanes and bike paths, priority traffic signals for cyclists, traffic calming of residential neighborhoods and car restrictions in the city center. Also there are many infrastructure facilities such as cyclist bridges and underpasses to further separate cyclists from motor vehicles (Pucher & Buehler, 2007). All these measures make car travel unattractive, less convenient and more time consuming than bike travel.

Picture 3.21: Intersection in Groningen
Source: http://www.fietsberaad.nl/

3.6 Critical overview

What can be understood from the above cases of shared space is that the change in the street design radically changes the behavior of road users. Everyone is more alerted and car speeds in every case went down, resulting in fewer accidents. Shared space also discourages car use, since such a street design is less attractive to car drivers especially in the presence of high volumes of pedestrians and cyclists. In some cases the vehicle volumes reduced, while in others they remained high, proving that it can be effective in busy roads as well. A matter of question is, when there is a significant reduction in vehicle volumes in shared space areas, is it because car drivers switched to another transport mode or because they avoid the area? In the second case, maybe traffic is only moved to areas nearby, causing more problems there, but this is not the subject under study in this research.

What seems reasonable and was pointed out by Juergen Gerlach, a professor at the Center of Traffic and Transport at the University of Wuppertal in Germany, is that shared space should be implemented at intersections or short distances, which is valid in every case study so far, because it can bring the opposite results if it covers more than a half-mile (≈800 meters) of road at a time, since the continuous slow pace can cause the frustration of drivers (Whitlock, 2007). Moreover, he claimed that the shared space concept works only at intersections that attract fewer than 15,000 vehicles a day and researches can also be found stating that when there are vehicle volumes higher than 100 vehicles per hour, pedestrians treat the space as a road they have to cross, not to share, so in this case less shared design elements may be necessary (Flow Transportation Specialists, 2011, Department for Transport, 2011). However, these numbers are not binding and practice has proved otherwise. In the Laweiplein intersection in Drachten for example, shared space works perfectly for approximately 22,000 vehicles per day, which means that the upper limit of the vehicle volume shared space can handle is vague.

An observation mostly from the visits to Drachten and Haren, but also by looking at pictures of the rest of the shared space cases is that a fully shared space is nowhere applied. Some principals of separation still exist more in some cases, less on other. The one thing they all have in common is the elimination of height differences; all the road users are on the same level. The use of different paving though or land markings suggest which space which road user should use and to whom priority should be given, being congruous with the definition given in chapter 2, that shared space is the street design that minimizes demarcations between vehicles and pedestrians.

Table 3.1 was formed containing all the case studies of shared space of the chapter and their results after implementation concerning the elements of the conceptual model gathered all together.

Table 3.1: The collection of the shared space cases outcomes in relation to the conceptual model

	behavior & performance	traffic speed	users' perception	spatial quality
Norrköpping	no accidents	decreased from 21 to 16 Km/h	cyclists and pedestrians indicated satisfaction and confidence	a spacious fountain, benches and other street furniture instead of zebra crossings and traffic lights
Ejby	less accidents	not found	high degree of local satisfaction	upgraded, intrusive highway elements removed
Chambéry	dramatic decrease of accidents	30 Km/h zone	not found	every sign was taken down
Brighton	reduction in motor vehicle trips and increase in cyclist and pedestrian usage	around 10 mph ≈16 Km/h	it has become the city's fourth most popular visitor attraction	the route of vehicles shown only by street furniture
Ashford	only 6 accidents after implementation	21 mph ≈33 Km/h	not found, but it's an award-winning scheme	unnecessary street furniture, road markings and traffic lights removed
Bohmte	no accidents	30 mph ≈48 Km/h	not found	all traffic controls, traffic lights and stop signs removed
Drachten	increase in traffic volumes and accident reduction from 8 to 1 per year	not found	general satisfaction with the scheme	all traffic lights, signs and bicycle lanes were removed and a squareabout was placed
Haren	accident reduction from 13 to 5 per year	reduction to 38 Km/h	high degree of local satisfaction	road markings, traffic signals, bike lanes and high curbs removed and replaced by trees and fences

It is evident from the table that there were positive outcomes in every single case of shared space from all aspects. Another fact is that shared space schemes seem to increase pedestrian activities and lead to an economic revitalization where implemented and there is no evidence that they result in more casualties than traditional layouts. On the contrary, the data available show that there is a positive

effect in reducing the number of casualties and the level of risk to pedestrians and cyclists. In addition, the smoother traffic flow and the elimination of delays have a positive effect in the energy consumption, air pollution, hence environmental protection (Firth, 2010).

In a lot of shared space cases there is the important issue of blind and partially sighted people, who may feel excluded from their own towns in such a street design. A UK study claims that there is insufficient evidence to support arguments for the advantages of shared space and that lack of early consultation with blind and partially sighted and other disabled people affects their confidence to use these streets and public spaces (Thomas Pocklington Trust, 2011). Efforts are being done though to train guide dogs or place tactile paving in shared space areas to guide blind and vision impaired pedestrians, the shared space scheme in Mainz in Germany is such an example, but blind people associations and their campaigns keep fighting against it (Gillies, 2009).

At last, it is apparent from the cases of separation and their general development plans that there are a lot of measures to improve traffic safety. All it takes is careful planning and as it was proven, redesigning parts of a city, creating car-free zones, promoting cycling and investing in infrastructure made the numbers of traffic accidents greatly reduce in comparison to the ones in the 1980s or the 1990s. Separation of different types of traffic has also advantages and can successfully enhance traffic safety.

A final issue very well pointed out by Hill (2010) but not referred to in the analysis of the case studies because of the lack of data availability, is the one of drivers' behavior related to the vehicles (see conceptual model in *figure 2.6*). In the UK it was proven that the safer the vehicles are designed, with more air bags for example, the more reckless people's driving performance becomes (Hill, 2010). Consequently, with this fact in combination with a street design in which users are separated and don't pay attention to each other, traffic safety can be compromised.

So to link all the elements collected from the case studies to Ajzen's theory of planned behavior discussed in *chapter 2.4*, road users seem to lean more in favor of shared space and the behavior that comes with it. Concerning the subjective norm, there is high social pressure, because as soon as shared space is implemented all road users are expected to behave accordingly in it. Finally, the perceived difficulty to perform the behavior is low, since road users and especially drivers adjusted quickly by reducing their speed.

3.6.1 Advantages and disadvantages

Taking into consideration all of the above and the analysis of the case studies, the following tables of advantages and disadvantages of the two different street designs

are formed (*table 3.2* and *table 3.3*). The elements of both tables are based either on the case studies concerning specific locations or on general researches on road users' behavior, therefore they cannot be proved valid for each case. The two tables serve the purpose of presenting everything that could be considered an advantage or disadvantage from the findings examined thus far. What can be definitely observed for shared space in all of the cases where it was implemented is that it had overall positive results over traffic safety and none of them switched back to their previous design of separation.

Table 3.2: Advantages and disadvantages of shared space

Shared space	
Advantages	**Disadvantages**
increase of objective safety (less accidents and victims)	decrease of subjective safety, vulnerable users may not feel safe → improvement by creating danger
vehicle speed reduction	hard to be accepted by older road users
Less traffic, less stops, shorter travelling time → better mobility	difficult for blind and partially sighted people, guide dogs can't be trained this way
discourage car use → enhances sustainability	pedestrians and cyclists are still the vulnerable users
increases every road user's awareness	more manoeuvres that can be dangerous for cyclists
avoids the cost of installing and maintaining a wide range of expensive safety features	
increase pedestrian activity and enhance the economic livability/regeneration of a place	
Aesthetic improvement	

Table 3.3: Advantages and disadvantages of separation of different types of traffic

Separation	
Advantages	**Disadvantages**
increased feeling of safety for all users	road seen as a competitive space with a survival of the fittest mindset
existence of rules to control users' behavior	drivers are used to obey only to traffic lights and signs
with a good design of walk paths and cycling routes, still car use can be limited	at intersections no real separation exists, which is where most accidents occur

Chapter 4: The Municipality of Kalamaria

This chapter begins with a brief description of Thessaloniki and then an analysis of the mobility in the Municipality of Kalamaria follows; the evolution in traffic safety numbers, the Local Town Plans it had through the last two decades, the measures taken and their results. In the end a shared space implementation is examined for the Municipality and the suggestion of such a scheme is formed.

4.1 The city of Thessaloniki in Greece

As briefly described in the first chapter, mobility in Thessaloniki is diverging from sustainable values and it is a car-based city, degrading vulnerable users' safety. Eight out of ten accidents in Thessaloniki (81%) occur within its urban area in residential areas and the majority of victims are pedestrians, cyclists and motorcycle drivers (Ignatiadis, 2011). According to the Hellenic Statistical Authority, between 2001 and 2006 the number of road accidents involving pedestrians in residential areas in Thessaloniki has more than doubled, while just in the four first months of 2008, 154 citizens were swept away by cars; eight of them were killed, five seriously injured and the rest 141 survived with minor injuries (Hellenic Statistical Authority, 2012). As illustrated in *figure 4.1* in the general course of traffic accidents and casualties in Thessaloniki, the highest peak was reached in 2005, when there were 1315 victims in 1014 accidents, both fatal and with injuries, while 21% of the fatalities were pedestrians (Hellenic Statistical Authority, 2012). After this, both accidents and victims started steadily decreasing, reaching the numbers of 800 and 957 in accidents and victims respectively, from which 17 people lost their lives and 926 were injured (Hellenic Statistical Authority, 2012). Most accidents have occurred in the city center, in crowded places, but in other large municipalities too, such as Kalamaria.

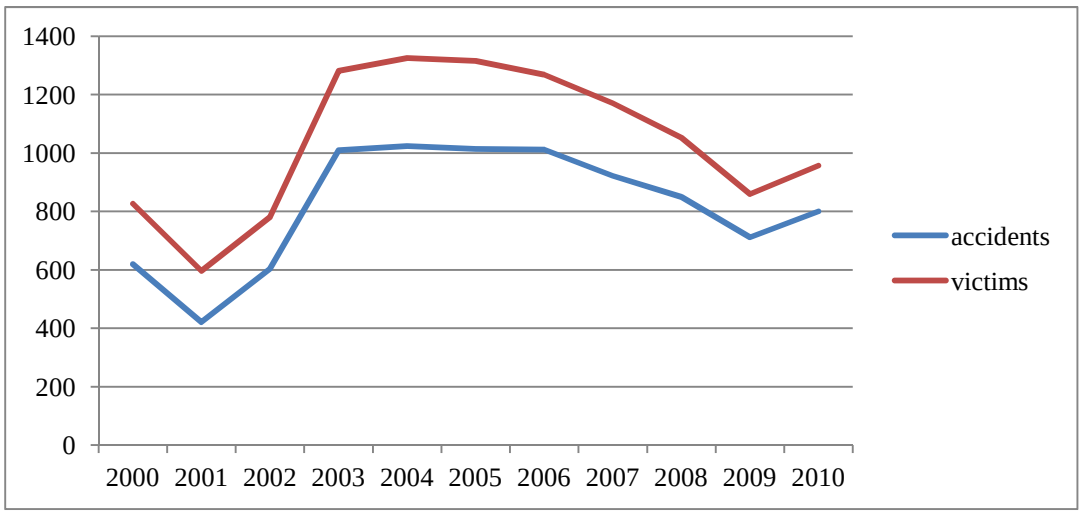


Figure 4.1: Number of traffic accidents and victims in Thessaloniki between 2000-2010
Source: Hellenic Statistical Authority, 2012

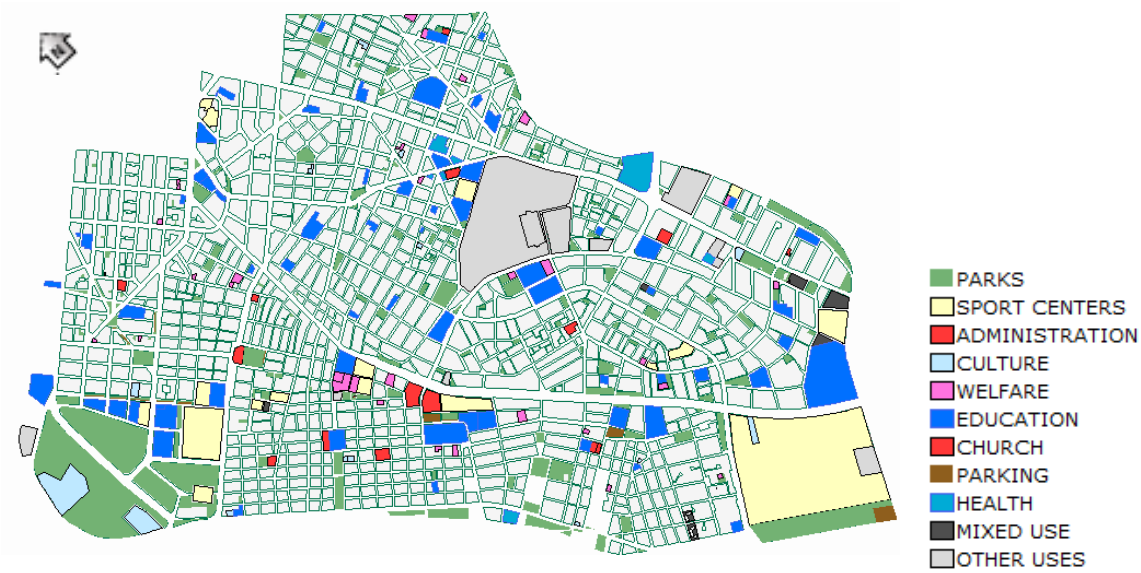
4.2 Description of the Municipality of Kalamaria

Kalamaria is the second largest Municipality of the Greater Thessaloniki Area (GTA) and it can be characterized as a rather extensive area with mild topography, an adequate road network, lack of parking space, high traffic demand and concentration of activities (Papaioannou et al., 2000). *Picture 4.1* is used as a reminder of the GTA and Kalamaria's location on the map of Greece.

Picture 4.1: The GTA and Kalamaria on the map of Greece
Source: AUTH, Municipality of Kalamaria, 2003

Kalamaria has developed important commercial activity over the years and in 2003 there were counted 1643 shops and retail workplaces, along with 1182 office workplaces in the Municipality (AUTH, Municipality of Kalamaria, 2003). *Picture 4.2* shows the number of shops per block, which are extensively distributed in the whole area, while the red lines indicate the streets with high commercial activity. Furthermore, there are numerous other lands uses evenly covering the area, as illustrated in *picture 4.3*. It is apparent from the land use maps that all the different kinds of activities are fairly spread through the Municipality's area, which gives more potential for traffic reduction and the improvement of mobility through suitable planning.

Picture 4.2: Number of shops pre block and street with high commercial activity
Source: AUTH, Municipality of Kalamaria, 2003



Picture 4.3: Special land uses in Kalamaria
Source: http://gis.kalamaria.gr/mkgis_en/

The Master Plan of the Greater Thessaloniki Area (GTA) describes the urban planning policy for Thessaloniki. The Master Plan consists of goals, directives and measures for the regional and urban planning of the area, in the context of five-year development programmes. At a local level, each Municipality has a Local Town Plan which deals with local urban planning matters, like definition of land use (residential

areas, education, green areas, health services etc.), the traffic system, road classification and traffic services. The rule is that Local Town Plans should not come to opposition to the Master Plan of the GTA (AUTH, Municipality of Kalamaria, 2003).

In the past two decades Kalamaria has started showing vital progress in engaging measures that improve traffic safety in its plans and address to its increasing traffic problems. The first attempt was in 1989 with the elaboration of the "Traffic Management Study for the Municipality of Kalamaria" and afterwards with the first update of it in 1999 and the second in 2009 (Papaioannou et al., 2000, Municipality of Kalamaria, 2011). In order to reduce speed and traffic flow in specific areas, measures such as pedestrianizations of streets, with no or limited access to other road users and the narrowing of some others took place after 1991, resulting in the numbers of accidents shown in *table 4.1*.

Table 4.1: Number of accidents in Kalamaria before and after the measures' implementation
Source: Papaioannou et al. (2000)

Period	Total number of accidents	Fatalities	Injuries	Accidents involving pedestrians
1986-89	211	9	291	66
1994-96	206	6	NA	29

Even though the number of injuries is not found, a general improvement can be seen in this table, especially concerning accidents involving pedestrians. In 1999, the update of the traffic management study for Kalamaria was deemed necessary by the Municipal Authority of Kalamaria, due to its high population growth and the proportional rapid increase in vehicles. This update was also necessary to assess the effectiveness of the measures taken over the past decade and to review the new data obtained in the meantime (TRIAS S.A., 2011). The project was implemented in four phases between 2000 and 2001 (TRIAS S.A., 2011):

1) the collection and update of the required data
2) the processing of the collected data and the analysis of the current situation through the construction of traffic simulation model with SATURN software
3) the formation of suggestions of alternative traffic management plans
4) the detailed presentation of the proposed interventions in a hierarchy of importance divided in categories of measures

The project has indicated streets where the safety index was stable or lower, and others where the safety index has increased from 1989 to 1999, and additional measures should be applied. Overall, it was concluded that the measures taken during the earlier study of 1989 did not have negative implications on road safety (AUTH,

Municipality of Kalamaria, 2003). The second update of the study had two stages (Alexandri, 2008):

1) the collection, update and analysis of the required data and the formation of alternative traffic management, parking and traffic safety measures
2) the finalization of the proposed measures and their suggested implementation period

The first stage was approved and completed in 2009 while the proposal for the second stage was made in 2011 (Municipality of Kalamaria, 2011). The most important problem identified is the lack of infrastructure for pedestrians and cyclists. The incomplete network of walking paths and the unsatisfactory width of sidewalks discourage pedestrian movement and compromise their safety, especially for disabled people. The next issue is the problem of lack of parking spaces, which is estimated at around 7000 (Municipality of Kalamaria, 2011).

The measures proposed are the creation of a complete pedestrian network, along with the integration of public spaces and the significant increase of green spaces. These will be achieved through the pedstrianization of streets, the increase of the sidewalks' width and the construction of cycle paths to enforce pedestrians, cyclists and disabled people's safety and ease of movement. As a solution to the parking problem, off-street parking facilities, the construction of an underground parking station, in combination with public transport improvement and discouragement of cars to enter the center are proposed (Municipality of Kalamaria, 2011).

Studies are already taking place and some reconstructions of streets have begun to create bigger sidewalks by reducing the number of traffic lanes, while the construction of two underground parking stations is planned offering a capacity of 500 spaces. These measures are really promising a sustainable future for the Municipality and it will be interesting to observe the effect they are going to have on the people, their behavior and the numbers of traffic accidents in the upcoming years.

Concerning the number of traffic accidents and victims in the last decade and following the general trend of the GTA as described in *figure 4.1*, the numbers evolved accordingly for Kalamaria between 2000 and 2010, as shown in *figure 4.2*. Starting in 2001, they fast increased, reaching a peak of 141 accidents and 191 victims in 2005 and then they gradually reduced. At least a positive fact is that the number of fatalities remained really low, below five per year, as shown in *table 4.2* (Hellenic Statistical Authority, 2012).

Table 4.2: Fatalities in Kalamaria
Source: Hellenic Statistical Authority 2012

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
5	3	2	1	4	2	4	2	3	0	1

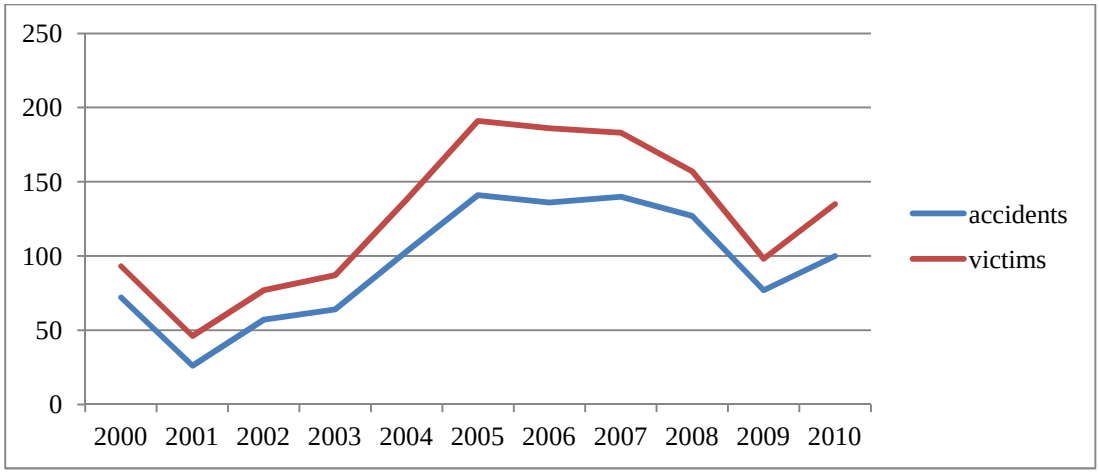
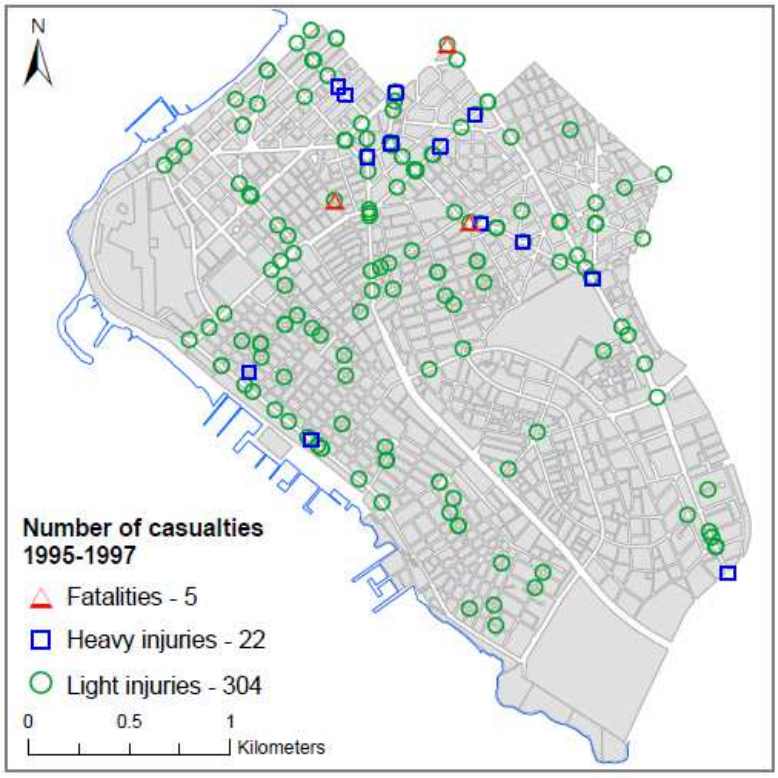


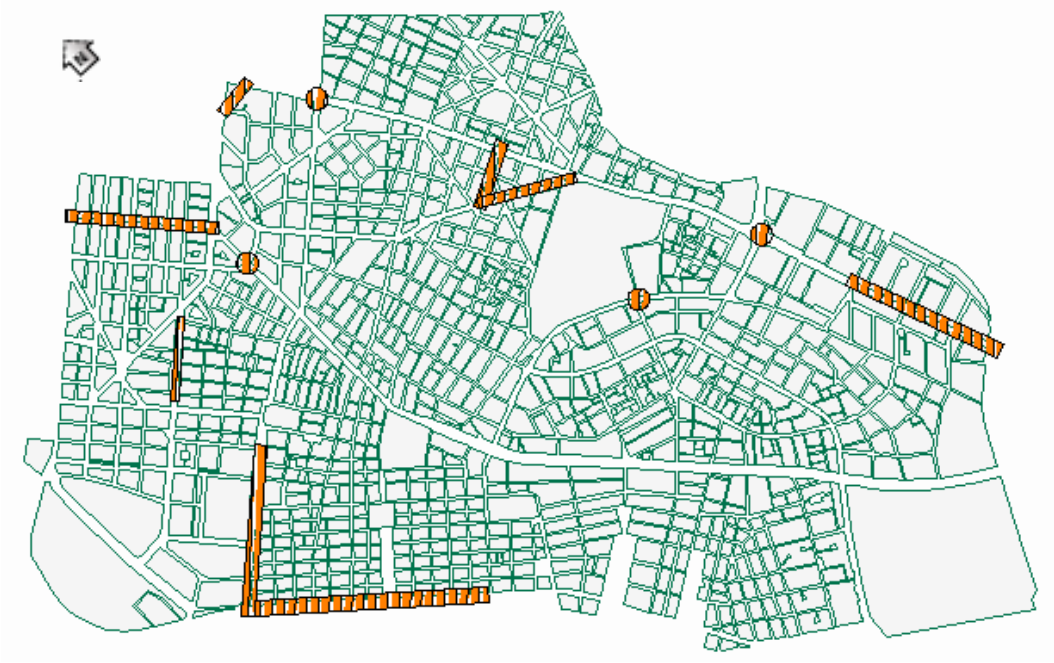
Figure 4.2: Number of traffic accidents and victims in Kalamaria between 2000-2010
Source: Hellenic Statistical Authority, 2012

An interesting map is the one below in *picture 4.4* indicating the exact locations where accidents took place between 1995 and 1997.



Picture 4.4: Number of casualties in Kalamaria between 1995-1997
Source: AUTH, Municipality of Kalamaria, 2003

Unfortunately, a similar map with more up-to-date data couldn't be found, but the official website of Kalamaria provides a GIS map of the area showing the current dangerous spots where most of the traffic accidents occur. The map is presented in *picture 4.5*.



Picture 4.5: The dangerous spots in Kalamaria
Source: http://gis.kalamaria.gr/

4.3 Observations

By comparing the two maps (*pictures 4.4* and *4.5*) it is evident that the spots indicated as problematic concerning traffic safety in *picture 4.5* are the same spots where most of the accidents occurred during those three years in the 1990s, especially involving fatalities and heavy injuries, in *picture 4.4*. Also, some areas with multiple accidents are not considered dangerous anymore, which justifies the decline in the number of accidents and victims of *figure 4.2* and it shows that there have been positive results after the implementation of the measures suggested in the first update of the Traffic Management Study for the Municipality of Kalamaria.

Another thing that can be observed is that Kalamaria, as the rest of Thessaloniki and Greece in general, follows the patterns of separation of different types of traffic in its design and has successfully managed to address, to a certain extent, the traffic safety problems it was facing. Shared space is a concept unknown in Greece and as it was previously explained in *chapters 1.1* and *4.1*, cars dominate the streets. The traffic calming measures introduced in Kalamaria were a first step to increase the awareness of one another among road users and affect their behavior. Like every intervention to people's commuting habits, some will like them and be benefitted, while others will protest against them and given also the fact that experimentation is needed for innovations and transformations to take place, shared space projects can be introduced in the Municipality of Kalamaria. Therefore, inspired by the cases in the Netherlands, shared space can be implemented in Greece in Kalamaria, as it did in other countries as well. Of course the process and the designs that will be created will not be identical to the Dutch ones, but they will be matched to each and every individual situation.

Inspired by Banister (2002), factors that can be considered as implementation barriers are first of all, the social behavior or road users in Greece, recognizing car drivers as superior to the rest of the users and giving them priority. This kind of barrier can affect the public acceptability of shared space implementation. The modal split in Greece can hint the encouragement of such a behavior, in total contrast to the modal split in the Netherlands.

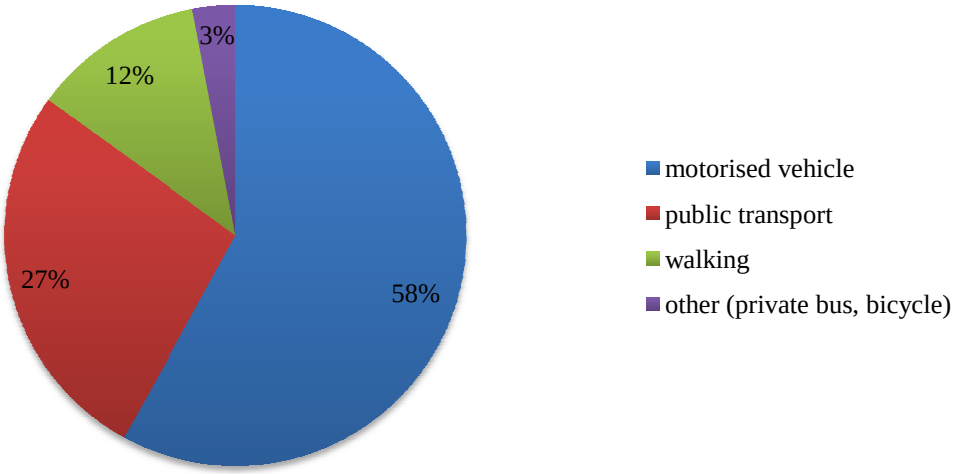


Figure 4.3: Modal split in Thessaloniki 2011
Source: http://www.civitas-initiative.org/index.php?id=117&city_id=222

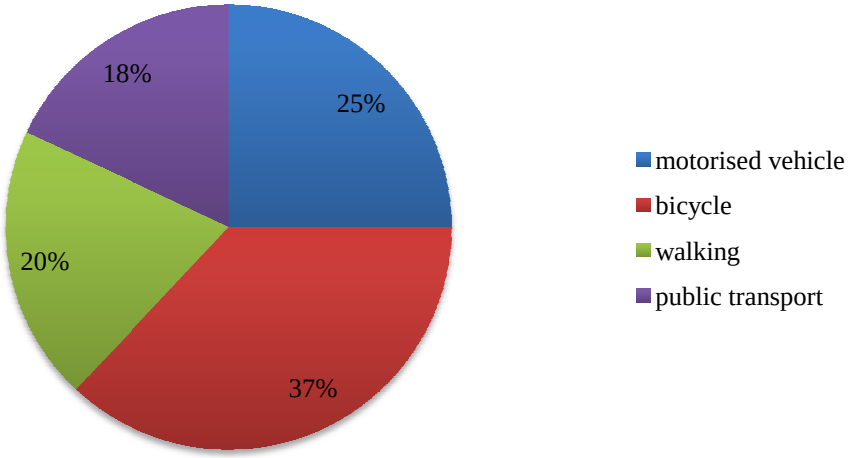


Figure 4.4: Modal split in Amsterdam 2012
Source: http://www.aviewfromthecyclepath.com/

Figure 4.3 presents the modal split in Thessaloniki with motorized vehicles prevailing with 58% (from which 45% are cars, 7% motorcycles and 6% taxis). Amsterdam's modal split was chosen in *figure 4.4*, as the country's largest city and being closer to the population of Thessaloniki, but of course the two cities are different and their

numbers are cannot be directly compared. These figures have the purpose to illustrate a general image of the modal share differences in two big cities between the two countries, from which the biggest one that can be observed is the almost absence of the bicycle as a mode of transportation in the city of Thessaloniki and then, the low share motorized vehicles hold in Amsterdam. This leads to another obstacle that makes a direct shared space transfer from the Netherlands to Greece impossible, which is the different commuting habits people in the two countries have. When the car share is so high in Thessaloniki, shared space must be combined with other measures that will shift the whole modal share and encourage the use of other means of transport, especially the one of bicycles. In the Netherlands there isn't such an issue to be dealt with in the first place, because in the urban environment, car use is generally limited and bicycles are a very popular mode of transport.

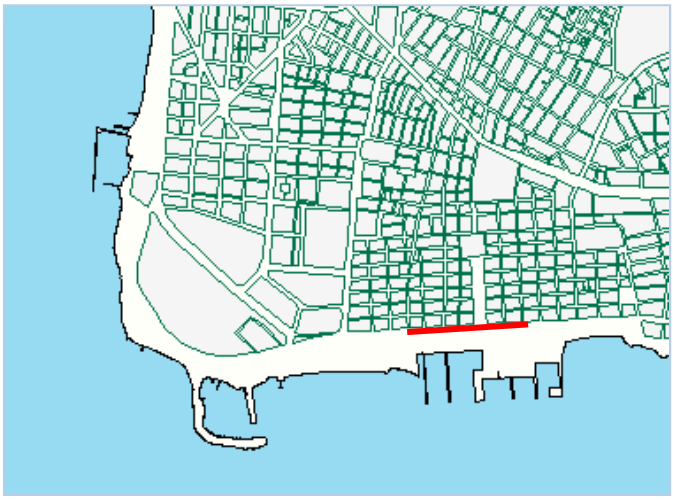
Furthermore, there are spatial differences to be considered between the two countries. On one hand, the Netherlands is a flat country so cycling is convenient in every city, while the big altitude changes in some parts of Thessaloniki constitute an important factor to turn commuters to other travel modes than the bicycle or walking. On the other hand, the warmer climate of Greece can be more encouraging to persuade commuters to walk or give the bicycle a try.

Other important barriers to be considered are institutional. These barriers relate to coordination problems between government and/or private organization bodies (Banister, 2002). For its transport provision, Kalamaria is in constant cooperation with other Authorities responsible for the transport system in Thessaloniki (AUTH, Municipality of Kalamaria, 2003), which may bring difficulties in achieving successful coordination between them.

In addition, there is also the matter of resources. Kalamaria spends a 10% of the total municipal budget to road construction and maintenance. The total amount spent yearly is approximately € 4,0m. About 40% of this amount comes from national funds, 30% from European funds and 15% from Municipal funds (AUTH, Municipality of Kalamaria, 2003). Given the country's current financial difficulties, the implementation could be delayed or even cancelled if the required financial resources are not available in time. Having all the above said, it is obvious that the problems the two countries face are different, hence the solutions provided will be different.

4.4 Suggestion of shared space in Kalamaria

As a pilot project, the suggested location for shared space in Kalamaria is part of the Nikolaou Plastira street (between the Ioanni Pasalidi and Agiou Nikolaou streets) as illustrated with a red line in *picture 4.6*.



Picture 4.6: Suggestion for a shared space project in Kalamaria

This location is selected for various reasons. First of all, it is one of the problematic areas of the Municipality where traffic accidents occur and measures need to be taken in order for traffic safety to improve. Secondly, it is on the coastal zone and since shared space projects improved the spatial quality where implemented, an upgrade of the specific road's spatial quality is highly desirable. In addition, during spring and summer this specific street attracts a high volume of people because on its upper (north) side there are exclusively cafes and restaurants in line, one next to the other and on the lower (south) side there is the entrance to the marina.

The selected part of the Nikolaou Plastira street has a length of 450 meters and its current design is presented in *picture 4.7*, designed by the author. It is a two-way street with one traffic lane for each direction, zebra crossings and traffic lights at two of its intersections, while on-street parking is permitted along its whole length on both sides. *Pictures 4.8* and *4.9* provide a visual representation of the situation on the two sides of the street.

Picture 4.7: Current situation with traffic light control in two intersections

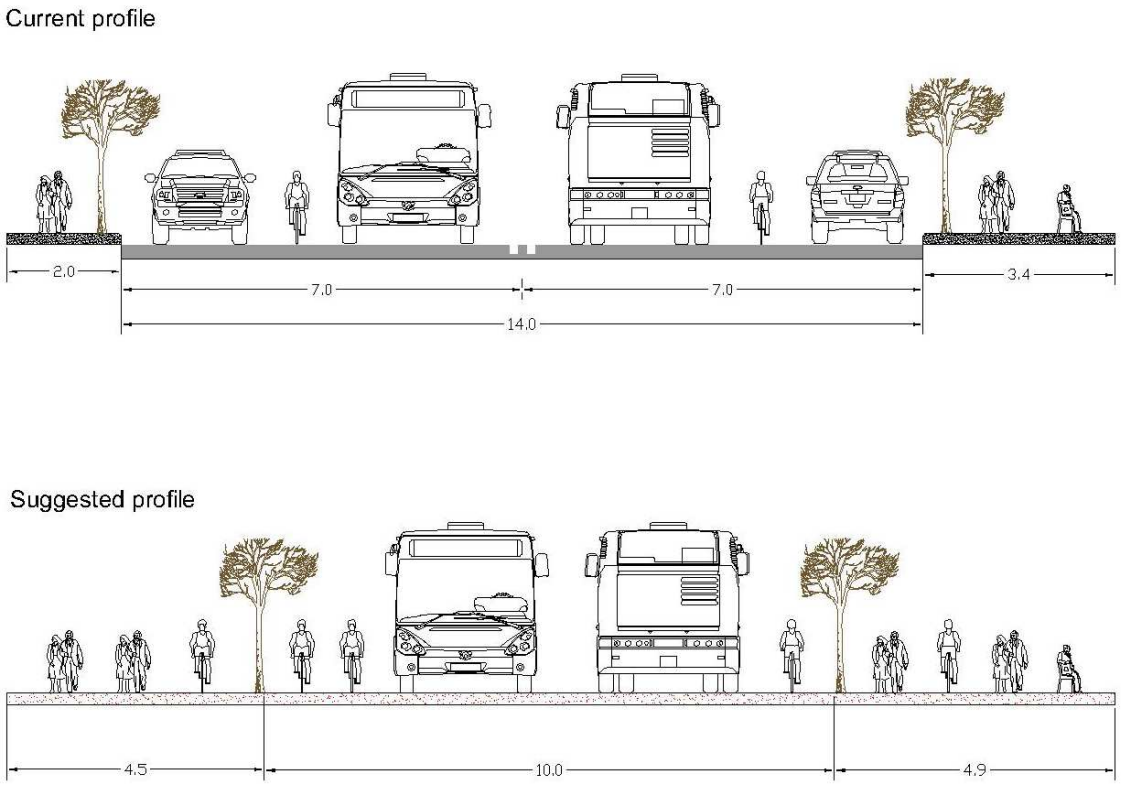
Picture 4.8: The upper side of N. Plastira street **Picture 4.9:** The lower side of N. Plastira street
Source: http://www.trivago.com/item.php?path=31408&item=1072210&pagetype=images&source=uk

According to a study conducted by the author in the Municipality in 2010, in the selected part of Nikolaou Plastira street there was a smooth flow of vehicles with no particular delays observed and a maximum volume of 700 vehicles per hour, as calculated during rush hour. This number of vehicles is acceptable for a shared space scheme, being by far lower than the Laweiplein intersection's traffic volumes and a little higher than the volumes in Rijksstraatweg, which is more similar, as a design, to the one proposed.

The road profiles of the current and the suggested situation are presented in *picture 4.10*, also designed by the author using AutoCAD 2010 software. The cars show the parking space occupied, the buses are used as the largest vehicle that goes through the street and cyclists are used to indicate their position on the pavement, even though their presence is not very common. It may seem as if there is a lot of space for each traffic lane of approximately 4.5 meters, since parked vehicles occupy approximately 2.5 meters width, when the sufficient width required for each lane is 3.5 meters (Hellenic Ministry for the Environment, Physical Planning and Public Works, 2001). But in reality, this one extra meter encourages illegal double parking, making it an everyday phenomenon, especially on the upper side of the street, which forces moving vehicles to maneuver over the double line in order to pass. To solve this major traffic safety problem, combined with the construction of off-street parking facilities scheduled to take place, the suggestion is to transform this part of the street into a 'no parking' zone.

Parking is usually an important issue and there are no rules about it in shared space areas. Usually it is permitted for loading and unloading trucks and for taxis, e.g. Haren (Fietsberaad, 2008), while in some cases the areas are strictly enforced and violators receive a penalty charge notice, e.g. Ashford (Ashford.gov.uk, 2010). It is beyond doubt though the aesthetic improvement a no parking zone brings, the way pedestrians who want to cross become more visible and cyclists are not wedged between driving and parked cars. Therefore, the strategic placement of trees as shown in the suggested profile provides significantly more space to pedestrians, while 10

meters are left for the vehicles; cyclists' movement can be possible in either side. This way, there is also enough physical space left for parking for loading and unloading zones, which already exist on the right side in the current profile. Since the shared space scheme along with other measures in the Municipality enhancing sustainable mobility are expected to increase pedestrian and cyclist activity, more of them are added in the suggested profile. Also the removal of the traffic lights, signs and zebra crossings and instead the placement of signs at every entrance to the street is suggested, warning road users that they are entering a shared space area and drivers that it is a 30 Km/h, no parking zone.



Picture 4.10: Current and suggested profile of the selected part of N. Plastira street in Kalamaria

It is evident that, as in most shared space cases, the suggested scheme is not fully regulation-free; there is the 30 Km/h speed limit and the 'no parking' rule, while the placement of trees implies the separation of pedestrians from the rest of the road surface. The suggested alternations are expected to lead the area closer to sustainability and improve its spatial quality with the significant reduction of cars' presence since parking will be prohibited, while the speed of vehicles will inevitably go down. The results on traffic safety though are more important and judging by the rest of shared space cases in Europe, the expectations are positive. Observation of the case after implementation is necessary and perhaps the presence of enforcement, especially in the beginning, will assist in the scheme's smooth operation concerning mostly the respect of the speed limit, and the road users' transition to it. Shared space

has no difference from the rest of the road network, so police enforcement doesn't contradict its principles.

Another important matter is the public acceptability of such a scheme, which can be enhanced with early public notification and engagement in the process for those who are going to be influenced by it (Vanclay, 2005). This way the social impact will be limited, since the more information and participation is given to the people, the more collaborative they are. So, through early community engagement in the Municipality's committee meetings, combined also with smart advertisement of shared space will affect their intention and attitude and will create a favorable position of the public towards the whole process, as discussed earlier in *chapter 2.4* in the theory of planned behavior.

Finally, shared space implementation will happen in the context of experimentation; when an experiment has been successful, it can be repeated in different contexts (Loorbach, 2010) and since it was of major success in the Netherlands where it first started, it is adequate to try it in Greece too. Logically, advantages and disadvantages will arise, that fall into the contents of *table 3.1*, but in the end, such a project would reveal if shared space can actually work and have positive results overall in traffic safety and if the Greek community can adapt to it.

Chapter 5: General conclusions, reflection and recommendations

Traffic safety is an on-going issue occupying many countries and the mobility plans they follow are aiming at sustainability for every city, which in *chapter 2.1* was proven to be directly linked to traffic safety. An important element of traffic safety which needs to be influenced in order for sustainability to be reached, is the behavior of people and their travel mode choice. All the efforts of cities recently were put into reducing car use and promoting other means of transport (public transport, cycling, walking) by creating safe conditions for their use and improving their infrastructure. This way, the intentions of people are influenced and their behavior becomes positive towards any changes applied. Shared space projects were also implemented in this context, in areas of increased traffic accidents. An undeniable fact acquired by the data collected is that the results were positive everywhere, reducing the numbers of traffic accidents and victims. Especially the questionnaire research in the two Dutch locations showed a positive attitude of pedestrians towards sharing space, which makes the schemes operate successfully. But as many researchers agree upon, it is relatively early to draw conclusions on shared space schemes and further observation is needed.

In the end, the objective of the research, to analyze if road safety can be improved with the integration or separation of different types of traffic in general and in the urban area of Kalamaria in particular and under which conditions this improvement will be reached, has been met and it has been proven that traffic safety can be improved in both street designs with measures taken adjusted to each individual situation. This proved to be applicable for all the cases examined in countries in Europe, including the case of the Municipality of Kalamaria in particular, where, no matter the street design, the measures applied thus far, successfully increased traffic safety.

Throughout the research, also all the questions posed in the first chapter were answered and the answers are briefly explained below:

- *What are the advantages and disadvantages of integration and separation of different types of traffic in terms of traffic safety?*

Generally, both designs have advantages and disadvantages in several domains. When it comes to traffic safety, it should be highlighted that the results were positive in every case of shared space examined, where the numbers of traffic accidents significantly reduced. A detailed answer to this question can be provided by *tables 3.1* and *3.2*, which include all the advantages and disadvantages of both street designs as they were identified in the research process.

– *To what extend shared space can contribute to traffic safety and spatial quality?*

The analysis of cases of shared space in different European cities has shown the level of its contribution to traffic safety and spatial quality improvement. All the shared space projects are relatively new, implemented less than a decade ago, but the overall results are positive. In every single case, traffic accidents immediately decreased or even completely ceased. There is the matter of the subjective safety though, which researches have proven that decreased, meaning that road users don't feel safe when sharing space, so they are more alerted and this sense of danger leads to less traffic accidents. But through time, road users and especially the vulnerable ones are getting acquainted with the street design and feel comfortable. As the questionnaire research has revealed in Drachten and Haren, today, nine years after shared space implementation in both locations, almost 100% of the pedestrians feel safe walking there. Concerning spatial quality, it was greatly upgraded in every location, since all traffic lights and signs were taken down and more trees and flowers were placed, along with fountains, benches and other street furniture.

– *What are the experiences in other countries?*

The cases of shared space examined were eight in six countries and the ones of separation of types of traffic were five in four countries. Generally, in both types of cases measures were taken to improve traffic safety and their goal was the reduction of traffic accidents. For the shared space projects, the initial motive for implementation was the constant occurrence of traffic accidents at a specific location, while for the cases having the design of separation, the general measures taken for whole cities to improve the situation are examined. The experience shows that traffic safety has been successfully improved in each case regardless of the street design and the number of traffic accidents in the urban environment keeps getting reduced through the years, reaching sustainable mobility more and more.

– *Can there be a shared space policy transfer from the Netherlands to Greece and what are the implementation barriers?*

The conclusion from the exploration of shared space cases in the Netherlands is that a shared space policy transfer is applicable to Greece. As other countries were inspired by Dutch projects for their shared space schemes, Greece and the Municipality of Kalamaria in the specific case can be as well. The implementation barriers spotted after the analysis of the mobility situation in both the Netherlands and Greece are cultural, spatial, institutional and resource barriers. There are differences in the behavior of road users, recognizing car drivers as dominant in the road network in Greece, different commuting habits, with the car having a really high share in Greece in the city of Thessaloniki, where the Municipality of Kalamaria belongs and spatial differences concerning big altitude changes, also in Thessaloniki. In addition, the

coordination between the government and private bodies involved in such a scheme's provision may be challenging, along with the financial difficulties Greece faces, in contrast to the Dutch economy. Shared space projects have always been innovative and radical and first implemented in an experimental manner; this way a shared space scheme could be introduced to the Municipality of Kalamaria and observation of the case will reveal if it has been successful in terms of traffic safety.

As a final point, the fast changing pace of modern society that is heading towards sustainability requires innovations to take place and enhance traffic safety, which should be provided to everyone with equal terms. Shared space is such an innovation initiated by the Dutch and sets an example for the rest of the world. As Hans Monderman said "without any doubt, it is all about human space and people all over the world are the same but the cultures are the ones that are different. So copying the solutions the Dutch make can never be feasible, but what is, is copying the ideas and from those ideas new designs can be made, fitting in each culture and they will absolutely be different; they should be different."

5.1 Reflection

As in every research, things didn't evolve exactly as planned and several problems arose in the process, with the different than the desired methodology used, being the biggest one. Satisfactory data for the case studies were expected to be obtained to cover all elements of the conceptual model. But first, data for the cases of separation of types of traffic were nowhere to be found for specific problematic locations, so in the end a general reflection was made on the development of traffic safety on a city level for every selected country. This way a comparison between these cases and the ones of shared space was completely impossible. Second, even the cases of shared space can only be looked at separately; no comparison between them would be realistic since they are unique, focused on different features (i.e. spatial, safety, etc.). This affected the formation of the tables of advantages and disadvantages of the two designs as well, since they are not applicable to every case. Besides that, there are also some aspects questioned; for example the way the number of traffic accidents and victims are counted and registered in a city's or country's system, which could not be inspected.

It also comes to the author's awareness that many of the sources used are not written by academic personnel, since shared space concerned many architects and traffic engineers and policy documents were more easily obtained. Combined with actual academic theoretical background though, they provide adequate insight to the theoretical chapter.

Furthermore, the case of the Municipality of Kalamaria serves the purpose of examining the situation in a country that the concept of shared space is unknown and

discovering the possibilities of a shared space implementation in it. The suggested scheme that is developed focuses more on street design and the potential ways it can be altered in order to affect road users' behavior, decrease the speed of vehicles, reduce the number of traffic accidents and improve the spatial quality of the area. In other words, it is based on the conceptual model and the theory that lies behind it, mostly on the theory of planned behavior to influence the intentions of the road users that will be affected. No in depth institutional or financial features are examined.

5.2 Recommendations

In conclusion, the present thesis is not a complete research with solid conclusions on shared space and its effects on traffic safety. Further research is recommended for the formation of more concrete results. Possibly, focus could be set on single countries because cases in the same country are easier to compare with each other since they have similar characteristics. A more extended questionnaire research could also reveal more information and combine more elements concerning the interviewees and the motivation behind their answers. Furthermore, contact with people involved in the transformation of shared space cases could provide more insight to the process of implementation. Nevertheless, the research encloses a holistic view of traffic safety and shared space in the urban environment and it is hoped that it has matched the readers' expectations.

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