# TAKING A LOOK INTO THE ORACLE: FORECASTING FUTURE URBAN MOBILITY

*A Delphi Forecasting Study on Technology-Related Social Exclusion and Inclusion in Future Urban Mobility in the next twenty Years*
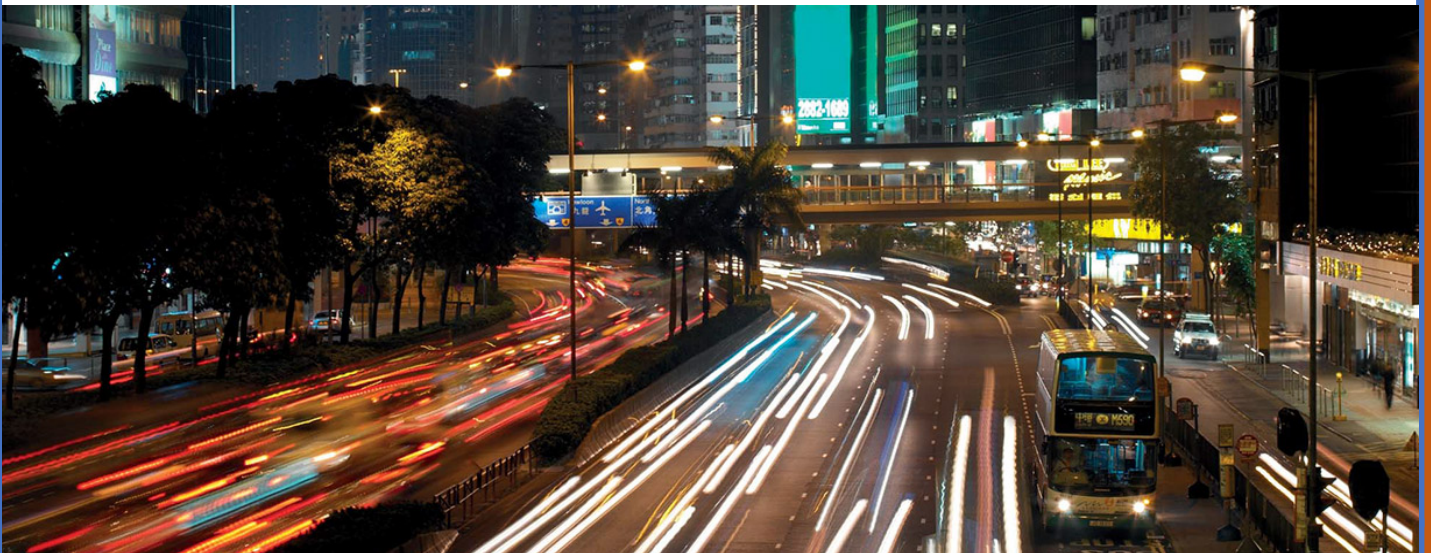
**Nathalie Dezoteux, 381821**

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*Global Business and Sustainability*

Institution: Rotterdam School of Management, Erasmus University Rotterdam

Supervisor: Prof. Dr. L. C. P. M. Meijs

Co-reader: Prof. Dr. A. J. J. A. Maas

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# Preface

I would like to use the opportunity and thank all the people that have helped me along this fun but also challenging thesis trajectory. First, I would like to thank my coach Prof. Dr. Lucas Meijs for his knowledge and support at times needed. They helped me greatly in finding the right direction for this research project. I would also like to acknowledge the support of Prof. Dr. Alexander Maas, the co-reader of my thesis. Thank you very much for your insightful feedbacks whenever I needed them. I very much enjoyed having you as my supervisors over the last few months!

Furthermore, I would like to thank all experts that participated in my study. Your commitment and contributions to this research project were invaluable and I hope that you found this experience as fun and rewarding as I do. I also hope that you can find value in the findings of this study and make use of them for future research in the field.

Finally, I would like to express gratitude towards my family and friends for their support, encouragement and inspirations. Especially you, Florence Dezoteux, Karin Dezoteux and Matthew Blome. You helped me all along this project, each one of you in your way. Thank you!


Nathalie Dezoteux

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# Executive Summary

The importance of mobility in future cities can hardly be underestimated. Demographic factors such as world population and poverty will significantly shape the future urban mobility landscape. A common perception is that mobility is accessible to everyone. However, this is not the case and many groups of society get pushed into social exclusion since they are prevented from using mobility due to reasons such as financial restrictions or a physical disability. At the same time, technology will also play an integral part and change the way people will travel and use mobility.

While research has suggested that urban mobility can lead to social exclusion as well as inclusion, it is of importance to explore how either can be avoided or fostered. Simultaneously, technology-driven innovation has taken an integral role in our world, reshaping the urban mobility landscape. Hence, the question arises how technology stands in relation to social exclusion and inclusion in future urban mobility. To explore this relationship, this thesis aims at exploring future predictions and developments within the urban mobility landscape.

A qualitative Delphi research study is conducted to receive judgements of experts to make forecasts of the future urban landscape. The participating experts are identified based on pre-defined criteria and come from a variety of countries. The findings are obtained through two questionnaires and a survey, circulated through the internet and filled out by the experts.

The results demonstrate that experts predict an improved position for cyclists, pedestrians and public transportation in future urban mobility, an impact on the environment, and an increasing important role of data, information and communication. Furthermore, experts see personal costs to arise due to technology affecting social exclusion in urban mobility, as well as new partnerships, governance, policy models and interventions. Lastly, results suggest that technology-related social inclusion is likely to allow for data and information to play a more important role in future urban mobility, as well as the emergence of new travel concepts, and the shift to a better quality of life. These results give rise to recommendations on how

to cope with the challenges and opportunities that may lie ahead in the future urban mobility landscape. In the last section of this paper, limitations as well as suggestions for future research are provided.

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# 1. Introduction

Every day, millions of people make use of transportation in urban life to get from one location to the other. In fact, mobility holds a fundamental role in urban life. Without mobility, it is impossible to lead a normal urban life and to perform daily activities that contemporary societies demand of us (Hine & Mitchell, 2001). As such, mobility is essential to the quality of our lives, by making places accessible and bringing people together (European Commission, 2014). Furthermore, it gives access to job opportunities, enables civic involvement, as well as facilitates access to leisure and knowledge. It is also fundamental for social interactions with family and friends who, in turn, has an impact on human health and well-being. Bonss and Kesselring (2004) define mobility as a person's ability to freely make projects happen while being on the move. Currently, about 75% of Europe's population lives and works in cities, and by 2050 this number is expected to grow to 82% (UN World Urbanization Prospects, 2012). Furthermore, about 65% of all travel kilometres are made in urban environments and the number of urban kilometres travelled is expected to triple by 2050.

This depiction creates the impression that mobility is accessible to everyone. However, some people simply do not have the financial means to use urban mobility, which hinders their economic and social capabilities, while others, who can afford it, may have a physical disability that prevents them from using it (Kenyon *et al.*, 2002). Or there are others who, while experiencing neither of the previous limitations, simply do not understand or lack the knowledge required to use transportation (Kenyon *et al*., 2002). These constrains lead to a push of those certain groups of society into social exclusion. This exclusion could range from a slight growth of difficulty in using mobility to a total lack of access to relevant daily activities (Currie & Stanley, 2008; Hine & Mitchell, 2001). In fact, several studies have found significant evidence that hurdles to participation in key activities, such as education, health, social, and job, are due to the non-existence of appropriate transportation (Hine & Mitchell, 2001; Currie & Stanley, 2008). Thus, those unable to participate in urban mobility are most likely confronted with absolute transport-related social exclusion, leading to reduced employment and social opportunities and eventually also frustration and loneliness (Luo *et al*., 2012; Victor & Bowling, 2012). While only little

scholarly attention has been put on the societal costs of urban mobility, more attention has been paid on urban mobility's environmental impacts. UN Habitat (2011) argues that the transportation sector is complicatedly interrelated to the climate change challenge, as it is currently responsible for 13% of Greenhouse Gas (GHG) emissions worldwide and 23% of total energy-related GHG emissions. In fact, this contribution to climate change is likely to continue to grow, especially considering current worldwide trends, with the whole transportation sector's share of global GHG emissions potentially reaching 40% by 2050 (International Energy Agency, 2011). Thus, current mobility patterns are generally considered to be environmentally unsustainable as they place enormous demands on our environment.

The idea that future cities must become more sustainable in general is widely recognized. Earlier definitions of sustainable transport have often resembled the concept of sustainable development, being defined as: 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs.' (Brundland Report, 1987, p. 41) Inspired by this definition, one of the first widely accepted definitions of sustainable transportation was 'transportation that does not endanger public health or ecosystems and meets mobility needs consistent with (a) the use of renewable resources at below their rates of regeneration; and (b) the use of non-renewable resources at below the rates of development of renewable substitutes.' (OECD, 1997, p. 12) This shows that early efforts of sustainable transportation have mainly been focused on the dominant environmental impacts of transportation. More recently, however, scientific publications have also begun to incorporate the social dimension of mobility. This is especially reflected by the shift in use of the term sustainable transportation to the term sustainable mobility. One of the more influential definitions used today was constructed by the World Business Council for Sustainable Development, who defines sustainable mobility as being 'the ability to meet the needs of society to move freely, gain access, communicate, trade, and establish relationship without sacrificing other essential human or ecological values today or in the future.' (WBCSD, 2004, p. 5) This definition suggests that the societal dimension of urban mobility plays an equal importance compared to the economic and environmental dimension.

Recent years have seen a growing recognition that mobility problems can be a significant barrier to social inclusion. However, when looking at sustainable mobility measures being taken, most of them only focus on reducing mobility's environmental impacts, through technology-related innovation. In fact, advancements in technology and innovation have been at the forefront in lessening the environmental impacts of urban mobility. Especially with regards to alternative driving technologies, including improved fuel efficiency, alternative fuels and propulsion systems (Mathiesen *et al.*, 2008). Yet, there is a growing urge for pursuing sustainable urban mobility within the societal dimension. This is due to several current trends taking place, that may directly impact social inclusion and exclusion in future urban mobility. The world is increasingly urban and mobile, with 82% of Europeans expected to live and work in cities by 2050, and with 65% of all travel kilometres made in urban environments and its number of urban kilometres travelled to triple by 2050 (UN Word Urbanization Prospects, 2011). Furthermore, life expectancy of people is increasing and redesigning the function of ageing people in society. This means urban mobility needs to be more tailored for the desires of our ageing population, by making it inclusive for all, and available in closer proximities to people's homes (Cairns *et al.*, 2014). Also, issues such as poverty and access inequalities pose new social challenges to urban mobility. Especially, as technology becomes more integral to everyone's lives, the risks of exclusion increase for certain social groups. At the same time, technology can promise a window of opportunity at this point, with mobility solutions for underprivileged groups embedded in future urban mobility (Warschauer, 2003).

Concluding that there are several societal trends that are likely to influence social inclusion and exclusion in future urban mobility, and with technology playing a predominant role, it is important to further understand the relationship between them. Hence, this research seeks to examine the relationship between social inclusion and exclusion and future urban mobility, and, in particular, the role that technology plays in relation to it. To do so, this research aims to provide perspectives on the future urban mobility landscape in cities with already highly developed transport infrastructures. This will allow for leveraging the opportunities that technology holds in tackling the complex and growing opportunities and challenges of social inclusion

and exclusion in future urban mobility. Ultimately, recommendations on how to prepare for or cope with expected future developments will be provided. While examining the different perspectives of the future of technology in relation to social inclusion and exclusion in urban mobility, this research does not seek a best practice or best-fit approach. Under these circumstances, the process of information collection involves the Delphi study.

## 1.1. Research Question

The main research question of the present study is defined as:

*How do practitioners foresee technology affecting social exclusion and inclusion in urban mobility in the coming twenty years?*

Due to the complexity of the research question, it seems useful to divide it into five relevant sub-questions, which will be answered separately. These sub-questions are defined as:

1. What is social exclusion and inclusion (in urban mobility)? (Chapter 2)
2. What do you consider will be the most important developments in urban mobility in the coming twenty years? (Chapter 4)
3. Which developments can be expected to occur concerning technology affecting social exclusion in urban mobility? (Chapter 4)
4. Which developments can be expected to occur concerning technology affecting social inclusion in urban mobility? (Chapter 4)
5. What can be done to cope with the challenges and opportunities that may lie ahead? (Chapter 5)

The present work proceeds as follows: The remainder of this chapter will be devoted to emphasizing the relevance of this research. The second chapter will provide a literature review and discuss the main concepts of social exclusion and inclusion and their connection to the urban mobility landscape. These insights will allow for answering the first research sub-question. This is followed by chapter three, which presents the overall research methodology. Then, chapter four discusses the

findings, which will provide the answers to sub-research question two, three and four. This is followed by an Evaluation of the Delphi Technique, in chapter five. Lastly, in chapter six, the conclusion draws upon the previous insights to answer the main research question. Furthermore, recommendations on how to cope with the foreseen developments are provided and giving answers to sub-question five. Lastly, this chapter will end with limitations to the study as well as a call for further research. For a graphical structure, see Figure 1 below:

| | |
|---|---|
| *"TAKING A LOOK INTO THE ORACLE: FORECASTING FUTURE URBAN MOBILITY"* | **Introduction (Chapter 1)** |
| | **Literature Review (Chapter 2)** |
| | *Sub-question 1* |
| | **Research Methodology (Chapter 3)** |
| | **Findings (Chapter 4)** |
| | *Sub-question 2* / *Sub-question 3* / *Sub-question 4* |
| | **Evaluation of Delphi Technique (Chapter 5)** |
| | **Conclusion and Discussion (Chapter 6)** |
| | *Sub-question 5* / *Main research question* |

**Figure 1**. Research Structure (Author of this report, 2017)

## 1.2. Research Relevance

Numerous trends are likely to come together and create drastic changes in the urban mobility landscape over the next fifteen years (WBCSD, 2011).

Firstly, technological advances will become an integral part of future mobility. Electrification, autonomy and shared mobility are taking off. Car sharing and door-to-door travel services are already at work in many cities. Nearly every major automaker and a variety of technology companies is actively investing and testing

self-driving capabilities, with the goal of soon having door-to-door travel with no required human intervention at all. This will change the way people travel and ultimately may push certain groups into social exclusion as they do not know how to use these new services (Cass *et al.*, 2005).

At the same time, several macro drivers will shape the future urban mobility landscape. Demographic factors such as world population, life expectancy and poverty are expected to increase dramatically in the near future. The world is also becoming increasingly urban. While currently 52% of the population live in urban areas, this proportion is expected to increase to 67% by 2050. This is accompanied by a massive growth in the number of individual journeys taken on a daily basis. Today 64% of all travel happens within urban environments, and this number of urban kilometres travelled is expected to triple by 2050, leading to an increasing demand for passenger mobility. At the same time, customers' expectations are changing and while some people are only becoming more concerned about the accessibility of certain modes of travel, others are prepared to avoid certain transport methods because of it. Given these demographic trends, the availability of urban mobility and its accessibility for future mobility needs of people and goods is essential and it needs to be questioned how this can be achieved.

At the same time, urban mobility does not only lead to social exclusion, but can also foster social inclusion. Technology may lead to an extension of transportation to the previously immobile, such as for example elderly or those with disabilities. Thus, with the rise in technology-driven innovation it seems relevant to explore what role it could play not only in future urban mobility-related social exclusion but also in social inclusion (Warschauer, 2003).

In that sense, exploring future predictions through this research, may have the potential of identifying possible developments and offer a preview of the future, which may help actors of within the environment to adjust to circumstances and challenges that may lie ahead. Hence, researching the role of technology in urban mobility-related social exclusion and inclusion is an important part of the larger aim of contributing towards societal inclusion.

## 2. Literature Review

*This chapter provides an in-depth literature review to clarify the relevant theoretical background of the present study. This section explains the concepts of social exclusion and social inclusion. Reviewing both concepts relation to mobility follows this.*

### 2.1 Social Exclusion

Despite the growing prominence of the term "social exclusion", there has been much disagreement amongst literature on its exact meaning. However, contrarily, scholars have agreed about a significant conceptual shift in the term's explanation, away from traditional forms of explanations that were previously applied to individuals or social groups excluded from society due to factors such as poverty or deprivation. Mernagh and Commins (1997) have in fact highlighted this problem and argued that concepts like social exclusion are often misunderstood as they are being used so commonly. Thus, it is important to make distinctions between them and not use them interchangeable. In that sense, traditional definitions are to be seen non-equivalent with social exclusion (Lee & Murie, 1999). The absence of a widely accepted definition has in fact even been called to be problematic. Yet, at the same time, Littlewood (1999) argues that we need to stop seeking the "right" meaning as due to the complexity of the term and it being time and context-relative, finding the "right" definition is too exhaustive. Nonetheless, all definitions emphasize the multidimensionality of the concept, 'which goes beyond than material poverty to encompass other forms of social disadvantage such as a lack of regular and equal access to education, employment, healthcare and societal participation.' (European Parliament, 2015, p. 14)

The European Commission on social inclusion has put a clear and suitable definition on social exclusion forward in a 2004 joint report. The definition describes social exclusion as the following: 'Social exclusion is a process whereby certain individuals are pushed to the edge of society and prevented from participating fully by virtue of their poverty, or lack of basic competencies and lifelong learning opportunities, or as a result of discrimination. This distances them from job, income and education opportunities as well as social and community networks and activities. They have

little access to power and decision-making bodies and thus often feeling powerless and unable to take control over the decisions that affect their day to day lives.' (Council of the European Union, 2004, p. 8)

Many scholars have also devoted their time to define dimensions of social exclusion to determine different levels that will allow for monitoring social exclusion over time. However, here similarly no commonly accepted definition can be found. Though many of the approaches taken by numerous scholars roughly overlap. Lee and Murie (1999) identified eight social exclusion dimensions, these are: labour markets and employment, welfare markets and poverty traps, exclusion from financial circuits and public utilities, education, health, housing markets, neighbourhoods and social networks. This suggests that certain demographic trends are likely to lead to more social exclusion. The European Commission (2014) found similar findings in their report and warned about some significant demographic and structural changes that could lead to more social exclusion of particularly vulnerable groups. These changes include the growth in population, the rise in information and communication technologies, changes in household structures and several others. During their research, Lee and Murie (1999) found several connections between different areas and social exclusion, but only limited proof for transportation playing a role in some of these areas. Burchardt *et al.* (1999) developed a more suitable dimensional framework, while focusing more on the everyday activities of people within a society. These dimensions are as followed:

1. The inability to consume goods and services
2. The inability to save
3. The inability to participate in economically or socially valuable activities
4. The inability to be involved in local or national decision-making
5. The inability to engage in social interaction with friends, family and community

Burchardt *et al*. (1999) also determined several variables that may have an impact on the factors that determine as to what extend a person or a group's is capable of partaking in the dimensions mentioned above. These are:

1. The individual's own characteristics (*e.g*., health)
2. Events in the individual's life (*e.g*., job loss)

3. Characteristics in the area he or she lives in (*e.g.*, transport links)
4. Social, civil and political institutions of society (*e.g.*, welfare stare)

Especially interesting for the goal of this research, is the following definition of social exclusion: 'Social exclusion is the process by which people are prevented from participating in the economic, political and social life of the community because of reduced accessibility to opportunities, services and social networks, due in whole or part to insufficient mobility in a society and environment built around the assumption of high mobility.' (Kenyon *et al.*, 2003, p. 210) This definition is particularly noteworthy, as it emphasizes the key role of mobility in contemporary societies. Having thought about the different definitions of social exclusion allows us now to further take mobility into consideration. This will be addressed in the next paragraph.

## 2.2. Social Exclusion in Urban Mobility

Urry (2007) emphasizes many different types of mobility: the corporeal travel, the virtual travel, the communicative travel and the imaginative travel. Yet, this research will focus on the corporeal travel through physical space. Scholars have largely agreed upon the role that urban mobility plays in regard to social exclusion. Similarly, it is widely accepted that urban mobility may in fact be a potential determinant in creating social exclusion. Kenyon *et al.* (2002) have described mobility-related social exclusion as: 'the process by which people are prevented from participating in the economic, political and social life of the community because of reduced accessibility to opportunities, services and social networks due in whole or in part to insufficient mobility in a society and environment built around the assumption of high mobility.' (p. 2010-2011)

Church *et al.* (2000) further add to this understanding of the interrelation of physical mobility and social exclusion, by recognising seven mobility-related categories of social exclusion. These are:

1. Physical exclusion
2. Geographical exclusion
3. Exclusion from facilities

4. Economic exclusion
5. Time-based exclusion
6. Fear-based exclusion
7. Space exclusion (p.198-200)

Other research has emphasized two main social dimensions that are affected by mobility; provision and accessibility. The World Bank (2002) for instance, underlines the significance of mobility accessibility in relation to social interactions: 'accessibility is important for its role as part of the social capital that maintains the social relations forming the safety net of poor people in many societies.' (Gwilliam, 2002, p. 25)

The European Commission (2014) has also defined several factors that may lead to social exclusion caused by the limited access to transport. These are:

- Limited ability for people to access jobs
- Limited ability to access health, culture and sports services
- Limited ability for disadvantaged groups (e.g. elderly, people with disabilities) to access facilities
- Forcing people on low income to spend disproportionate part of their income on transport
- Undermining social capital and forcing people on low incomes to have an increasingly local and restricted lifestyle
- Holding back the opportunities for immigrants and ethnic minorities living in disadvantaged areas to engage and integrate with the wider society

## 2.3. Groups at Risk of Social and Mobility Exclusion

Burchardt *et al.* (2002) have revealed that the lack of participation in activities (*e.g.*, job, education, social, et cetera) has been identified as the key outcome of social exclusion. In fact, it is being suggested that the barriers to participating in these activities are either a lack of suitable transport or a lack of accessible opportunities (Currie & Stanley, 2008; Hine & Mitchell, 2001; Kenyon *et al.*, 2002). Thus, the mobility disadvantaged are therefore those social groups who are confronted with these problems. There is a general agreement that groups at risk of social exclusion are also particularly subject to mobility-related social exclusion. In a literature review done by Currie (2011), it was identified which groups of people are confronted with

mobility disadvantage. According to this review, those cited the most are: the elderly, youth, the disabled, low-income/unemployed and migrants and ethnic minorities. Yet, other groups of people were also identified, such as women.

The elderly are particularly at risk of mobility-related social exclusion but at the same time also heavily rely on it, mostly for leisure activities and to access healthcare activities. Thus, the availability and accessibility of mobility is of primary importance for the wellbeing of the elderly. What often hinders accessibility are mobility problems and sight/hearing deficiencies, that make elderly people more susceptible to poor-quality transport services, such as for instance the lack of elevators. Consequently, the poor access to mobility may lead to social exclusion, and as perceived by Dwyer and Hardill (2011), could ultimately have a negative impact on the health of elderly people.

Young people also heavily rely on mobility, while poor access and high transportation fees often put them in a socially disadvantage position (Kenyon, 2011). Most of all, mobility for young people provides access to education; thus, connectivity is particularly important. Especially, those who do live in a more deprived area or who are from families with a low-income are thus reliant on public transportation. Similarly, mobility is also extremely important for young people and job access. Particularly, the availability and affordability of mobility play a key role in ensuring young people can get to work (European Commission, 2014).

Another social group at risk of mobility-related social exclusion are the disabled (European Parliament, 2015). Access to mobility has been increasingly acknowledged as being important for the quality of life of people with disabilities. However, the disabled have specific mobility problems and often need a different way of access to standard means of mobility (DPTAC, 2002). Physical accessibility to mobility is often obstructed by unreachable transport stations or poor-quality of pedestrian pavements. In addition, accessible transport information systems are extremely important for disabled people that are for instance affected by dyslexia (Lamonta *et al.*, 2013). These barriers may hinder disabled people from having access to mobility, and thus push them into social exclusion.

Low-income and unemployed people are particularly at risk of mobility exclusion, as in most cases they do not have the financial means for a private car and are thus particularly reliant on local public transportation (Eurostat, 2014). Another obvious problem for this group of people is the cost of transportation. Moreover, Bradshaw (2004) finds that low income people have a higher chance of not having appropriate physical access to transportation, as social research suggests, that this group of people is often also physically disabled or has children. At the same time, enhancing transport accessibility could directly benefit unemployed people by providing transport access and enhancing their employment probability.

Lastly, migrants and ethnic minorities are also at high risk of mobility-related social exclusion. According to Assum *et al.* (2011), immigrants are more likely to use public transportation, as owning a car and getting a driver's license is very costly. Yet, migrants and ethnic minorities face several significant barriers when using public transportation. These are for instance language barriers which immigrants face when trying to understand transport information or buying tickets. Furthermore, Assum *et al.* (2011) also identified the availability, accessibility and the costs as barriers to mobility for this social group.

## 2.4. Social Inclusion

Social inclusion is often considered to be the converse of social exclusion while at the same time also mostly being defined almost exclusively in terms of employment. But, to regard social inclusion mainly in economic terms is to strictly limit the meaning of social inclusion. It would in fact reject the social dimensions of the concept. Of course, the economic aspect is equally important, but even so more important is to not overlook the other spheres that are necessary to achieve full social participation. This suggests that social inclusion needs to be perceived beyond its economic sphere, and rather in terms of the integration of people into social life, social cohesion and social empowerment. Likewise, social inclusion and social exclusion should not be considered to be the converse of each other, since social inclusion is more proactive in the sense that it entails action, while social inclusion is more of an observation of a status.

The European Commission in a report published in 2004 provided a clear definition of social inclusion. The authors of the report define social inclusion in the following way: 'Social inclusion is a process which ensures that those at risk of poverty and social exclusion gain the opportunities and resources necessary to participate fully in economic, social, and cultural life and to enjoy a standard of living and well-being that is considered normal in the society in which they live. It ensures that they have greater participation in decision making which affects their lives and access to their fundamental rights.' (Council, 2004, p. 8) Un-DESA (2009) defines social inclusion according to the status when people have the chance to fully participate in "all aspects of life", then they belong to a society.

## 2.5. Social Inclusion in Urban Mobility

The connections between mobility and social inclusion are complex and multifaceted and no definite conclusion can be drawn. However, a significant number of scholars have made the attempt to provide an overview of the connection between the two and it seems that the role of mobility as a possible supportive factor of social inclusion is well amongst socioeconomic literature. In fact, there seems to be consensus that mobility can help promote social inclusion by allowing people to get to their jobs, get access to education and other activities. By overcoming these problems associated with social exclusion, people feel more included into society.

The report *Delivering a Sustainable Transport System* (2008, p. 16) suggests that a prerequisite for urban mobility to be socially inclusive is when it contains the following four features: availability, accessibility, affordability and acceptability. If it fulfils these four criteria, then it can successfully connect people to the above-mentioned opportunities.

The first feature relates to availability, meaning that mobility should be in easy reach of peoples' places of residence with convenient times and frequencies fitting into peoples' patterns of social and working life. Furthermore, equally important is that people are aware of those services being available. There is no point in mobility being available, if those in need of it are not aware of its existence. Then, mobility also needs to accessible in order to be socially inclusive. This presumes that vehicles, stops routes and everything else in mobility must be constructed and

planned in a way that anyone can access it without any hinders. Especially important are also the interchanges that need to be accessible so that they do not hinder people to continue their journey without obstacles. Thirdly, mobility needs to be affordable if it wants to be socially inclusive. This means mobility should not take advantage of people using transportation by only offering high fares. Different ticket options should exist that meet the different needs of the people for the best value. It is often the case that high fares affect low-income households the most, since they often live further away and thus have to travel most frequently. Thus, mobility needs to be affordable for those groups who can least afford it. This also includes older people, disabled people, jobseekers and children. In fact, free mobility could have many advantages beyond social inclusion. For elderly people, free transportation would allow them to keep their independence, access any activities they would like, without having to worry about its financial implications. This independence and freedom can greatly contribute to the elderlies' mental and physical life. The report also mentions the role that technology plays in fostering social inclusion. The authors suggest that the potential of smart ticketing technology for developing simpler, and more consistent faces for children and young people needs to be explored. This is particularly interesting to this paper, since we aim to explore the connection of these two concepts - social inclusion and technology. Lastly, the report also suggests that acceptability plays a significant role in order for it to be socially inclusive. Apparently, the perception people hold over mobility influences whether they will use it or not. Negative perceptions could be related to the cleanliness or reliability of mobility and may put off people of using transportation. On the contrary, people may hold positive perceptions if they feel like they can rely on the different modes of transportation. This leads to positive outcomes since they can participate in all activities they want to. A person may accept to move to a place that is a bit further away from their workplace, since they know they will still be able to get to their work in time. This allows them to remain socially included. From this point of view, greater social inclusion requires the availability, accessibility, affordability, and acceptability of mobility.

# 3. Methodology

*This chapter discusses the overall research methodology that is being applied to the present study. More specifically, it will elaborate on the research objective, research design as well as the selected research method. It will also look at the selection of experts and the data information process. The chapter finishes with explaining the type of data analysis that was employed as well as introducing the Follow-Up Evaluation.*

## 3.1. Research Objective

It has become clear that social exclusion and inclusion within the urban mobility landscape is likely to undergo significant changes due to the rise in technology and several social trends having a direct impact on urban mobility. While the predominant notion is that urban mobility may lead to social exclusion, it has also been discussed how in fact it can foster social inclusion through technology-driven innovation. In that sense, the present study aims to provide perspectives on the future urban mobility landscape in regard to technology-related social exclusion and inclusion. These insights, in turn, shall provide practitioners in the field with a preview of the future, which may help them to adjust to circumstances and challenges lying ahead. Therefore, the research question "*How do practitioners foresee technology affecting social exclusion and inclusion in urban mobility in the coming twenty years?*" will be answered.

## 3.2. Research Design

For the purpose of this research, it seemed most suitable to choose a forecasting method. Within forecasting methods there are two fundamental paradigms to study phenomenon: these are quantitative and qualitative methods. Essentially, a quantitative forecasting method is based on an analysis of historical data where statistics is used to analyse data from the past in various time aspects. On the other side, qualitative forecasting methods use the judgement of experts to make a forecast, that can only be obtained in that way as either historical data are not sufficient or predictions can not be explained by quantifiable information (Habibi *et al.*, 2014). Using historical data for the goal of this paper would not be enough, since we aim to use the judgement of experts in order to make predictions of what is likely

to happen in 20 years. For this reason, this paper adopts the qualitative Delphi research method.

It also needs to be differentiated between the three types of Delphi, namely, conventional, real-time and policy. In the conventional Delphi, a questionnaire is sent out to a group of experts, while using the responses as feedback for the second questionnaire. In the real-time Delphi, the process is much shorter and usually takes place during a meeting where participants respond participate and hear about their summarized responses in real-time. Lastly, in the policy Delphi the focus is less on having a group reach a decision, but the emphasis is more on presenting options and supporting evidence (Linstone & Turoff, 1975). For the suitability of this study, a conventional Delphi method approach was chosen.

## 3.3. Research Method

*History*

The name of the method comes from the Ancient Greek God Apollo, whose Delphi oracle was viewed as the most truthful and trustworthy "expert informer" with powers of predicting the future (Kennedy, 2004). The origins of the method can be attributed to the 1950s, at the research laboratory, Rand Corporation, in California and was directed to military technology forecasting (Linstone & Turoff, 2002). Since then, the Delphi method has matured and been widely used for facilitating judgemental forecasting and decision making in a variety of industry sectors.

Delphi forecasting basically determines factors that will eventually alter the future of an industry, whereas historic data, conventional opinion surveys and focus groups cannot adequately determine these factors (Dull, 1988). The technique has been called unique in its way, as it is based on the notion that a group of experts is better than one expert when exact knowledge is not available (Paliwoda, 1983). According to Gordon (1994), the Delphi method can be classified into three types of situational judgements. These are: (1) prediction of future developments, (2) prediction of possibilities of an event in the future and related recommendations and (3) ways to achieve or avert future situations. This paper's research fits into Gordon's situational

judgement "prediction of future developments", which in turn had a direct influence on the structure of the questionnaire as well as the choice of the panel experts.

During the conventional Delphi, a chosen panel of experts within the field of study is questioned separately during several rounds of interviews or questionnaires on a particular subject (Young & Jamieson, 2001). Different than in focus groups, here the panel members do not converse with the other participants. This also prevents any conflictuous situation that a meeting in person may have provoked. After each round, the results are merged, edited, and fed back to the participants with the purpose of participants to adjust and reconsider their responses. This means, that the results are fed back to the participants without them knowing whom the other experts are. The respondents then have the chance to resubmit their views. This process continues until a consensus has formed (Grisham, 2009). This is usually achieved after three rounds, since most adjustments usually take place between rounds one and two (Bellamy *et al.,* 1991).

*Advantages*

The inherent characteristics of the Delphi method bring along many advantages, and make it particular useful as a research instrument in long-range forecasting (Gordon, 1994). Probably the technique's most significant benefit is its ability of participant motivation. Chosen experts develop a sense of ownership of the researched topic during the process. This translated into more effective and efficient motivation and engagement (Sahakian, 1997). Moreover, many scholars have also looked at the accuracy of the Delphi technique for forecasting. Czinkota (1986) and Czinkota and Ronkainen (1997) looked at three Delphi studies within the international business field, and found the average predictive accuracy to be 76%, which proves for the Delphi method to be a powerful forecasting tool. In one of the studies, the inaccuracies could have resulted from the fact that only experts from one country were chosen. This shows the significant importance that the selection of the participants plays. Additional advantages are the elimination of geographical distance and logistical issues in the case of face-to-face meetings and the chance to provide an equal opportunity for all participants to respond. These advantages lead to better results in the research process (Glenn *et al*., 2009).

*Disadvantages*

Despite the above-mentioned advantages, critics have also raised concerns in relation to the Delphi Method. It is possible that the participants are being influenced by the way that the researcher formulates the questions. This could directly impact the participants' comprehension of the purpose of the study. Moreover, due to the lack of contact in person, the researcher may never be able to truly evaluate each panel member's full expertise (Murry & Hammons, 1995). The method also required a continued commitment from the different participants over multiple rounds of interviews. This can be problematic due to the time-consuming nature of the method and lead to problematic time delays in between the different rounds and respondents dropping out (Jefferey & Hache, 1995). To avoid this the researcher could possibly send out several reminders in form of emails to remind each panel expert about the importance of contributing to the research. Landeta (2006) argues that the validity specifically can be threatened by the following factors:

- The bias involved in interaction through written and controlled feedback
- The absence of social compensation for individual contribution to the group
- The anonymity creates the opportunity for irresponsible answers on the part of the experts
- The methodology makes it relatively easy for the researcher to manipulate the study
- The difficulty of assessing the Delphi study's accuracy and reliability
- The required time to execute a full study
- The necessary effort from the respondents
- The absence of consideration of possible relations between future developments

There are several alternative methods to the Delphi method that may have been considered for this study. These are the for example the Nominal Group Technique (NGT) or the Q-Methodology (Adler & Ziglio, 1996). The Nominal Group Technique is very similar to the Delphi method and also uses expert respondents in a panel. Yet, it requires respondent to meet in a group setting. This seems impossible in the case of this study due to time and distance constraints. Similarly, the Q-Methodology could have also been combined with the Delphi study. The aim of a Q-Methodology is to identify and describe a range of shared interview answers among participants. Respondents then arrange cards with different statements of the study and rank them on a predefined scale (Curt, 1994). While both alternative methods could be

combined with this paper's Delphi method to not do so due to distance and time constraints.

Given these merits and drawback, it seems now appropriate to explain why the method was chosen. According to Rowe and Wright (2001), a Delphi should be used to elicit expert opinions under the subsequent four conditions:

1. Expert judgement is necessary since the use of statistical methods is inappropriate,
2. A number of experts are available,
3. The alternative is simply to average the forecasts of several individuals,
4. When the alternative is a traditional group.

After carefully assessing each of those conditions, we come to the conclusion that our research complied with all of them. Based on this examination, the decision was taken to use the Delphi. More specifically, the first condition was met, since the use of statistical methods was impossible as historical data's ability to predict future developments of urban mobility is limited. Secondly, we also had the chance to find several experts to be available for this study. If research would have proven that individual human judgement forecasts better than that of several experts, then we would have had to use individuals instead. However, this was not the case. Several experts were available, and research suggests that if this is the case, they should be used. Thirdly, during the forecasting process, judgements received by the experts may be combined in several ways. One option is for individuals to give their forecasts without interacting with the others and for those forecasts to be then weighted equally and statistically combined. The difference here to the Delphi procedure is, that the individuals do not interact with the others, whereas in the Delphi, panellists are instructed to use the feedback from others. The latter may lead panellists to consider the problem more deeply and possibly make better judgements. Thus, simply taking the average of the forecasts of several individuals is not an option since the initiation of several rounds including the feedback information is crucial. Lastly, a Delphi should be used if the alternative is a traditional group. In this type of group meeting, multiple social and psychological issues can arise which may obstruct successful communication during the process. The Delphi was in fact designed to progress this by adding more structure to the process.
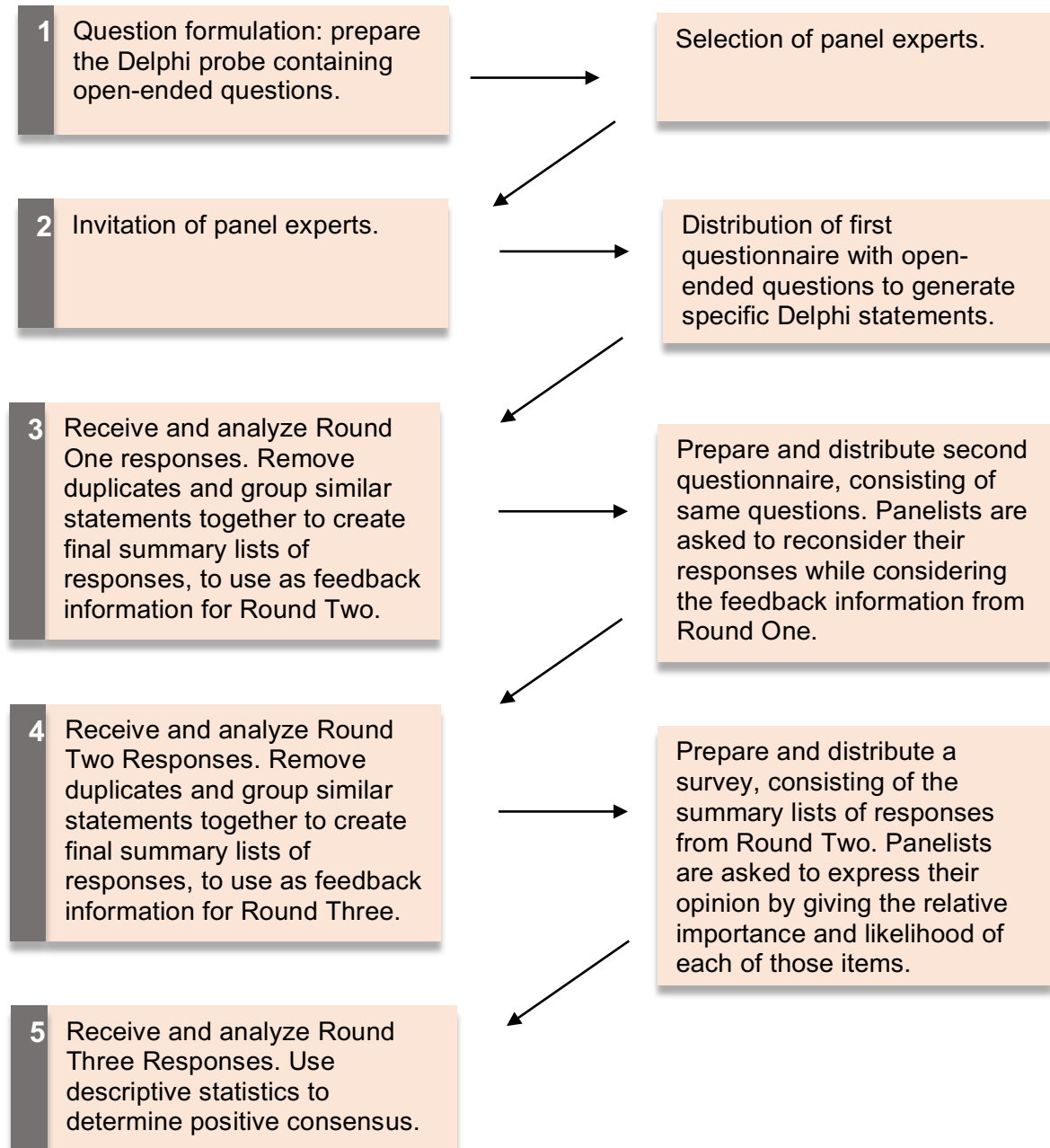
*Consensus*

The notion of consensus has been identified as the most difficult component of the Delphi method. While the aim of the Delphi method is to achieve consensus, there does not exist one way to reach it. This is because the understanding of the term is so debatable. Some would define consensus as being a group option and others as a general agreement (Mitchell, 1991). Since there is such a disagreement on what consensus means, there is also a lack of standards on how to measure the level of agreement amongst the panels.

Many researchers use descriptive statistics and subjective criteria in order to determine consensus. While researchers have pretty much used all kinds of descriptive statistics there seems to be no agreement over what mathematical aggregation seems to be the best for measuring consensus (Murphy *et al.,* 1998). When it comes to subjective criteria, researchers may decide to end the Delphi process if they do not believe that continuing it would add to the results. Weatherman and Swenson (1974), for instance, argue that the opinions in three rounds of a Delphi study should be sufficient for a general consensus. However, this approach should rather be avoided since it is scientifically questionable. The most frequent measures being used are measures of central tendency such as the mean, media, mode, or percentages. Greatorex and Dexter (2000) argue that the mean is used to represent group opinion, whereas the standard deviation helps to understand the amount of disagreement within the panel. So, in the case the standard deviation is high, there is disagreement amongst the panel, and then the contrary also applied. However, in a research conducted by Murphy *et al.* (1998) the researcher came to the conclusion that the median is the best way to measure consensus since it is more robust than other descriptive statistics, such as the mean or standard deviation. Ultimately the choice as to which to use depends on the level at which a certain variable is used (Heiko, 2012). Argyrous (2011) suggests that the mean can be used for internal/ratio data that is not skewed, the median for ranked data that is ordinal and interval/ratio. However, it is not useful for scales with few values. Lastly, the mode can be used with all levels of measurement, but is not useful with scales that have many values.

*Structure of the Delphi Method*

This section will clarify the procedure of the Delphi process employed in this research. This is helpful to keep an organised overview of the different steps undertaken. The process specific to this study is illustrated in the below Figure 2 and further explained in section 3.5.

| 1 | Question formulation: prepare the Delphi probe containing open-ended questions. | → | Selection of panel experts. |

| 2 | Invitation of panel experts. | → | Distribution of first questionnaire with open-ended questions to generate specific Delphi statements. |

| 3 | Receive and analyze Round One responses. Remove duplicates and group similar statements together to create final summary lists of responses, to use as feedback information for Round Two. | → | Prepare and distribute second questionnaire, consisting of same questions. Panelists are asked to reconsider their responses while considering the feedback information from Round One. |

| 4 | Receive and analyze Round Two Responses. Remove duplicates and group similar statements together to create final summary lists of responses, to use as feedback information for Round Three. | → | Prepare and distribute a survey, consisting of the summary lists of responses from Round Two. Panelists are asked to express their opinion by giving the relative importance and likelihood of each of those items. |

| 5 | Receive and analyze Round Three Responses. Use descriptive statistics to determine positive consensus. |

**Figure 2**. Structure of this Paper's Delphi Method (Author of this paper, 2017)

## 3.4. Delphi Process

*Question Formulation*

The first round of questionnaire, referred to as the Delphi Probe, contained open-ended probes to give participants the opportunity to generate ideas and give them complete freedom in their responses. The open-ended questions extracted answers that responded to the overarching research question regarding technology affecting social exclusion and inclusion in urban mobility in the next twenty years. The responses were also the basis for the creation of the subsequent survey rounds. The open-ended questions that were decided on to use for the Delphi Probe were:

1. What do you consider will be the most important developments in urban mobility in the coming twenty years?
2. Which developments in urban mobility will arise due to technology-related social exclusion?
3. Which developments in urban mobility will arise due to technology-related social inclusion?

*Selection of Panel Experts*

The next step consisted of selecting the panel experts. The right selection of panel experts is one of the most critical components of the Delphi process as the methods results directly depend on the experts' knowledge on the subject (Gordon, 1994). Literature on the Delphi method does not provide a clear definition of what an "expert" is, though Simon (1965) categorize expertise as identical with authority and a level of knowledge that distinguishes an expert from a learner. It has been advised to identify and recruit these experts according to a set of inclusion criteria, rather than selecting them merely based on personal preference (Williams *et al.*, 1994). According to Skulmoski *et al.* (2007), literature recommends using the following criteria: 1) knowledge and practical experience regarding the area under investigation, 2) ability and willingness to participate in the study, 3) adequate time to contribute to the Delphi panel, and 4) effective communication skills. Miller (2006) recommends using the following criteria: 1) national or international reputation, 2) has conducted research, written or lectured on the area of research, and 3) experience in sharing knowledge. Roger and Lopez (2002) suggest that expert panel must fulfil at least two of the following criteria within the subject of study: 1)

authorship, 2) conference presenter, 3) research field employed in practice with at least 5 years of experience, and 4) member/chair of committee.

For this research, experts were defined using a combination of the criteria suggested above. It was decided that panellists had to meet at least 3 specific requirements to qualify themselves as experts on the research topic of this paper. An overview of the guidelines for this Delphi research method is provided in Table 1 below.

**Table 1**. Guidelines for Implementation of Delphi Research Method (Author of this report, 2017)

| Characteristics | Minimum Requirement |
|---|---|
| Qualification of panel experts | - At least 5 years of professional/academic experience in the field of urban mobility and social inclusion/exclusion<br>- Membership in a relevant nationally recognized committee<br>- Invited to present at a relevant conference<br>- Advanced degree in the field of urban mobility or related fields (minimum MSc)<br>- Primary or secondary writer of journal articles in this field<br>- Lectures in this field at institution of higher learning |
| Number of panellists | 8 |
| Number of rounds | 3 |

*Number of Panel Experts*

The size of the expert panel can vary widely and there is no determined rule about how many experts should be in a Delphi panel since no 'statistical sample is needed that attempts to be representative of a population.' (Okoli & Pawloski, 2004, p. 20) Opinions on the ideal panel size vary significantly amongst researchers. The number of panellists depends on the characteristics of the study, which could be the availability of experts or geographic limitations. It also needs to be taken into

consideration that it is quite common for panel experts to drop out during the study due to unexpected commitments coming up or not being interested in the study anymore. Thus, an adequate number of panel experts should be recruited at the beginning of the Delphi study to ensure an adequate number throughout the entire process. It seems that most qualitative Delphi studies employ between 5 and 20 panel members (Armstrong, 1985) Hence, it was decided to have at least 8 panel members participating in this paper's research.

With the consideration that this research was to be undertaken by one researcher and a considerable lack of available time, it was decided to identify 30 potential panellists fitting into the above-mentioned selection criteria.

*Invitation of Panel Experts*

After identifying the 30 prospective panellists, the next step consisted of sending out invitations to the study. Finding the email addresses of all potential panel experts via the Internet did this. Out of thirty prospective participants, only twenty-two email addresses were found. These were then used to send out an invitation email on the 26th of March (see Appendix A). The researcher gave a short introduction of herself, explained the goal of this research and informed about how the Delphi process would be conducted. Potential participants were also informed about the confidentiality of their identity. Ten out of twenty-two accepted to participate in the study, five declined, and seven did not respond.

*Participating Panel Experts*

The panel consisted of individuals working in the broader field of urban mobility, sustainable transportation or more specifically related to social inclusion and exclusion. Participants may have been researchers, consultants, company representatives or professional. From the overall ten experts who accepted to participate in the study, eight remained through to the final round. Table 2 below presents the composition of the panel experts.

**Table 2**. Composition of the Panel Experts (Author of this report, 2017)

| Type | Number of Experts |
|---|---|
| Private Sector | 1 |
| Public Sector | 3 |
| Academic Field | 4 |

### 3.5. Data Collection

*Round One*

After selecting the above-mentioned experts, each participant was sent an invitation email to the first Delphi Round, on 6 April. Attached to this email was the Round One questionnaire (see Appendix B), comprised of the following three questions:

1. What do you consider will be the most important developments in urban mobility in the coming twenty years?
2. Which developments in urban mobility will arise due to technology-related social exclusion?
3. Which developments in urban mobility will arise due to technology-related social inclusion?

The researcher asked the participants to provide as many opinions as possible to the open defined questions. The researcher also notified them to complete the questionnaire within the given time frame.

The first round was scheduled to finish within 2 weeks. Due to some late submission, the round only finished on 24 April. Out of ten experts, eight experts replied to the first questionnaire while two dropped out. Several personal emails were send repeatedly to motivate the last two experts to participate in the research, but these were ignored and the researcher did not receive any responses. Thus, it was assumed that the two experts would not continue with the research and had decided to drop out.

Counting all responses together resulted in thirty statements for question 1, 19 statements for question 2 and 17 statements for question 3. The full list of responses can be found in Appendix C, D and E.

*Round Two*

In Round Two all eight experts who participated in Round One, was send the next and invitation email with the next questionnaire, on 5 May. It was decided to also send an invitation to the two experts that did not participate in Round One. The researcher hoped that the two experts may have not participated in Round One due to time constraints and not due to lack of interest. Thus, giving them a second chance to participate seemed reasonable and of advantage for both, the expert and the researcher. Attached to this invitation email were two documents. The first document contained Round Two questionnaire and its instruction; the second document consisted of the participant's previous Round One responses and the summary lists of statements given by the experts to Round One questionnaire (see Appendix F, G and H).

In Round Two the questionnaire consisted of the same three questions as in Round One questionnaire. The idea of this round was to ask the experts to reconsider their responses, while considering all other responses given by the experts. They were given the possibility to edit their responses, add to them by using statements from the summary lists, or retain their original responses.

Round Two was planned to finish within 1½ weeks. Most experts sent their responses later, which resulted in the finishing of this round only on 22 May. Out of eight experts, all eight replied.

*Round Three*

In Round Three all remaining experts were sent an invitation email to participate in the Final Round. This round consisted of a survey that was created through EUR's Qualtrics account. The invitation email with the survey link was sent out on 3 June, and panellists were asked to fill it in the latest, by 8 June. All eight experts who participated in the previous round also responded to this round. Most experts send their responses within the asked timeframe, except for one who only filled out the

survey on 12 June. This resulted in a small delay and meant that the researcher could only begin with the analysis of the results a bit later than expected.

The survey was created based on the Round Two summary lists. It contained the same three questions as asked in the previous rounds and the ready-made answers in the form of developments (Round Two summary lists). The instructions directed the experts to express their opinions by indicating with the help of a 5-point Likert scale, the relative likelihood and importance they would attribute to each of those developments.

All timelines for each of the three Delphi Rounds are summarized in the table below.

**Table 3**. Timeline of Delphi Rounds (Author of this report, 2017)

| Questionnaires/ Rounds | Send out | Replies Received | Data Analysis |
| --- | --- | --- | --- |
| Round One | 26 March 2017 | 10 – 24 April | 26 April – 2 May |
| Round Two | 5 May 2017 | 9 – 28 May | 29 May – 2 June |
| Round Three | 3 June 2017 | 8-12 June | 13 – 20 June |

### 3.7. Data Analysis

*Round One*

All statements received in Round One, were qualitatively thematically analysed by the researcher, to develop common themes and concepts provided by the experts. Assessing and examining all statements, to eliminate any duplicates and summarize those with similar meanings together, did this. Some responses also contained several statements within one sentence. These were then separated from each other and added as an individual statement to the list. This resulted in a final list of 28 statements for question 1, 18 statements for question 2 and 16 statements for question 3, representing the expert's Round One comments (see Appendix F, G and H), and serving as information for Round Two questionnaire and feedback.

To gain a better understanding on how the final list of statements per question was compiled, the following paragraph will give two examples of how several statements were reduced to a single one.

From all responses to question 1, several statements or parts of a statement were concerned with "the electrification of all forms of public" and "private transport and the reduction of pollution", which four experts considered to be a development likely to occur in urban mobility within the next twenty years. A list of all these statements is provided in the list below.

6) "Electrification of all forms of transport, including zero emission bus travel. This will also benefit the development of smart grids and energy storage solutions"

9) "Shift towards public transport, Autonomous vehicles, communication based mobility, shift towards pollution free travel, but travel costs may increase in future"

16) "Air quality"

28) "Highly reduced or zero carbon emission vehicles for both private and public transport"

All 4 statements mention the electrification of transport and its impact on pollution. Thus, after carefully examining the statements, a new statement was created. Rather than summarizing the above statements into a single one, some parts of each statement were extracted to form the new concise statement: "Electrification of all forms of public and private transport will lead to less pollution". Thus, as mentioned above, some statements contained several statements within one. This is for example the case for statement No. 1. The second sentence was separated and turned into a new statement itself. The same was done for statement No. 2.

Another example can be derived from question 2 responses. Two responses were concerned with "the exclusion of people due to a lack of technological skills". These two statements can be seen in the list below.

> 1) "Without (understanding) IT (smart phone) people will have more difficulty finding their way"
>
> 16) "Exclusion from mobility and employment due to lack of technological skills"

Subsequently, these two statements were summarized into the single statement: "People will be excluded from mobility and employment due to lack of technological skills."

*Round Two*

The Second Round was also qualitatively analysed by examining the completed questionnaires and firstly looking for duplicate statements. Those were then removed. Since the goal of this round was for the experts to reconsider their responses, the researcher proceeded by looking at the number of statements that were reinstated. By gathering all responses, the following was revealed:

To begin with the researcher looked at all statements given to question 1. Out of all 28 group summary statements that were given to question 1, the experts reinstated 22. The statements that did not receive a mention were:

- "The combination of smaller cars, no heavy trucks and lower speeds lead to higher capacity, easier crossings for pedestrians (single lane) and less injuries"
- "Public opinion will lead to lower speeds of car traffic"
- "Rise of the Information and Communication Technology (due to inter-networking of physical devices)"
- "Traffic lights will be replaced by smaller scale infrastructure"
- "Increase in travel costs"
- "Mass rapid transport"

Furthermore, experts added 5 statements to the list that they found to be developments in urban mobility arising in the coming 20 years. These statements were:

- "Separate comfortable systems for rich and 'important' people and infrastructure for 'the rest'"

- "Climate driven 'hackers' will confront travellers with their personal eco-footprint. These public lists will speed up public discussions and decisions about eco taxes."
- "Free mobility for children"
- "Increase in parking charges"
- "Higher taxes on pollution-oriented mobility"

Thus, for question 1, a new summary list of 27 development statements was compiled (see Appendix I).

When aggregating all summary statements for Question 2, it was found that 17 out of the 18 statements from Round 1 were reinstated by the experts. The only one that was not mentioned again was: "Seniors not having access to mobility or health care due to lack of technological skill". No new statements were added to this question. Altogether, this resulted in a new summary list of 17 development statements for question 2 (see Appendix J).

When gathering all summary statements for Question 3, it was found that 16 out of the 17 statements from Round 1 were reinstated by the experts for this round. The only statement that was not mentioned again was: "Slow modes of mobility". One expert added the following statement: 'Trusted small-scale information systems' will provide people with trusted and customized information.' Thus, for question 3, a new summary list consisting of 17 developments was compiled (see Appendix K).

*Round Three*
In Round Three participants were asked to fill out a survey by indicating their opinion with the help of a 5-point Likert scale. The choice to use the Likert scale was made because of its suitability for the Delphi research (Deutsch & Hamm, 1975).

For question 1, "What do you consider will be the most important developments in urban mobility in the coming 20 years?", the following 5-point Likert scale was used:

(1) Extremely important
(2) Very important

(3) Moderately important

(4) Slightly important

(5) Not at all important

For question 2, "Which developments in urban mobility will arise due to technology-related social exclusion", and question 3, "Which developments in urban mobility will arise due to technology-related social inclusion", the following 5-point Likert scale was used:

(1) Extremely likely

(2) Somewhat likely

(3) Neither likely nor unlikely

(4) Somewhat unlikely

(5) Extremely unlikely

The findings from this Round were analysed in an effort to reach consensus among the experts. The data was quantitatively analysed by using descriptive statistics. The data was analysed based on the mode, which is the proportion of experts who chose a score most popular in rating an item. This descriptive statistic was decided to be used, since this measure of central tendency can be used with all levels of measurements and is suitable for scales with few values. Considering this is the case for this research, it seemed to be the most suitable choice.

To determine when a positive consensus was reached, a threshold of 75% was used. This means that at least 75% of responses have to fall into the category "extremely important" and "very important" combined (Question 1) and "extremely likely" and "somewhat likely" combined (Question 2 and 3).

### 3.6. Follow—Up Evaluation

A follow-up round followed the conduction of all three Delphi Rounds. In this follow-up round the participating experts were send another email, containing Round Three responses and a Follow-Up Evaluation Questionnaire (see Appendix L). The goal of this Follow-Up Round was to obtain comments from the experts concerning the potential they saw of the Delphi Technique in predicting the future of urban mobility.

The questionnaire that participants were asked to fill in, consisted of the following open-ended questions:

1. To what extend do you agree with the results?
2. To what degree have your views about the future of urban mobility developments changed while participating in this study?
3. Did you face any major problems when responding to the questionnaires?
4. If you have any additional comments, please put them here.

After sending out this follow-up evaluation, five out of the remaining eight experts provided their feedback. An analysis of their responses will be examined in chapter 5.

# 4. Findings

*The previous chapter defined the research design of the present study. This chapter will summarize the results obtained from Round One, Round Two and Round Three of this Delphi research. The results will then be examined and discussed in the light of this paper's main research question: "How do practitioners foresee technology affecting social exclusion and inclusion in urban mobility in the coming twenty years?". Lastly, this chapter will also provide a discussion on the conducted Follow-Up Evaluation.*

## 4.1. Round One

After completion of Round One, the researcher received a total of 30 response statements for question 1, 19 response statements for question 2 and 17 response statements for question 3. A selection of responses that were given are exemplified below:

1. What do you consider will be the most important developments in urban mobility in the coming twenty years?

1) Driverless cars and car sharing schemes, freeing up space currently used for parking
2) Limiting of car access to city centres, improving the position of cyclists, pedestrians and public transport
3) Shift towards public transport, Autonomous vehicles, communication based mobility, shift towards pollution free travel, but travel costs may increase in future.
4) Increasing urbanization (more people in urban areas)

Then, as outlined in the previous chapter, all responses were examined, clustered together, eliminated and summarized, to form a summary list of responses for each question (Appendix I, J, K). The responses to each question were not listed in no particular order, rather, an effort was made to group those statements with a similar topic together.

This resulted in the following categories for question 1. Statements 1) and 2) were related to Mobility as a Service; statements 4) and 5) dealt with autonomous

vehicles; statements 5) to 9) focused on the improved position for cyclists, pedestrians and public transport; statements 10) and 11) related to information and communication technology; statements 12) to 14) handled with environmental quality; statements 15) and 16) were demographic trends; statements 17) and 18) related to new partnerships, governance and policy models and statements 19) to 28) were sorted as "other".  In summary, 8 categories emerged from Round One (question one) result statements. These were: Mobility as a Service, autonomous vehicles, improved position for cyclists, pedestrians and public transport, information and communication technology, environmental quality, demographic trends, new partnerships, governance and policy models and "other". The largest set of statements related to improved position for cyclists, pedestrians and public transport (apart from "others"). For the full list, see Table 4 below.

**Table 4**. Categories Round One – Question 1 (Author of this report, 2017)

| 1. What do you consider will be the most important developments in urban mobility in the coming 20 years? | |
|---|---|
| **Categories** | **Developments** |
| 1) Mobility as a Service | - Mobility as Service (MaS) will make use of an increasing amount of available data and technology<br>- Mobility as a Service (self-driving cars and shared services) enabled by technology and new business models |
| 2) Autonomous Vehicles | - Autonomous vehicles for short and long distance public mass transport<br>- Driverless cars and car sharing concepts will free up space currently used for parking |
| 3) Improved Position for Cyclists, Pedestrians and Public Transport | - The limitation of car access to city centres will improve the position of cyclists, pedestrians and public transport<br>- The combination of smaller cars, no heavy trucks and lower speeds lead to higher capacity, easier crossings for pedestrians (single lane) and less injuries<br>- Public opinion will lead to lower speeds of car traffic<br>- Shift towards public transport<br>- Slow modes of mobility (cycling, walking) |
| 4) Information and Communication Technology | - Communication based mobility<br>- Rise of the Information and Communication Technology (due to inter-networking of physical devices) |
| 5) Environmental Quality | - Pollution free travel<br>- Electrification of all forms of public and private transport leading to less pollution<br>- Electrification of all forms of transport will benefit the development of smart grids and energy storage solution |

| 6) Demographic Trends | - Increasing urbanisation<br>- Increase in elderly people with specific mobility needs |
|---|---|
| 7) New Partnerships, Governance and Policy Models | - Multi-stakeholder alliances and new governance models / public-private innovation<br>- New policy models (more nimble frameworks enabled by technology and diverse leadership eco-systems) |
| 8) Other | - New cultures of mobility<br>- New cultural preferences and expectations<br>- Fluidity across moving people, moving goods, and moving less<br>- Traffic lights will be replaced by smaller scale infrastructure<br>- Congestion<br>- Increase in travel costs<br>- The collapse of private vehicles ownership in mature economies, and the rising ownership in emerging countries, goes hand in hand with new way of thinking urban logistics<br>- Understanding of transport as access<br>- Mass rapid transport<br>- High-speed trains will improve to cover more distances in less time. |

For question 2, the following categories could be derived. Statements 1) to 4) dealt with technological skills; statements 5) and 6) with accessibility to mobility; statement 7) with privacy concerns; statements 8) to 13) focused on costs to people (financial, social and psychological); statement 14) related to new knowledge; statement 15) to unemployment and lastly; statements 16) to 18) were categorized as "other". In summary, 7 categories emerged from Round One (question two) result statements. These were: technological skills, accessibility to mobility, privacy concerns, costs to people (financial, social, psychological), knowledge, unemployment, and "other". The largest number of statements related to costs to people (financial, social, psychological). The full list of Categories is depicted in Table 5 below.

**Table 5.** Categories Round One – Question 2 (Author of this report, 2017)

| Categories | Developments |
|---|---|
| 1) Technological Skills | - People will be excluded from mobility and employment due to lack of technological skills<br>- Cashless payment in public transport might limit travel of people who struggle with modern technology<br>- Seniors not having access to mobility or health care due to lack of technological skill<br>- Technology related social exclusion will lead to greater traffic problems due to insufficient information on appropriate journey times and schedules. |

| | |
|---|---|
| 2) Accessibility to Mobility | - Expensive facilities (parking, taxi) will only be accessible to privileged<br>- Sharing concepts will first only be accessible to middle and upper classes, while lower classes in the mid-term will be excluded from these forms of mobility |
| 3) Privacy Concerns | - Privacy-minded people might be hesitant to embrace data-driven developments, such as mobility as a service |
| 4) Costs to People (financial, social, psychological) | - People suffering from technology related social exclusion will have to bear financial, social and psychological costs<br>- People not being able to get around to meet basic needs<br>- People not being able to get to their jobs<br>- People not receiving products/things<br>- Increased polarity/disparity of having access to mobility leads to increased dissatisfaction and unrest<br>- Increased polarity/disparity of having access to mobility leads to increased enforcement and social costs |
| 5) Knowledge | - Increasing need for personal travel coaching |
| 6) Unemployment | - Fewer jobs being available as automation takes over |
| 7) Other | - Technological exclusion could be transformed into social inclusion if appropriate policies, programs, infrastructures, innovation and economic and business incentives are present<br>- Public sector, civil society and industry have the responsibility to work together to ensure transport accessibility for all who need it in the future<br>- While the degree of connectivity will increase due to information technology, a small group will stay depend on "old" school info (*e.g.*, like bus timetables, service counters) |

Also for question 3, the researcher formed several categories. Here, statements 1) to 6) focused on new travel concepts; statements 7) and 8) on innovation; statements 9) to 11) on quality of life and lastly statements 12) to 16) were categorized as "other". Thus, in summary, 4 categories emerged: new travel concepts, innovation, quality of life, and "other". The largest set of statements related to new travel concepts. All categories can be found in Table 6 below.

**Table 6.** Categories Round One – Question 3 (Author of this report, 2017)

| Categories | Developments |
|---|---|
| 1) New Travel Concepts | - Driverless cars (for those with no driving licence)<br>- New travel concepts will emerge (smart travel, shared travel, car pooling, community concepts)<br>- Mobility as a service<br>- Slow modes of mobility<br>- More people friendly infrastructure<br>- Vehicle ownership will become more complex, which in turn will bring forward independent/coordinated mobility (more socially inclusive) |

| 2) Innovation | - New mobility options will result in increased innovation opportunities across a wider range<br>- New mobility options will result in increased business opportunities across a wider range |
|---|---|
| 3) Quality of Life | - Mobility as a service will make the customer journey more attractive for all participants<br>- New mobility options will result in improved quality of life<br>- New mobility options will result in increased safety and security |
| 4) Other | - In emerging countries, the access to motorized mobility will offer greater opportunity to reach further destinations<br>- New mobility options will result in improved economic indicators<br>- New mobility options will result in improved environmental quality<br>- Price for public transport will depend on people's financial income<br>- Real-time travel information |

These resulting summary lists from the first round formed the basis for the Round Two questionnaire and the initiation of feedback information.

## 4.2. Round Two

After completion of Round Two and experts reconsidering their responses from Round One, summary lists with 27 statements for question 1, 18 statements for question 2 17 statements for question 3, were compiled. Some statements were deleted and some newly added. Those were mentioned in the previous *Data collection* section (page). These new items were then numbered respectively, put into the corresponding category and added to the Round Two summary lists.

For question 1, experts added 5 new statements. The statements were numbered 23) – 27) (see Appendix I). If we consider that 6 statements were dropped from the initial Round One summary list, then it can be assumed that the experts are too close to nearing consensus. However, the fact that the experts added 5 new statements, revealed that they expressed new viewpoints, which were most likely facilitated by the feedback information they received and their participation in this research.

Once the new summary list for Respondents Round Two Question One was compiled, the researcher again divided the statements into categories. These new

categories are a further fine-tuning to the categories that resulted during the Round One.

The first category of developments in this case related to "New Travel Concepts" such as for example Mobility as a Service or autonomous vehicles. This category consisted of the following items: 2), 3), 20), 21) and 26). The next category of developments was associated with the "Improved Position for Cyclists, Pedestrians and Public Transport" and consisted of items: 4), 5), 6), 7), and 22). Another category was related to "Demographic and Cultural Trends", with items 12), 13), 16), 17), and 18) being in it. Those developments related to "Data, Information and Communication" were reflected in items 1) and 8). The items 9), 10), 11), 19) and 27) were concerned with either positive or negative impact on the environment and were thus put into the category "Impact on Environment". Lastly, items 14), 15), 23), 24) and 25) emphasized government intervention of partnerships and were thus put into the category "New partnerships, governance and policy models & interventions".

To summarize, the following six categories were derived: "New Travel Concepts", "Improved position for Cyclists, Pedestrians and Public Transport", "Demographic and Cultural Trends", "Data, Information and Communication", "Impact on Environment", and "New Partnerships, Governance and Policy Models & Interventions". All the categories and their respective statements can be found in Table 7 below. Here we can see that all categories contained 5 items except for one category, which only contained 2. This suggests that the experts considered developments relating to "Data, Information and Communication" and occurring within the next twenty years to be less important than those of the other categories.

Next to putting the items into categories as was described above, the researcher also decided to count the frequency of the number of experts who stated each item in Round Two. The results are shown in Table 8. The frequency count reveals that 14 out of 27 items were mentioned by at least two experts and out of those 14 items, 4 items received a mention by even three or more experts.

A further analysis of the items shown in Table 8 reveals that of the first 14 items, which were mentioned by at least two experts, most items fall into the category "Improved Position for Cyclists, Pedestrians and Public Transport". The experts,

implying that the experts consider developments in urban mobility in the coming twenty years that will improve the position of cyclists, pedestrians and public transportation of high priority, mentioned all items within this category.

To conclude, the following can be derived from the Round Two (Question 1) analysis of results:  The most important set of developments occurring in urban mobility in the coming 20 years that were mentioned by at least two experts, relate to "Improved Position for Cyclists, Pedestrians and Public Transport". Furthermore, items "Slow modes of mobility (cycling, walking)", "Communication based mobility", and "The limitation of car access to city centres will improve" are the only 3 items that were mentioned by more than half of the experts during Round Two. Since two of these items also fall into the category "Improved Position for Cyclists, Pedestrians and Public Transport" the assumption that the experts consider these developments of high priority, is even more reinforced.

**Table 7**. Categories Round Two – Question 1 *(Author of this report, 2017)*

| 1. What do you consider will be the most important developments in urban mobility in the coming twenty years? | |
| --- | --- |
| **Categories** | **Developments** |
| 1) New Travel Concepts | - Mobility as a Service (self driving cars and shared services) enabled by technology and new business models<br>- Autonomous vehicles for short and long distance public mass transport<br>- The collapse of private vehicles ownership in mature economies, and the rising ownership in emerging countries, goes hand in hand with new way of thinking urban logistics<br>- Understanding of transport as access<br>- Separate comfortable systems for rich and "important" people and infrastructure for "the rest". |
| 2) Improved Position for Cyclists, Pedestrians and Public Transport | - Driverless cars and car sharing concepts will free up space currently used for parking<br>- The limitation of car access to city centres will improve the position of cyclists, pedestrians and public transport<br>- Shift towards public transport<br>- Slow modes of mobility (cycling, walking)<br>- High-speed trains will improve to cover more distances in less time. |
| 3) Demographic and Cultural Trends | - Increasing urbanisation<br>- Increase in elderly people with specific mobility needs<br>- New cultures of mobility<br>- New cultural preferences and expectations<br>- Fluidity across moving people, moving goods, and moving less |
| 4) Data, Information and | - Mobility as Service (MaS) will make use of an increasing amount of available data and technology |

| Communication | - Communication based mobility |
|---|---|
| 5) Impact on Environment | - Highly reduced or zero carbon emission vehicles for both private and public transport<br>- Electrification of all forms of public and private transport leading to less pollution<br>- Electrification of all forms of transport will benefit the development of smart grids and energy storage solution<br>- Congestion<br>- Climate driven "hackers" will confront travellers with their personal eco-footprint. These public lists will speed up public discussions and decisions about eco taxes. |
| 6) New Partnerships, Governance and Policy Models & Interventions | - Emergence of multi-stakeholder alliances and new governance models / public-private innovation<br>- New policy models (more nimble frameworks enabled by technology and diverse leadership eco-systems)<br>- Free mobility for children<br>- Increase in parking charges<br>- Higher taxes on pollution-oriented mobility |

**Table 8**. The Frequency of Mention for Round Two - Question 1 Results (Author of this report, 2017)

| 1. What do you consider will be the most important developments in urban mobility in the coming 20 years? | | |
|---|---|---|
| **Frequency** | **Developments** | **Categories for each item** |
| 5 | - Slow modes of mobility (cycling, walking) | 2) |
| 4 | - Communication based mobility | 4) |
| 4 | - The limitation of car access to city centres will improve the position of cyclists, pedestrians and public transport | 2) |
| 3 | - Highly reduced or zero carbon emission vehicles for both private and public transport | 5) |
| 2 | - Autonomous vehicles for short and long distance public mass transport | 1) |
| 2 | - The collapse of private vehicles ownership in mature economies, and the rising ownership in emerging countries, goes hand in hand with new way of thinking urban logistics | 1) |
| 2 | - Driverless cars and car sharing concepts will free up space currently used for parking | 2) |
| 2 | - Shift towards public transport | 2) |
| 2 | - High-speed trains will improve to cover more distances in less time. | 2) |
| 2 | - Increasing urbanisation | 3) |
| 2 | - Increase in elderly people with specific mobility needs | 3) |
| 2 | - Mobility as Service (MaS) will make use of an increasing amount of available data and technology | 4) |
| 2 | - Electrification of all forms of transport will benefit the development of smart grids and energy storage solution | 5) |
| 2 | - Emergence of multi-stakeholder alliances and new governance models / public-private innovation | 6) |
| 1 | - Mobility as a Service (self driving cars and shared | 1) |

| | | |
|---|---|---|
| | services) enabled by technology and new business models | |
| 1 | - Understanding of transport as access | 1) |
| 1 | - Separate comfortable systems for rich and "important" people and infrastructure for "the rest". | 1) |
| 1 | - New cultures of mobility | 3) |
| 1 | - New cultural preferences and expectations | 3) |
| 1 | - Fluidity across moving people, moving goods, and moving less | 3) |
| 1 | - Electrification of all forms of public and private transport leading to less pollution | 5) |
| 1 | - Congestion | 5) |
| 1 | - Climate driven "hackers" will confront travellers with their personal eco-footprint. These public lists will speed up public discussions and decisions about eco taxes. | 5) |
| 1 | - New policy models (more nimble frameworks enabled by technology and diverse leadership eco-systems) | 6) |
| 1 | - Free mobility for children | 6) |
| 1 | - Increase in parking charges | 6) |
| 1 | Higher taxes on pollution-oriented mobility | 6) |

The same process as for question 1 was followed for question 2. No new statements were added to this question and only one statement was dropped. Once the new summary list for Respondents Round Two Question Two was compiled, the researcher again fine-tuned the categories from Round One, and created new ones.

The first category for developments that will arise in urban mobility due to technology-related social exclusion, related to "Accessibility to Basic Needs", with the following items: 4),5), 8), 9), 10). The next category of developments was associated with "Technological Skills" and consisted of items 1) and 2). Another category was related to the "Personal Costs" that people had to bear due to technology related social exclusion. Here items 6), 7), 11), 12) and 14) were grouped together. All items relating to "New Partnerships, Governance and Policy Models & Interventions" were also put into a category. These were items 15) and 16). The last category was named "Information & Knowledge" and included items 3), 13) and 17).

To summarize, after this Round the following six categories could be derived for Question 2: "Accessibility to Basic Needs", "Technological Skills", "Personal Costs",

"New Partnerships, Governance and Policy Models & Interventions", "Information & Knowledge". Table X below shows all the categories and their corresponding items. What is very noticeable is that the items relating to "Accessibility to Basic Needs" and "Personal Costs" form the most prominent categories with each 5 items. These are followed by the remaining categories with each only containing 2-3 items. All the categories and their respective statements can be found in Table 9 below.

Here also, the researcher decided to count the frequency of the number of experts who stated each item in Round Two. The results are shown in Table 10 below. The frequency count reveals that 14 out of 17 items were mentioned by at least two experts and out of those 14 items, 8 items received a mention by even three or more experts.

A further analysis of the items shown in Table 10 reveals that of the first 14 items which were mentioned by at least two experts, most items fall into the following two categories: "Accessibility to Basic Needs" and "Personal Costs". All items within these two categories were mentioned by four experts, implying that the experts consider these developments in urban mobility that will arise due to technology-related social exclusion of high priority.

To conclude, the following can be derived from the Round Two (Question 2) analysis of results:  The most important set of developments in urban mobility occurring due to technology-related social exclusion that were mentioned by at least two experts, relate to "Accessibility to Basic Needs" and "Personal Costs". Furthermore, out of all 8 items that were mentioned the most (by three experts), most fall into the category "Accessibility to Basic Needs". Here, experts mentioned 3 out of the 5 statements that were classified into this category.

**Table 9.** Categories Round Two - Question 2 (Author of this report, 2017)

| 2. Which developments in urban mobility will arise due to technology-related social exclusion? | |
|---|---|
| **Categories** | **Developments** |

| 1) Accessibility to Basic Needs (incl. Mobility) | - Expensive facilities (parking, taxi) will only be accessible to privileged people<br>- Sharing concepts will first only be accessible to middle and upper classes, while lower classes in the mid-term will be excluded from these forms of mobility.<br>- People not being able to get around to meet basic needs<br>- People not being able to get to their jobs<br>- People not receiving products / things |
|---|---|
| 2) Technological Skills | - People will be excluded from mobility and employment due to lack of technological skills<br>- Cashless payment in public transport might limit travel of people who struggle with modern technology |
| 3) Personal Costs (Financial, Social, Psychological) | - People suffering from technology related social exclusion will have to bear financial, social and psychological costs<br>- Increased polarity/disparity of having access to mobility leads to increased dissatisfaction and unrest<br>- Increased polarity/disparity of having access to mobility leads to increased enforcement and social costs<br>- Privacy-minded people will be hesitant to embrace data-driven developments, *e.g.* mobility as a service<br>- Fewer jobs being available as automation takes over |
| 4) New Partnerships, Governance and Policy Models & Interventions | - Technological exclusion could be transformed into social inclusion if appropriate policies, programs, infrastructures, innovation and economic and business incentives are present<br>- Public sector, civil society and industry have the responsibility to work together to ensure transport accessibility for all who need it in the future |
| 5) Information & Knowledge | - While the degree of connectivity will increase due to information technology, a small group will stick to "old" school info (*e.g.*, like bus timetables, service counters)<br>- Increasing need for personal travel coaching<br>- Technology related social exclusion will lead to greater traffic problems due to insufficient information on appropriate journey times and schedules. |

**Table 10**. The Frequency of Mention for Round Two (Question 2) Results (Author of this report, 2017)

| 2. Which developments in urban mobility will arise due to technology-related social exclusion? | | |
|---|---|---|
| **Frequency** | **Developments** | **Categories for each Item** |
| 3 | - Expensive facilities (parking, taxi) will only be accessible to privileged people | 1) |
| 3 | - Sharing concepts will first only be accessible to middle and upper classes, while lower classes in the mid-term will be excluded from these forms of mobility | 1) |
| 3 | - People not being able to get around to meet basic needs | 1) |
| 3 | - People will be excluded from mobility and employment due to lack of technological skills | 2) |
| 3 | - Cashless payment in public transport might limit travel of people who struggle with modern technology | 2) |

| | | |
|---|---|---|
| 3 | - Increased polarity / disparity of having access to mobility contributes to increased enforcement and social costs | 3) |
| 3 | - Technological exclusion could be transformed into social inclusion if appropriate policies, programs, infrastructures, innovation and economic and business incentives are present | 4) |
| 3 | - Increasing need for personal travel coaching | 5) |
| 2 | - People suffering from technology related social exclusion will have to bear financial, social and psychological costs | 3) |
| 2 | - Increased polarity / disparity of having access to mobility contributes to increased dissatisfaction and unrest | 3) |
| 2 | - Privacy-minded people will be hesitant to embrace data-driven developments, *e.g.* mobility as a service | 3) |
| 2 | - While the degree of connectivity will increase due to information technology, a small group will stick to "old" school info (*e.g.*, like bus timetables, service counters) | 5) |
| 2 | - Public sector, civil society and industry have the responsibility to work together to ensure transport accessibility for all who need it in the future | 4) |
| 2 | - People not being able to get to their jobs | 1) |
| 1 | - People not receiving products / things | 1) |
| 1 | - Technology related social exclusion will lead to greater traffic problems due to insufficient information on appropriate journey times and schedules | 5) |
| 1 | - Fewer jobs being available as automation takes over | 3) |

In response to question 3, "Which developments in urban mobility will arise due to technology-related social inclusion?" only one expert added one new statement, which was numbered 17) (see Appendix K). If we consider that only one statement from the Initial Round One summary list was dropped and only one new statement added, it can be assumed that the experts are coming closer to nearing consensus. This is most likely facilitated by the feedback information they received.

Once the researcher compiled the new summary list for this round, it was again looked at the different categories and an attempt was made to fine-tune them and create new ones. For this round 5 categories were formed. The first category for developments that will arise due to technology-related social inclusion, related to "New Travel Concepts" and included items 1) - 5). The second category of developments evolved around "Innovation" and consisted of items 6) and 7). All items relating to "Quality of Life" formed another category of developments - items 8) – 13). Items relating to "Data & Information" formed another category and consisted

of items 15) – 17). Item 14) did not fit into any of the categories and was thus left in a category called "Other".

To summarize, 5 categories could be derived after this Round for Question 3. These were: "New Travel Concepts", "Innovation", "Quality of Life", "Data & Information", and "Other". All the categories and their respective statements can be found in the Table below. For this question, there are two particular categories that are associated with the most items. Developments concerning the "Quality of Life" form the most prominent category with 6 items. This is followed by category "New Travel Concepts" with 5 items. All remaining categories contain only 1-3 items each.

Again, the second step consisted of counting the frequency of the number of experts who stated each item in Round Two. The results can be found in Table 11 below. The frequency count reveals that 12 out of 17 items were mentioned by at least two experts and out of those 12 items, 5 items received a mention by even 3 or more experts.

A further analysis of the items shown in Table 12 revealed that of the first 12 items which were mentioned by at least two experts, most items fall into the category: "New Travel Concepts". Furthermore, it is interesting to note that all 5 statements of this category were mentioned, each, by two to five experts. This implies that the experts consider new travel concepts in urban mobility that will arise due to technology-related social inclusion of high priority.

To conclude, the following can be derived from the Round Two (Question 3) analysis of results: The most important set of developments in urban mobility occurring due to technology-related social inclusion that were mentioned by at least two experts, relate to "New Travel Concepts". Also, all 5 items that fall within this category were mentioned by always at least two experts.

**Table 11.** Categories Round Two - Question 3 (Author of this report, 2017)

| 3. Which developments in urban mobility will arise due to technology-related social inclusion? | |
|---|---|
| **Categories** | **Developments** |
| 1) New Travel Concepts | - Driverless cars (for those with no driving licence)<br>- New travel concepts will emerge (smart travel, shared travel, car-pooling, community concepts)<br>- Mobility as a service<br>- More people friendly infrastructure<br>- Vehicle ownership will become more complex, which in turn will bring forward independent/coordinated mobility (more socially inclusive) |
| 2) Innovation | - New mobility options will result in increased innovation opportunities across a wider range<br>- New mobility options will result in increased business opportunities across a wider range |
| 3) Quality of Life | - Mobility as a service will make the customer journey more attractive for all participants<br>- New mobility options will result in improved quality of life<br>- New mobility options will result in increased safety and security<br>- In emerging countries, the access to motorized mobility will offer greater opportunity to reach further destinations.<br>- New mobility options will result in improved economic indicators<br>- New mobility options will result in improved environmental quality |
| 4) Data & Information | - Real-time travel information<br>- Personalized information and introduction of feedback loops<br>- "Trusted small-scale information systems" will provide people with trusted and customized information. |
| 5) Other | - Price for public transport will depend on people's financial income |

**Table 12.** The Frequency of Mention for Round Two (Question 3) Results (Author of this report, 2017)

| 3. Which developments in urban mobility will arise due to technology-related social inclusion? | | |
|---|---|---|
| **Frequency** | **Developments** | **Category for each Item** |
| 5 | - New travel concepts will emerge (mobility as service, smart travel, shared travel, car-pooling, community concepts) | 1) |
| 4 | - In emerging countries, the access to motorized mobility will offer greater opportunity to reach further destinations. | 3) |
| 3 | - More people friendly infrastructure | 1) |
| 3 | - Mobility as a service | 1) |
| 3 | - New mobility options will result in increased innovation opportunities across a wider range | 2) |
| 2 | - Vehicle ownership will become more complex, which in turn will bring forward independent/coordinated mobility | 1) |

| | | |
|---|---|---|
| | (more socially inclusive) | |
| 2 | - Driverless cars (for those with no driving licence) | 1) |
| 2 | - Real-time travel information | 4) |
| 2 | - Personalized information and introduction of feedback loops | 4) |
| 2 | - New mobility options will result in increased business opportunities across a wider range | 2) |
| 2 | - New mobility options will result in increased safety and security | 3) |
| 2 | - New mobility options will result in improved economic indicators | 3) |
| 1 | - Mobility as a service will make the customer journey more attractive for all participants | 3) |
| 1 | - New mobility options will result in improved quality of life | 3) |
| 1 | - New mobility options will result in improved environmental quality | 3) |
| 1 | - "Trusted small-scale information systems" will provide people with trusted and customized information. | 4) |
| 1 | - Price for public transport will depend on people's financial income | 5) |

## 4.3. Round Three

After completion of Round Three, all findings were summarized in a table and listed according to their rank of importance, based on the mode and the percentage of responses falling within the first two categories of the Likert scale. The first column of the table shows the development number, the second column the development, and the third column presents the mode score that the combined experts gave to the respective developments. The fourth column shows the percentage of responses that chose "extremely important" and "very important" combined (Question 1) and "extremely likely" and "somewhat likely" combined (Question 2 and 3). Lastly, the fifth column shows the ranking of the statements. When there was a tie in the consensus percentage, then the item with the mode closest to 1 was ranked highest. To reach positive consensus, at least 75% of the experts' responses should fall into the "extremely important" and "very important" categories combined.

For question 1, "What do you consider will be the most important developments in urban mobility in the coming twenty years?", consensus was achieved for 7 out of 27 developments in total. These developments were 7), 25), 1), 9), 19), 21) and 5). All developments with their respective mode, consensus percentage and ranking can be found in Table 13 below. The top two developments with a consensus of 87,5% were: 7) "Slow modes of mobility" and 25) "higher taxes on pollution-oriented

mobility". For both items, seven out of eight participating experts choose "extremely important" or "very important". However, from looking at the mode we can see that most choices fell into the category "very important" (mode = 2). The remaining developments that achieved a consensus of 75% were: 1), 9), 19), 21) and 5). Here, interestingly to see is that several experts for instance consider "Mobility as Service (MaS) will make use of an increasing amount of available data and technology" to be one of the most important developments in urban mobility in the coming twenty years, since the mode for this development is 1. This is similar to the developments "Highly reduced or zero carbon emission vehicles for both private and public transport" and "Congestion", which both have a mode of 1 and 2, since most experts' responses fell into the "extremely important" and "very important" option.

**Table 13**. Round Three - Question 1: Results, including Mode, Consensus Percentage and Ranking measure (Author of this report, 2017)

| 1. What do you consider will be the most important developments in urban mobility in the coming 20 years? | | Mode | % | Rank |
|---|---|---|---|---|
| | **Developments** | **Mode** | **%** | **Rank** |
| 7 | - Slow modes of mobility (cycling, walking) | 2 | 87,5% | 1 |
| 25 | - Higher taxes on pollution-oriented mobility | 2 | 87,5% | 2 |
| 1 | - Mobility as Service (MaS) will make use of an increasing amount of available data and technology | 1 | 75,0% | 3 |
| 9 | - Highly reduced or zero carbon emission vehicles for both private and public transport | 1,2 | 75,0% | 4 |
| 19 | - Congestion | 1,2 | 75,0% | 5 |
| 21 | - Understanding of transport as access | 2 | 75,0% | 6 |
| 5 | - The limitation of car access to city centres will improve the position of cyclists, pedestrians and public transport | 2 | 75,0% | 7 |
| 8 | - Communication based mobility | 1 | 62,5% | 8 |
| 2 | - Mobility as a Service (self-driving cars and shared services) enabled by technology and new business models | 2 | 62,5% | 9 |
| 10 | - Electrification of all forms of public and private transport leading to less pollution | 2 | 62,5% | 10 |
| 11 | - Electrification of all forms of transport will benefit the development of smart grids and energy storage solution | 2 | 62,5% | 11 |
| 12 | - Increasing urbanisation | 2,3 | 62,5% | 12 |
| 13 | - Increase in elderly people with specific mobility needs | 2 | 62,5% | 13 |
| 14 | - Emergence of multi-stakeholder alliances and new governance models / public-private innovation | 2 | 62,5% | 14 |
| 15 | - New policy models (more nimble frameworks enabled by technology and diverse leadership eco-systems) | 2 | 62,5% | 15 |
| 16 | - New cultures of mobility | 2 | 62,5% | 16 |
| 18 | - Fluidity across moving people, moving goods, and moving less | 2 | 62,5% | 17 |
| 24 | - Increase in parking charges | 2 | 62,5% | 18 |
| 20 | - The collapse of private vehicles ownership in mature | 1,3 | 50,0% | 19 |

| | | | | | |
|---|---|---|---|---|---|
| | | economies, and the rising ownership in emerging countries, goes hand in hand with new way of thinking | | | |
| 17 | - | New cultural preferences and expectations | 1,3 | 50,0% | 20 |
| 6 | - | Shift towards public transport | 2 | 50,0% | 21 |
| 4 | - | Driverless cars and car sharing concepts will free up space currently used for parking | 3 | 37,5% | 22 |
| 3 | - | Autonomous vehicles for short and long distance public mass transport | 4 | 37,5% | 23 |
| 27 | - | Climate driven "hackers" will confront travellers with their personal eco-footprint. These public lists will speed up public discussions and decisions about eco taxes. | 3 | 37,5% | 24 |
| 26 | - | Separate comfortable systems for rich and "important" people and infrastructure for"the rest". | 3 | 25,0% | 25 |
| 22 | - | High-speed trains will improve to cover more distances in less time. | 3,4 | 25,0% | 26 |
| 23 | - | Free mobility for children | 4 | 12,5% | 27 |

Furthermore, the attempt was made to categorize the developments that achieved consensus according to the topic categories that had been established in the previous chapter. This allowed seeing whether the developments that achieved consensus could be grouped according to certain mobility-related topics. Table 14 below shows these developments and their respective categories.

**Table 14**. Round Three - Question 1: Developments that reached consensus and their according categories (Author of this report, 2017)

| 1. What do you consider will be the most important developments in urban mobility in the coming twenty years? | |
|---|---|
| **Categories** | **Developments** |
| 2) Improved Position for Cyclists, Pedestrians and Public Transport | - The limitation of car access to city centres will improve the position of cyclists, pedestrians and public transport<br>- Slow modes of mobility (cycling, walking) |
| 5) Impact on Environment | - Highly reduced or zero carbon emission vehicles for both private and public transport<br>- Congestion |
| 1) New Travel Concepts | - Understanding of transport as access |
| 4) Data, Information and Communication | - Mobility as Service (MaS) will make use of an increasing amount of available data and technology |
| 6) New Partnerships, Governance and Policy Models & Interventions | - Higher taxes on pollution-oriented mobility |

Following this categorization, all developments that reached consensus relate to 5 topics, namely: Improved position for cyclists, pedestrians and public transport;

impact on environment; new travel concepts; data, information and communication; and new partnerships, governance and policy models and interventions. In each category, there is a relatively small number of developments, always either 1 or 2. This suggests that the experts' opinions, on what they consider will be the most important developments in urban mobility in the coming 20 years, are relatively spread over many different topics. Even though they agree on their importance, there is no 1 or 2 specific topic they consider to be the most important.

For question 2, "Which developments in urban mobility will arise due to technology-relates social exclusion?", consensus was achieved for 6 out of 17 developments in total. These developments were 15), 16), 1), 6), 11) and 12). All developments with their respective mode, consensus percentage and ranking can be found in Table 15 below. Only one developments reached a consensus of 87,5%, which is: 15) "Technological exclusion could be transformed into social inclusion if appropriate policies, programs, infrastructures, innovation and economic and business incentives are present". Here, seven out of eight participating experts choose "extremely important" or "very important". However, from looking at the mode we can see that most choices fell into the category "very important" (mode = 2).

The remaining developments that achieved a consensus of 75% were: 16), 1), 6), 11) and 12). Here, interestingly to see is that several experts for instance consider the development "Public sector, civil society and industry have the responsibility to work together to ensure transport" to be "extremely likely" to arise in urban mobility due to technology-related social exclusion. However, for all remaining developments that achieved consensus most experts only considered them to be "somewhat likely" to arise due to technology related social exclusion, since the mode is 2.

**Table 15**. Round Three - Question 2: Results, including Mode and Ranking Measure (Author of this report, 2017)

| 2. Which developments in urban mobility will arise due to technology-related social exclusion? | | | |
|---|---|---|---|
| **Developments** | **Mode** | **%** | **Rank** |

| | | | | | |
|---|---|---|---|---|---|
| 15 | - | Technological exclusion could be transformed into social inclusion if appropriate policies, programs, infrastructures, innovation and economic and business incentives are present | 2 | 87,5% | 1 |
| 16 | - | Public sector, civil society and industry have the responsibility to work together to ensure transport accessibility for all who need it in the future | 1,2 | 75,0% | 2 |
| 1 | - | People will be excluded from mobility and employment due to lack of technological skills | 2 | 75,0% | 3 |
| 6 | - | Privacy-minded people might be hesitant to embrace data-driven developments, such as mobility as a service | 2 | 75,0% | 4 |
| 11 | - | Increased polarity / disparity of having access to mobility leads to increased dissatisfaction and unrest | 2 | 75,0% | 5 |
| 12 | - | Increased polarity / disparity of having access to mobility leads to increased enforcement and social costs | 2 | 75,0% | 6 |
| 4 | - | Expensive facilities (parking, taxi) will only be accessible to privileged people | 1,2,3 | 62,5% | 7 |
| 2 | - | Cashless payment in public transport might limit travel of people who struggle with modern technology | 2 | 62,5% | 8 |
| 7 | - | People suffering from technology related social exclusion will have to bear financial, social and psychological costs | 2 | 62,5% | 9 |
| 10 | - | People not receiving products/things | 2 | 62,5% | 10 |
| 17 | - | While the degree of connectivity will increase due to information technology, a small group will stay depend on "old" school info (*e.g.*, like bus timetables, service counters) | 2 | 62,5% | 11 |
| 3 | - | Technology related social exclusion will lead to greater traffic problems due to insufficient information on appropriate journey times and schedules | 2,4 | 63,5% | 12 |
| 5 | - | Sharing concepts will first only be accessible to middle and upper classes, while lower classes in the mid-term will be excluded from these forms of mobility | 2 | 50,0% | 13 |
| 9 | - | People not being able to get to their jobs | 2 | 50,0% | 14 |
| 13 | - | Increasing need for personal travel coaching | 2 | 50,0% | 15 |
| 14 | - | Fewer jobs being available as automation takes over | 2 | 50,0% | 16 |
| 8 | - | People not being able to get around to meet basic needs | 3 | 37,5% | 17 |

Furthermore, for this question we followed the same steps and categorized the developments that achieved consensus according to the topic categories that had been established in the previous chapter. This would allow seeing whether the developments that achieved consensus could be grouped according to certain mobility-related topics. Table 16 below shows these developments and their respective categories.

**Table 16**. Round Three - Question 2: Developments that reached Consensus and their according Categories (Author of this report, 2017)

| 2. Which developments in urban mobility will arise due to technology-related social exclusion? | |
|---|---|
| **Categories** | **Developments** |
| 3) Personal Costs (Financial, Social, Psychological) | - People will be excluded from mobility and employment due to lack of technological skills<br>- Privacy-minded people might be hesitant to embrace data-driven developments, such as mobility as a service<br>- Increased polarity / disparity of having access to mobility leads to increased dissatisfaction and unrest<br>- Increased polarity / disparity of having access to mobility leads to increased enforcement and social costs |
| 4) New Partnerships, Governance and Policy Models & Interventions | - Technological exclusion could be transformed into social inclusion if appropriate policies, programs, infrastructures, innovation and economic and business incentives are present<br>- Public sector, civil society and industry have the responsibility to work together to ensure transport accessibility for all who need it in the future |

All developments that reached consensus relate to 2 topics, namely: "Personal Costs" and "New Partnerships, Governance and Policy Models & Interventions". Four of the developments that reached consensus related to the "Personal Costs" category whereas the remaining two related to the latter. This suggests that the developments, which the experts have reached consensus on in being the developments that are most likely to arise due to technology-related social exclusion, relate to personal costs, such as for example being excluded due to a lack of technological skills.

For question 3, "Which developments in urban mobility will arise due to technology-related social inclusion?", consensus was achieved for 8 out of 17 developments in total. These developments were 15), 8), 16), 2), 3), 7), 13) and 17). All developments with their respective mode, consensus percentage and ranking can be found in Table 17 below. There is one development that reached a consensus of 100%, namely: "Real-time travel information", with a mode of 1. Five experts considered this development to be "very likely" of arising due to technology related social inclusion, whereas 3 considered it to be "somewhat likely". The second and third ranked developments, "Mobility as a service will make the customer journey more attractive for all participants" and "Personalized information and introduction of feedback loops" each reached a consensus of 87,5% with a mode of 1. The

remaining developments that achieved a consensus of 75% were: 2), 3), 7), 13) and 17). Here, interesting to see is that even though they only reached a consensus of 75%, all have a mode of 1, suggesting that several experts consider these developments to be "extremely likely" to arise in urban mobility due to technology-related social inclusion.

**Table 17.** Round Three - Question 3: Results, including Mode and Ranking measure (author of this report, 2017)

| 3. Which developments in urban mobility will arise due to technology-relates social inclusion? | | Mode | % | Rank |
|---|---|---|---|---|
| | **Developments** | **Mode** | **%** | **Rank** |
| 15 | - Real-time travel information | 1 | 100% | 1 |
| 8 | - Mobility as a service will make the customer journey more attractive for all participants | 1 | 87,5% | 2 |
| 16 | - Personalized information and introduction of feedback loops | 1 | 87,5% | 3 |
| 2 | - New travel concepts will emerge (smart travel, shared travel, car-pooling, community concepts) | 1 | 75,0% | 4 |
| 3 | - Mobility as Service | 1 | 75,0% | 5 |
| 7 | - New mobility options will result in increased business opportunities across a wider range | 1 | 75,0% | 6 |
| 13 | - New mobility options will result in improved environmental quality | 1 | 75,0% | 7 |
| 17 | - Trusted small-scale information systems' will provide people with trusted and customized information. | 1,2 | 75,0% | 8 |
| 6 | - New mobility options will result in increased innovation opportunities across a wider range | 1 | 62,5% | 9 |
| 9 | - New mobility options will result in improved quality of life | 1 | 62,5% | 10 |
| 12 | - New mobility options will result in improved economic indicators | 1 | 62,5% | 11 |
| 4 | - More people friendly infrastructure | 1 | 50,0% | 12 |
| 11 | - In emerging countries, the access to motorized mobility will offer greater opportunity to reach further | 2,3 | 50,0% | 13 |
| 5 | - Vehicle ownership will become more complex, which in turn will bring forward independent/coordinated mobility (more socially inclusive) | 3 | 50,0% | 14 |
| 10 | - New mobility options will result in increased safety and security | 3 | 50,0% | 15 |
| 14 | - Price for public transport will depend on people's financial income | 3 | 25,0% | 16 |
| 1 | - Driverless cars (for those with no driving licence) | 3,4 | 25,0% | 17 |

Here, similarly I followed the same steps categorizing the developments that achieved consensus according to the topic categories that had been established in the previous chapter. This would allow seeing whether the developments that

achieved consensus could be grouped according to certain mobility-related topics. Table 18 below shows these developments and their respective categories.

**Table 18**. Round Three - Question 3: Developments that reached Consensus and their according Categories (Author of this report, 2017)

| 3. Which developments in urban mobility will arise due to technology-related social inclusion? | |
| --- | --- |
| **Categories** | **Developments** |
| 4) Data & Information | - Real-time travel information<br>- Personalized information and introduction of feedback loops<br>- Trusted small-scale information systems' will provide people with trusted and customized information |
| 1) New Travel Concepts | - New travel concepts will emerge (smart travel, shared travel, car-pooling, community concepts)<br>- Mobility as a service |
| 3) Quality of Life | - Mobility as a service will make the customer journey more attractive for all participants<br>- New mobility options will result in improved environmental quality |
| 2) Innovation | - New mobility options will result in increased business opportunities across a wider range |

Following this categorization, all developments that reached consensus relate to 4 topics, namely: "Data & Information", "New Travel Concepts", "Quality of Life" and, "Innovation". In each category, there is a relatively small number of developments, always from 1-3. This suggests that regarding the developments that the experts consider to be the most likely to arise in urban mobility due to technology-related social inclusion, their choices are relatively spread over many different topics. Even though they agree on their importance, there is no 1 or 2 specific topic they consider to be the most important.

# 5. Evaluation of the Delphi Technique

*Chapter three of this paper discussed the Delphi Technique, by more specifically elaborating on the methods history, advantages and disadvantages, the research objective and research design. Furthermore, it was also looked at the selection of experts and the data information process. Chapter four presented the results from the three conducted Delphi Rounds. Upon receiving and analysing all findings, the participants were sent a Follow-Up Evaluation Questionnaire to express their evaluations on the Delphi Technique. This allowed exploring the potential of the Delphi Technique in predicting the future of urban mobility. The results of this Delphi Technique Evaluation are presented in this chapter.*

*Results*
Participants were given the opportunity to answer to 4 follow-up questions. They all received the questionnaire via email and were asked to respond to it as soon as possible. From the eight remaining participants remaining, six responded. Each question with their respective results and analysis will be discussed in the following section.

To the first question, "To what extend do you agree with the results?", four of the experts responded that they completely or mostly agreed with the responses of the others. Some of their responses were: 'I totally agree with the results', 'The responses are accurate', or 'While there are some responses that I not entirely concur with, I agree with most of the others.'

From looking at these responses it seems that the Delphi Technique in fact successfully generated consensus. This confirms the claim made by Helmer (1966) that in most cases people's opinions converge when the Delphi Technique is used.

Yet, the remaining two experts did have some difficulties with some of the results since they felt some questions, in the survey for instance, were bundled together which they felt were very different. They expressed that they felt they were forced to choose an answer that was a bit inaccurate. In that respect, they did not agree with all results. These were some of their responses: 'I did not agree with some of the

results since some questions bundled things together that I consider to be different from each other', and 'I thought differently about certain things which were put in a same statement and found it difficult to give an accurate answer.'

In conclusion, respondents expressed a general agreement on the results of the Delphi research, while a minority of respondents questioned the ranking of a few developments due to a so-called "apples & oranges" problem.

The second question was: 'To what degree have your views about the future of urban mobility developments changed while participating in this study?' All respondents noted that none of their views had changed really during the Delphi process. However, they did disclose that the feedback information they received after each round did expand their perspective on the other participant's views. These are some of the responses: 'My views about the future urban mobility developments changed very little throughout the study', 'Although my views changed very little, the feedback information still allowed me to broaden my views', and 'No changes to my views really, though the feedback made me more aware of the other participants views.'

In conclusion, all respondents expressed that none of their views had really changed during the Delphi study, but did feel that the other opinions broadened their own. This is in line with the findings of McGaw *et al.* (1976) who discovered that the combining of views in a Delphi, in this case the feedback iterations, does expand the choice of opinions available to all participants.

The third question from the follow-up evaluation asked: 'Did you face any major challenges when filling in the questionnaires?'. Here three out of six respondents expressed that they did not face any problems when filling out the questionnaires. The other three did disclose some challenges. One participant mentioned the problem that some questions in the Third Round survey seemed to vary between wanting to know whether something "will" happen or be likely to happen or whether something "should" happen. The person mentioned that this may have just been her interpretation but it did affect the accuracy with which she could answer. Another challenge raised relates to the scope. 2 respondents found it challenging to answer

some broad questions without having a specific indication about what continent or country it was focused on. Lastly, 2 participants also mentioned that time pressure was their main challenge. Since, relatively little time was given to them, they felt that this was not enough.

In summary, about half of the respondents did not experience any challenges, while the other half faced the following challenges: differences in the meaning of words, scope and time pressure.

The last question asked the respondents to give any additional comments if they had any. 3 participants did not add anything further, while the other 3 expressed their thankfulness for being able to participate in this study. Some of their responses were: 'I really liked participating in this study and was happy to help out', and 'I was glad to participate and it was interesting to see the other participants' responses.'

In summary, the responses to the Follow-Up Evaluation have revealed that: (i) Around 67% of the participants agreed with the results from the last round, (ii) all participants retained their own views on the developments of future mobility, while some expressed that the other opinions (feedback information) broadened their own, and (iii) around 50% of the participants faced challenges relating to the differences in the meanings of words, the scope and time pressure.

After receiving all responses to the Follow-Up Evaluation, we can draw the conclusion that the respondents generally support the Delphi Technique as a feasible tool for this research. To build onto this conclusion and to further assess the effectiveness of the Delphi Technique, section 6.4. will look at major methodological issues that the researcher as well as the participant were confronted with during the Delphi process.

# 6. Conclusion and Discussion

The *present study was conducted to assess how practitioners foresee the future of technology affecting social exclusion and inclusion in urban mobility. Chapter four provided the results of the Delphi study that were gained from two questionnaires and one survey. This chapter builds on the results by interpreting the top developments that reached positive consensus for sub-questions two, three and four. This discussion is followed by the conclusion, recommendations for governments and companies, the answer to the main research questions and lastly, a call for further research.*

## 6.1. Conclusion

Due to the complexity of the main research question: 'How do practitioners foresee the future of technology affecting social exclusion and inclusion in urban mobility', sub-questions were created and analysed during this research. Sub-question 1: 'What is social exclusion and inclusion?' was answered through the literature review in chapter 2.

This following section looks at sub-questions 2: 'What do you consider will be the most important developments in urban mobility in the coming twenty years?', sub-question 3: 'Which developments can be expected to occur concerning technology affecting social exclusion in urban mobility?' and 4: 'Which development can be expected to occur concerning technology affecting social inclusion in urban mobility?'. Looking at the top consensus-reaching developments for each of these sub-question, will allow to answer sub-questions and ultimately the main research question.

*Sub-question 2: What do you consider will be the most important developments in urban mobility in the coming 20 years?*

The results to this question have shown that respondents reached positive consensus over 5 categories of developments that will be the most important ones to occur in urban mobility in the coming twenty years. Firstly, the experts predict that there will be an improved position for cyclists, pedestrians and public transport in the future. This is due to a limitation of car access to city centres and an increase in slow

modes of mobility, such as for example cycling and walking. This suggests that the experts consider the developments to occur in the future to be positive in the first place, since they put people in an improved position.

Furthermore, experts agreed that urban mobility in the future is going to have an impact on the environment. Here though responses differed with some experts seeing future urban mobility to have a positive impact on the environment while others predicting a negative one. It was raised that highly reduced or zero carbon emission vehicles for both private and public transportation may contribute to a better environment. Others raised the issue of congestion and its detrimental consequences. These results suggest that there is no unifying agreement amongst the experts as to whether the impact on the environment will be positive or negative.

It is also interesting to learn from the results that the experts see data, information and communication to play an important role in future urban mobility. They think that Mobility as Service (MaS) will make use of an increasing amount of available data and technology in the future. Unfortunately, the experts did not further mention what implications this could have. Assuming that this development might occur, then the consequences would be two-fold. On one side, the increased use of available information and data may help to further adjust and improve different types of transportation due to services that are tailor-made to peoples' specific needs and wants. On the other side, people may feel an intrusion into their privacy and thus decide to avoid using MaS. This in turn could put them into a disadvantaged position where they face exclusion and the inability to access general human needs and services.

*Sub-question 3: Which developments can be expected to occur concerning technology-affecting social exclusion in urban mobility?*

The experts consider personal costs (financial, social, and psychological) to be the most likely development that will occur due to the impact that technology has on social inclusion in urban mobility. They agreed on the likelihood of people being excluded from mobility and employment due to a lack of technological skills. Furthermore, another result suggests that privacy-minded people might also be

hesitant to use data-driven developments to protect themselves and thus face exclusion. These developments may suggest that technology-related social exclusion will lead to increased dissatisfaction and unrest.

Secondly, what was interesting about the results to this question is that there was a consensus amongst the experts that new partnerships, governance, policy models and interventions could act a tool to transform technological-related social exclusion into social inclusion. In that sense public sector, civil society and industry have the responsibility to work together to ensure transport accessibility for all who need it in the future, realized through appropriate policies, programs, innovation and economic and business incentives. This suggests that maybe technological-related social exclusion first has to occur itself in order for it to foster new and positive developments that could lead to social inclusion.

*Sub-question 4: Which development can be expected to occur concerning technology affecting social inclusion in urban mobility?*

Results suggest that technology-related social inclusion is likely to allow for data and information to play a more significant role in the future. The more people are included and have access to mobility, the more real-time travel information, personalized information and introduction of feedback looks will exist. This is turn will provide people with increased trusted and customized mobility services.

Secondly, new travel concepts are said to emerge, such as for example smart travel, shared travel, car-pooling, mobility as a service and other community concepts. It was not revealed why exactly that is but one might suggest that the more people are included in using transportation, the more there will be the necessity to come up with alternative travel concepts. Not only for making transportation more efficient, and have a reduced impact on the environment, but also maybe because there will be more people who prefer to travel differently.

Thirdly, technology-related social inclusion in urban mobility is also said to lead to a better quality of live. Mobility as a service, for example, will make the customer journey more attractive for all participants, since people can benefit from a door-to-

door service. Furthermore, new mobility options are more technologically advanced and constructed in a way to have less impact on the environment. This results in improved environmental quality, and directly affects the people's lives.

*Sub-question 5: What can be done to cope with the challenges and opportunities that may lie ahead?*

This sub-question was not included in the questionnaires or survey but was created with the intention to be answered by the researcher of this paper based on the answers to the other sub-questions by the experts. This section does not seek a best practice or best-fit approach, but rather wants to provide recommendation on how to prepare for or cope with the future challenges and opportunities that lie ahead.

As mentioned, the experts of this study predicted certain opportunities in urban mobility to be likely to occur. The first one is the limitation of car access to cities, which leads to an uprising of slow modes of mobility since it puts cyclists and pedestrians into an improved position. The opportunity of this development does not necessarily only come with the development itself, but also with the ones it triggers. Limiting car access to cities often leads to improvements of the streets themselves, by paving materials or improving the lighting systems. Also, closing certain streets or parts of a city is nothing new but could be further developed in the future. Cities such as London or Singapore already have parts of their city for only pedestrians, but extending this in size and scope would have significant positive implications to people and urban mobility. By shifting the focus from cars to slow modes of mobility, travel time could be reduced and safety improved. Another interesting opportunity this development would trigger is the expansion of e-bikes and its advantages. Many companies in Silicon Valley are working on testing new models of electric bikes as a means of commuting. Apart from its environmental benefits it also affects people more directly, by for example them not having to pay for parking space anymore.

In light of these opportunities, infrastructure improvements and the shift from driving to slow modes of mobility will also have a significant impact on helping alleviating traffic congestion; one of the challenges the experts consider to be very important in future urban mobility. Another suggestion to deal with traffic congestion would be to implement effective urban planning strategies such as congestion pricing, forcing

people to pay a fee for driving or using transportation at certain times of the day, *e.g.* rush hours, or an alternative would be to introduce higher taxes on pollution oriented mobility.

Lastly, the experts predicted the challenge of mobility as a service making use of an increased amount of available data and technology. People fear an intrusion into their privacy if their data is being tracked and used and thus often then just simply avoid using transportation. In order to cope with this challenge, a suggestion is to educate people about the benefits of tracking travel data.

## 6.2. Answering the Main Research Question

In the previous section, the four sub-questions were discussed and allow us now to answer the main research question:

*How do practitioners foresee the future of technology affecting social exclusion and inclusion in urban mobility?*

Practitioners haven given interesting insights into the question how technology will affect social exclusion and inclusion in urban mobility. To begin with, experts foresee that technology will affect social exclusion by producing personal costs to people, such as financial, social or psychological costs. They predict that since technological skills will be required in order for people to know how to use transportation, those that lack this knowledge, will be excluded from mobility as well as the access to employment. Furthermore, the question of privacy will play an important role. Privacy-minded people will be hesitant to embrace data-driven urban mobility developments. Furthermore, technology will also affect social exclusion in the sense that it will give rise to new partnerships, governance, policy models and interventions. This is a rather positive development since it suggests that technology-related social exclusion can in fact be transformed into social inclusion.

At the same time, this research also revealed that experts agree on technology standing in relation to social inclusion. Most experts found that technology-related social inclusion will lead to more real-time travel information, personalized information and feedback loops being available. This is because the more people are included and have access to mobility, the more data and information becomes available. This in turn will provide people with trusted and customized mobility

services. Furthermore, if technology will enable more people to be gain access to urban mobility, it is likely for new travel concepts to emerge. Mobility as a service, one of these new travel concepts, will in turn make the customer journey more attractive. On a wider spectrum, this emergence in new travel concepts could also result in a continuous emergence of innovation through increased business opportunities across a wider range.

## 6.3. Discussion

This section will put some of results into the context of the literature which was discussed in the literature chapter. This will not only add extra value but also help to explain why some of results in the conclusion were surprising while others not. Furthermore, it will put other results into the wider context of society and public debate.

One of the developments that reached high consensus was that technology will affect social exclusion by producing personal costs to people, such as financial, social or psychological costs. Accordingly, people will be excluded from mobility and employment since they lack the technological skills to use mobility. Thus, technology appeared to be the obstacle that hindered people from having access to mobility. In previous studies, it was suggested that there are several factors that may lead to social exclusion caused by the limited access to transport. The factor "Limited ability for people to access jobs" due to limited access to transport is one of them (European Commission, 2014) and may consequently lead to social exclusion. However, in this empirical research, technology was not considered to be the factor that stands in peoples' way in order to access mobility. Furthermore, Church *et al.* (2000) identified seven mobility-related categories of social exclusion such as for example physical exclusion where physical barriers inhibit the accessibility of transport services. From those 7 categories in total, none of them refers to technological-related social exclusion. This view suggests that at that stage technology may have not yet been considered to be a factor that leads to social exclusion.

In addition, it was predicted that technology will affect social exclusion in the sense that it will give rise to new partnerships, governance, policy models and interventions. Thus, the question needs to be raised whether the existence of technology-related social exclusion itself fosters the emergence of new developments, such as partnerships and innovations. The potential of these latter to be appropriately put in place, would be that technological exclusion could possibly be transformed into social inclusion. While this was not addressed in the literature review of this research, discussing its potential and role in the context of wider society may add additional value. One potential way for transforming social exclusion into inclusion is the existence of strong partnerships and their appropriate usage of travel data. Traditionally, poor collaboration between the private and public sectors has been one of the reasons why not enough travel data existed. Improving these collaborations often between local governments and companies requires lowering the risk of certain concerns. One of the most significant concerns is that of privacy and its protection. Partnerships need to align their interests and explore methods to protect user privacy while simultaneously benefitting from collecting new data. Filling this gap of information but also benefitting from sharing it between different parties matters significantly, since it would give better insights into how people move around the city and improve urban mobility accordingly. Better insights into daily travel behaviour would help transportation agencies to design roads or understand geographical shifts of people moving from suburbs to cities or vice versa. Or it would also allow knowing when to change a bus route, build more bike lanes, or design new mobility services. For the user, it is equally beneficial since more and better information would exist and help them to decide which type of transportation to use, when to travel and what to avoid. In overall, this would make urban mobility more socially inclusive since it would allow users to go wherever they would like and participate in all social activities.

Furthermore, leveraging these data capabilities would allow addressing another pressing urban mobility challenge: providing access to mobility for those groups of people who need it most. Our theoretical background revealed five groups of people that are particularly at risk of being excluded from mobility but at the same time also heavily rely on it (Currie, 2011). The experts' opinions as part of this research predicted that it is particularly the elderly who would be excluded from mobility and

employment since they find it particularly difficult to adopt newly-required technological skills. Taking this issue into consideration, the question needs to be raised on how data capabilities can be exploited in order to find a solution to this problem. A possibility would be for data capabilities to focus on finding out what these specific difficulties are in order to use the insights and focus on creating new and more suitable services for those disadvantaged groups. The results of this research showed that new travel concepts will emerge, such as smart travel, shared travel or mobility as a service. This is not only because mobility will have to become more efficient but even more because of the changing demands and needs of users. While the Delphi experts did not make any connection between these new travel concepts and the disadvantaged groups of society, it seems essential to further extend the question on how they stand in relation to each other. Disadvantaged groups of a society that feel excluded from urban mobility would significantly benefit from new trusted and customized travel concepts that are tailored to their needs. This development would in turn improve their quality of life drastically. While new travel concepts would be highly valuable It needs to be made sure that these are customized to each disadvantaged group separately. While autonomous cars might be great for elderly since they might not be able to drive themselves anymore, mentally disabled people may not understand how to use such a car. Thus, the question remains how future technology driven urban mobility can meet the needs of all disadvantaged groups individually.

In conclusion, it can be said that of all results of this research it is surprising that the experts did not really make any connections to specific disadvantaged groups, but rather kept the scope more general. Other results such as the ones relating to new travel concepts emerging or the importance of travel data were less surprising since they are of incremental nature. Basically, the components of new travel concepts or tracking travel data already exist now, but it can be expected that in the future their complexity and importance will grow due to technological modifications. Thus, it was not too surprising to hear the experts predicting these developments.

## 6.4. Limitations

Despite an in-depth Delphi Analysis on the future of urban mobility in relation to technological social exclusion and inclusion, this research experienced several limitations. These are discussed in the following section.

*Panel Size*

The panel size is a crucial factor in any Delphi Study and opinions on the ideal panel size vary greatly amongst researchers. Since this research was undertaken by one researcher only, with a lack of finances, capabilities and the time to undertake a Delphi research with a large number of respondents, it could only be worked with a relatively small sample (n=8) of urban mobility experts. While this sample is statistically relatively small, the participants came from a several different countries and held different positions. As for the gender, the sample only consisted of one female and 7 males. Taking those aspects into mind, using the results to make generalisation beyond the sample should be done carefully.

*The Editing of Responses*

In the first two rounds an open-ended format was adopted to give respondents the opportunity to freely answer to the questions without having to choose from predetermined answers. The respondents were asked to respond with concise statements, but this was not always respected and resulted in a large number of responses that required a lot of editing. This process was much more time and effort consuming than was expected at the beginning of this research. What particularly posed problems was to edit the responses and to form concise statements in a systematic way. While this attempt was made, the issue of subjectivity can never be entirely avoided. Furthermore, it was also challenging to decide when to bundle certain concepts together and form a statement out of it or when to form to separate statements instead.

*Length of Time-Interval between the Rounds*

Although this study had to work with a tight time schedule, the researcher believed to have given enough time to the respondents to answer to the Delphi rounds. However, this seemed to not be entirely right, since in each round there were about one to two respondents that did not manage to send back their results within the

provided time frame. This was also confirmed by the comments of two respondents during the Follow-Up Evaluation, who indicated that time was a challenge they had to deal with. Thus, more consideration should have been taken of the participants' schedules.

*The Management of Delphi Results*

A common risk in the use of the Delphi method is that the researcher may change the Delphi results in order to get his/her preferred results. By purposely falsifying the results of one Delphi round and feeding this information to the participants in the next round, the researcher may try to influence the outcome of the entire Delphi research. Nevertheless, in this research this was not the case. Using an open-ended format for the first round and feeding back the experts' own replies and the summaries of the other experts' responses in both subsequent rounds, would have contradicted any attempt to change the study's final outcomes. Moreover, since the respondents did only receive their own responses and those of the other's as feedback information, they were not pressured to have to converge to any specific answers as they might have if they would have received statistical feedback such as for example the median.

## 6.5. Recommendations for Future Research

The present study was designed to generate expert knowledge on the future of urban mobility and technology-relates social inclusion and exclusion. Based on the discussion and limitations of this research, this section identifies opportunities for advancing research on this subject.

*Larger Sample*

Firstly, future research on this subject must clarify whether the gained results can be used to make generalisations. The results of this research were only identified based on a relatively small sample (n=8). This was a limitation but inherent to the chosen qualitative research method. Therefore, more qualitative research should be conducted on this subject, to see if there is positive consensus amongst other experts on the same expected future developments.

*Differences between Cities*

The present study focussed on urban cities as a broad category. No distinctions were made between different cities. This approach undoubtedly overlooked differences that occur from city to city. The changes in urban mobility that will occur in the future depend largely on factors, such as city density, existing infrastructure, pollution, as well as local governance capabilities. Therefore, additional research is needed to assess how the future of urban mobility will differ per city.

*Focus on Disadvantaged Groups*

The results of this present study revealed that disadvantaged groups would significantly benefit from new trusted and customized travel concepts that are tailored to their needs, since it would allow them to participate in society, by for example having access to their job. This development would in turn improve their quality of life drastically. Further research could assess to what extent this would have an impact on larger society and how society at large would benefit from this. For example, if elderly people would not be limited anymore in their daily life and could go wherever they would like, what impact would this have on their health. Thus, the questions could be what impact would this improved position of disadvantaged groups on health at a wider scale.

*Urban Policies and Regulations*

Given the importance to provide disadvantaged groups with the necessary mobility options, strong support clearly also needs to come from governmental and political side. Urban policies and regulations that are created today will most likely determine how mobility will develop in the next twenty years. A long-term financing perspective for accessible and affordable transportation options needs to be implemented. Also, political commitment needs to evaluate and prioritise different transport modes in cities depending on their use. However, the future will come with significant regulatory challenges. The increase in cycling lanes and walking paths for example comes at the expense of more driving lanes, and makes taxi drivers accordingly unhappy. Also, new technologies such as automated vehicles could help limit congestion, pollution and ultimately foster social inclusion. However, for them to be

adopted at scale, the issue does not lie within the technological frame, but rather in the definition and harmonization of regulations at a city, state, national and even international level. Thus, trade-offs are obviously inevitable, and while many mobility innovations make sense, politics and the government need to back them with the necessary support.

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# Appendices

## Appendix A: Invitation email

Dear X,

My name is Nathalie Dezoteux and I am a Master's student in Global Business & Sustainability from the Erasmus University Rotterdam. I am sending this email to invite you to participate in a Delphi study related to forecasting trends over the next 20 years regarding the future of technology affecting urban mobility-related social exclusion and inclusion. This study is part of my thesis, which is a requirement for the completion of my Master's Degree. The goal of my thesis research is to elicit expert opinions concerning the developments that can be expected to occur in the future urban mobility landscape, arising due to technology-related social exclusion and inclusion. Technology becomes more integral to everyone's lives and the risks of exclusion increase for certain social groups. At the same time, technology can promise a window of opportunity at this point, with mobility solutions for underprivileged groups embedded in future urban mobility.

This project will employ the Delphi technique. In this method, a chosen panel of experts is questioned separately during several rounds of questionnaires/surveys on a particular subject. After each round, the results are merged, edited and fed back to the participants so that they adjust and reconsider their responses. The identity of the experts remains anonymous, meaning no participant will know who the other experts are. The goal is for a consensus to be formed. The Delphi used here involves 2-3 rounds of questionnaires/surveys. The first questionnaire will entail 3 open ended questions to which you will be asked to answer freely. The second and third questionnaire/survey will be based on information gathered from the previous rounds. In the final round (second or third) a survey will ask you to rate the developments that were identified by you and the other panel experts.

This Delphi study requires very little time commitment. There will only be 2-3 rounds with each questionnaire/survey taking no more than 20-30 minutes. A timeframe of 2-3 weeks will be given to complete each questionnaire/survey. Exact dates will be communicated accordingly. All communication and transmission of files or documents will go via e-mail.

I would like to emphasise that your identity and opinions in this study will be treated as strictly confidential. The results will be reported only in summary form back to all participants. No participant will know the identity of the others. You may withdraw your consent and discontinue participation at any time.

While participation is voluntarily, I would highly appreciate your contribution. Nor will it only allow me to graduate but also contribute to this field of research. Exploring future predictions through this research, may have the potential to identify possible developments and would also offer a preview of the future, which may help actors of within the environment to adjust to circumstances and challenges that may lie ahead.

If you have any queries, please do not hesitate to contact me. If you need more information, in order to decide whether you would like to participate or not, then please let me know. In any case, supporting information will be send to you with each questionnaire/survey.

Please let me know by 1st of April the latest about your decision.

Best, Nathalie Dezoteux

## Appendix B: Round One Questionnaire

Dear panel participant,

With this questionnaire, I would like to invite you to round one of the Delphi research. I would like to remind you that only the principle investigator, Nathalie Dezoteux, will have access to the questionnaire data and that no other individuals will be involved in the data analysis or in writing the final research paper. All your responses will be treated confidential and no identities will be revealed.

I would also like to remind you that participation in this study is voluntarily. This means that you do not have to answer any question that you do not want to answer and may withdraw from the study at any time. Please, do inform me in case you would like to withdraw. However, your participation would be highly appreciated.

Date:

Please indicate your name here:

What is you gender? *Please, add a x where appropriate*

| | |
|---|---|
| male | |
| female | |
| other | |

How many years have you been working/researching in the field of this study (urban mobility and social exclusion/inclusion)? *Please, add a x where appropriate*

| | |
|---|---|
| 1-5 years | |
| 5-10 years | |
| 10-15 years | |
| 15-20 years | |
| more than 20 years | |

Please provide as many opinions as you can for each one of the open-ended questions. The aim of this first iteration is to generate ideas and give you complete freedom in your responses.

1. What do you consider will be the most important developments in urban mobility in the coming 20 years?
2. Which developments in urban mobility will arise due to technology-related social exclusion?
3. Which developments in urban mobility will arise due to technology-related social inclusion?

## Appendix C. Original Responses Round One (Question 1)

1. What do you consider will be the most important developments in urban mobility in the coming 20 years?
   1) Public opinion will lead to lower speeds of car traffic
   2) Traffic lights will be replaced by smaller scale infrastructure
   3) The combination of smaller cars, no heavy trucks and lower speeds lead to higher capacity, easier crossings for pedestrians (single lane) and less injuries
   4) The collapse of private vehicles ownership in mature economies, the rising ownership in emerging countries, new way of thinking urban logistic.
   5) Mobility as a Service (MaaS) making use of increasing amount of available data and technology and the development of seamless integration of different modalities (especially for the last mile).
   6) Electrification of all forms of transport, including zero emission bus travel. This will also benefit the development of smart grids and energy storage solutions.
   7) Driverless cars and car sharing schemes, freeing up space currently used for parking
   8) Limiting of car access to city centres, improving the position of cyclists, pedestrians and public transport
   9) Shift towards public transport, Autonomous vehicles, communication based mobility, shift towards pollution free travel, but travel costs may increase in future.
   10) Increasing urbanization (more people in urban areas)
   11) Aging (more elderly people with their specific mobility needs)
   12) Rise of the Information and Communication Technology (due to IoT)
   13) Mobility as a Service (MaaS) in combination with slow modes (walking, cycling), sharing concepts (bike sharing, car sharing, ride sharing) and mass rapid transport (bus, tram, subway, light rail)
   14) E-commerce (city logistics)
   15) Congestion
   16) Air quality
   17) Safety
   18) Mobility as a service (replacing single minded single solution thinking focused on self-driving cars only or shared use only or electric vehicles only, etc). i.e. shift from modal focus to multi-modal system door to door enabled by technology and new business models – this is a 'system of systems"
   19) Focus on user across all modes
   20) Multi-stakeholder alliances and new governance models / public-private innovation
   21) New policy models (more nimble frameworks enabled by technology and diverse leadership eco-systems)
   22) New cultural preferences and expectations
   23) Fluidity across moving people, moving goods, and moving less
   24) New cultures of mobility
   25) More granularity of options
   26) Understanding of transport as access. i.e. reorientation of means and ends. Currently depending on the sector, one can start to think that the physical infrastructure or space; or the technology platform; or the business model; are the end goal. Whereas the end goal is serving the access goal, ENABLED BY these "means".
   27) Supply of New Mobility by the New Mobiltiy industy CLUSTER with multiple actors enabled by open API's not just by one sector. Alternatively it could go in a monopolistic direction.
   28) Highly reduced/zero carbon emission vehicles for both private and public transport.
   29) Automated or man-less operated vehicles for long distance public mass transport, which is already in existence but for few people and shorter distance.
   30) High speed trains will improve to cover more distances in less time.

## Appendix D. Original Responses Round One (Question 2)

2. Which developments in urban mobility will arise due to technology-related social exclusion?

1) Without (understanding) IT (smart phone) people will have more difficulty finding their way
2) Perhaps only the happy few can afford to use expensive facilities (parking, taxi)
3) In mature economies the sharing economy will target and reach first middle and upper classes, creating in the mid-term exclusion of lower strata from these new form of mobility. This is already evident in car-sharing and car-pooling initiatives in Europa and USA. In the long run, it could be that, as for the railway, also lower strata will benefit.
4) Cashless payment in public transport might limit travel of people who struggle with modern technology
5) Privacy-minded people will be hesitant to embrace data-driven developments, e.g. mobility as a service
6) Those suffering from TRSE will stand to bear more financial and psychological costs of mobility. If you are asking how future urban mobility will be effected by TRSE, then I think TRSE will contribute to greater traffic problems, if people will not know clearly about the appropriate journey times and schedules, they will be more likely to create traffic problems than those with sufficient information /or without TRSE.
7) The degree of connectivity will increase due to information technology but a small group will stay depend on 'old' school info (e.g. bus timetables, service counters)
8) Increasing need for personal travel coaching
9) This could go in a number of directions. We have to remember we are still (so far at least) the deciders. Technology cannot (yet) itself make the decisions as to how we will live and move. Yet public sector, civil society and industry can all be seen relinquishing the responsibility of coming together shaping the future for all involved when confronted with the rapid onslaught of technological innovation. It is incumbent upon us both for society and economy, regardless of sector to supply the mobility (or better, accessibility) future we need for all who need it. And we must work together across silos to do this.
10) In this context good developments could arise if appropriate policies, programs, infrastructures, and innovation and economic and business incentives are present. Technological exclusion could consciously be transformed to a concerted goal / market of social inclusion.
11) People not being able to get around to meet basic needs
12) People not being able to get to jobs
13) Stuff not getting to people
14) Fewer jobs being available as automation takes over
15) Seniors not having access to mobility or health care due to lack of technological skill
16) Exclusion from mobility and employment due to lack of technological skill
17) Increased polarity / disparity of haves and have nots leading to increased costs, increased dissatisfaction and unrest, leading to increased enforcement and social costs – vicious circle.

## Appendix E. Original Responses Round One (Question 3)

3. Which developments in urban mobility will arise due to technology-related social inclusion?

1) More walking and cycling because more people find what they need (esp. friends) nearby.
2) More cheaper small e-cars/e-bikes. Infrastructure will follow with smaller (people friendly) crossings etc.
3) More small scaled PT
4) Well, again not so clear. However, in emerging countries, the access to motorized mobility will offer greater opportunity to reach further destination, also on daily basis. In the long run, anyway, this will create some contradictions.
5) Car sharing and Mobility as a service
6) Real-time travel information
7) Driverless cars (for those with no driving licence)
8) I think smart travel, shared travel, car-pooling or community vehicles concept will emerge. Vehicle ownership may become more complex and thus it will help independent /coordinated mobility for those who are more likely to be technology related socially included. (TRSI).
9) Personalized information and introduction of feedback loops
10) Mobility as a Service concepts will make the customer journey more seamless, more attractive for all participants
11) More subsidy related check-in cards for use depending on level of financial income. That is the more you earn, the more you pay for the public transport.
12) Mobility options (both individual options and systems) resulting in: Improved quality of life
13) Mobility options (both individual options and systems) resulting in: Improved economic indicators
14) Mobility options (both individual options and systems) resulting in: Improved environmental quality
15) Mobility options (both individual options and systems) resulting in: Improved safety and security
16) Mobility options (both individual options and systems) resulting in: Increased innovation opportunities across a wider range (base of pyramid)
17) Mobility options (both individual options and systems) resulting in: Increased business opportunities across a wider range (base of Pyramid)

## Appendix F: Summary List Round One (Question 1)

1. What do you consider will be the most important developments in urban mobility in the coming 20 years?
   1) Mobility as a Service (MaaS) will make use of an increasing amount of available data and technology
   2) Mobility as a Service (self driving cars and shared services) enabled by technology and new business models
   3) Autonomous vehicles for short and long distance public mass transport
   4) Driverless cars and car sharing concepts will free up space currently used for parking
   5) The limitation of car access to city centres will improve the position of cyclists, pedestrians and public transport
   6) The combination of smaller cars, no heavy trucks and lower speeds lead to higher capacity, easier crossings for pedestrians (single lane) and less injuries
   7) Public opinion will lead to lower speeds of car traffic
   8) Shift towards public transport
   9) Slow modes of mobility (cycling, walking)
   10) Communication based mobility
   11) Rise of the Information and Communication Technology (due to inter-networking of physical devices)
   12) Pollution free travel
   13) Electrification of all forms of public and private transport leading to less pollution
   14) Electrification of all forms of transport will benefit the development of smart grids and energy storage solution
   15) Increasing urbanisation
   16) Increase in elderly people with specific mobility needs
   17) Multi-stakeholder alliances and new governance models / public-private innovation
   18) New policy models (more nimble frameworks enabled by technology and diverse leadership eco-systems)
   19) New cultures of mobility
   20) New cultural preferences and expectations
   21) Fluidity across moving people, moving goods, and moving less
   22) Traffic lights will be replaced by smaller scale infrastructure
   23) Congestion
   24) Increase in travel costs
   25) The collapse of private vehicles ownership in mature economies, and the rising ownership in emerging countries, goes hand in hand with new way of thinking urban logistics
   26) Understanding of transport as access
   27) Mass rapid transport
   28) High speed trains will improve to cover more distances in less time.

## Appendix G: Summary List Round One (Question 2)

2. Which developments in urban mobility will arise due to technology-related social exclusion?
1) People will be excluded from mobility and employment due to lack of technological skills
2) Cashless payment in public transport might limit travel of people who struggle with modern technology
3) Seniors not having access to mobility or health care due to lack of technological skill
4) Technology related social exclusion will lead to greater traffic problems due to insufficient information on appropriate journey times and schedules.
5) Expensive facilities (parking, taxi) will only be accessible to privileged
6) Sharing concepts will first only be accessible to middle and upper classes, while lower classes in the mid-term will be excluded from these forms of mobility
7) Privacy-minded people will be hesitant to embrace data-driven developments, e.g. mobility as a service
8) People suffering from technology related social exclusion will have to bear financial, social and psychological costs
9) People not being able to get around to meet basic needs
10) People not being able to get to their jobs
11) People not receiving products/things
12) Increased polarity/disparity of having access to mobility leads to increased dissatisfaction and unrest
13) Increased polarity/disparity of having access to mobility leads to increased enforcement and social costs
14) Increasing need for personal travel coaching
15) Fewer jobs being available as automation takes over
16) Technological exclusion could be transformed into social inclusion if appropriate policies, programs, infrastructures, innovation and economic and business incentives are present
17) Public sector, civil society and industry have the responsibility to work together to ensure transport accessibility for all who need it in the future
18) While the degree of connectivity will increase due to information technology, a small group will stay depend on 'old' school info (e.g. bus timetables, service counters)

## Appendix H: Summary List Round One (Question 3)

3. Which developments in urban mobility will arise due to technology-related social inclusion?
1) Driverless cars (for those with no driving licence)
2) New travel concepts will emerge (smart travel, shared travel, car pooling, community concepts)
3) Mobility as a service
4) Slow modes of mobility
5) More people friendly infrastructure
6) Vehicle ownership will become more complex, which in turn will bring forward independent/coordinated mobility (more socially inclusive)
7) New mobility options will result in increased innovation opportunities across a wider range
8) New mobility options will result in increased business opportunities across a wider range
9) Mobility as a service will make the customer journed more attractive for all participants
10) New mobility options will result in improved quality of life
11) New mobility options will result in increased safety and security
12) In emerging countries, the access to motorized mobility will offer greater opportunity to reach further destinations
13) New mobility options will result in improved economic indicators
14) New mobility options will result in improved environmental quality
15) Price for public transport will depend on people's financial income
16) Real-time travel information
17) 'Trusted small scale information systems' will provide people with trusted and customized information

## Appendix I: Summary List Round Two (Question 1)

1. What do you consider will be the most important developments in urban mobility in the coming 20 years?
   1) Mobility as a Service (MaaS) will make use of an increasing amount of available data and technology
   2) Mobility as a Service (self-driving cars and shared services) enabled by technology and new business models
   3) Autonomous vehicles for short and long distance public mass transport
   4) Driverless cars and car sharing concepts will free up space currently used for parking
   5) The limitation of car access to city centres will improve the position of cyclists, pedestrians and public transport
   6) Shift towards public transport
   7) Slow modes of mobility (cycling, walking)
   8) Communication based mobility
   9) Highly reduced or zero carbon emission vehicles for both private and public transport
   10) Electrification of all forms of public and private transport leading to less pollution
   11) Electrification of all forms of transport will benefit the development of smart grids and energy storage solution
   12) Increasing urbanisation
   13) Increase in elderly people with specific mobility needs
   14) Emergence of multi-stakeholder alliances and new governance models / public-private innovation
   15) New policy models (more nimble frameworks enabled by technology and diverse leadership eco-systems)
   16) New cultures of mobility
   17) New cultural preferences and expectations
   18) Fluidity across moving people, moving goods, and moving less
   19) Congestion
   20) The collapse of private vehicles ownership in mature economies, and the rising ownership in emerging countries, goes hand in hand with new way of thinking urban logistics
   21) Understanding of transport as access
   22) High speed trains will improve to cover more distances in less time.
   23) Free mobility for children
   24) Increase in parking charges
   25) Higher taxes on pollution-oriented mobility
   26) Separate comfortable systems for rich and 'important' people and infrastructure for 'the rest'.
   27) Climate driven 'hackers' will confront travelers with their personal eco-footprint. These public lists will speed up public discussions and decisions about eco taxes.

## Appendix J: Summary List Round Two (Question 2)

2. Which developments in urban mobility will arise due to technology-related social exclusion?
1) People will be excluded from mobility and employment due to lack of technological skills
2) Cashless payment in public transport might limit travel of people who struggle with modern technology
3) Technology related social exclusion will lead to greater traffic problems due to insufficient information on appropriate journey times and schedules.
4) Expensive facilities (parking, taxi) will only be accessible to privileged people
5) Sharing concepts will first only be accessible to middle and upper classes, while lower classes in the mid-term will be excluded from these forms of mobility.
6) Privacy-minded people might be hesitant to embrace data-driven developments, such as mobility as a service
7) People suffering from technology related social exclusion will have to bear financial, social and psychological costs
8) People not being able to get around to meet basic needs
9) People not being able to get to their jobs
10) People not receiving products/things
11) Increased polarity/disparity of having access to mobility leads to increased dissatisfaction and unrest
12) Increased polarity/disparity of having access to mobility leads to increased enforcement and social costs
13) Increasing need for personal travel coaching
14) Fewer jobs being available as automation takes over
15) Technological exclusion could be transformed into social inclusion if appropriate policies, programs, infrastructures, innovation and economic and business incentives are present
16) Public sector, civil society and industry have the responsibility to work together to ensure transport accessibility for all who need it in the future
17) While the degree of connectivity will increase due to information technology, a small group will stay depend on 'old' school info (e.g. like bus timetables, service counters)

**Appendix K: Summary List Round Two (Question 3)**

3. Which developments in urban mobility will arise due to technology-related social inclusion?
1) Driverless cars (for those with no driving licence)
2) New travel concepts will emerge (smart travel, shared travel, car pooling, community concepts)
3) Mobility as a service
4) More people friendly infrastructure
5) Vehicle ownership will become more complex, which in turn will bring forward independent/coordinated mobility (more socially inclusive)
6) New mobility options will result in increased innovation opportunities across a wider range
7) New mobility options will result in increased business opportunities across a wider range
8) Mobility as a service will make the customer journed more attractive for all participants
9) New mobility options will result in improved quality of life
10) New mobility options will result in increased safety and security
11) In emerging countries, the access to motorized mobility will offer greater opportunity to reach further destinations.
12) New mobility options will result in improved economic indicators
13) New mobility options will result in improved environmental quality
14) Price for public transport will depend on people's financial income
15) Real-time travel information
16) Personalized information and introduction of feedback loops
17) 'Trusted small scale information systems' will provide people with trusted and customized information.

## Appendix L: Follow-Up Evaluation Questionnaire

Dear X,

First of all, I would like to thank you very much for participating in this study and returning all questionnaire. Your participation was very much appreciated and greatly contributed to this research.

Please find below a Follow-Up Evaluation Questionnaire. The goal of this questionnaire is to obtain your comments concerning the potential you saw in the Delphi Technique in predicting the future of urban mobility.

Please answer to the following questions.

1. To what extend do you agree with the results?
2. To what degree have your views about the future of urban mobility developments changed while participating in this study?
3. Did you face any major problems when responding to the questionnaires?
4. If you have any additional comments, please put them here.

Thank you for answering to these questions and sending them back to me via email.

Best,
Nathalie