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# School for Transportation Sciences

## Master of Transportation Sciences

***Masterthesis***

***Mobility as a Service: segmenting preferences for transport usership***

**Damian Glenn Robinson**

Thesis presented in fulfillment of the requirements for the degree of Master of Transportation Sciences, specialization Mobility Management

**SUPERVISOR :**
Prof. dr. Davy JANSSENS

**CO-SUPERVISOR :**
prof. dr. An NEVEN

**2017**
**2018**

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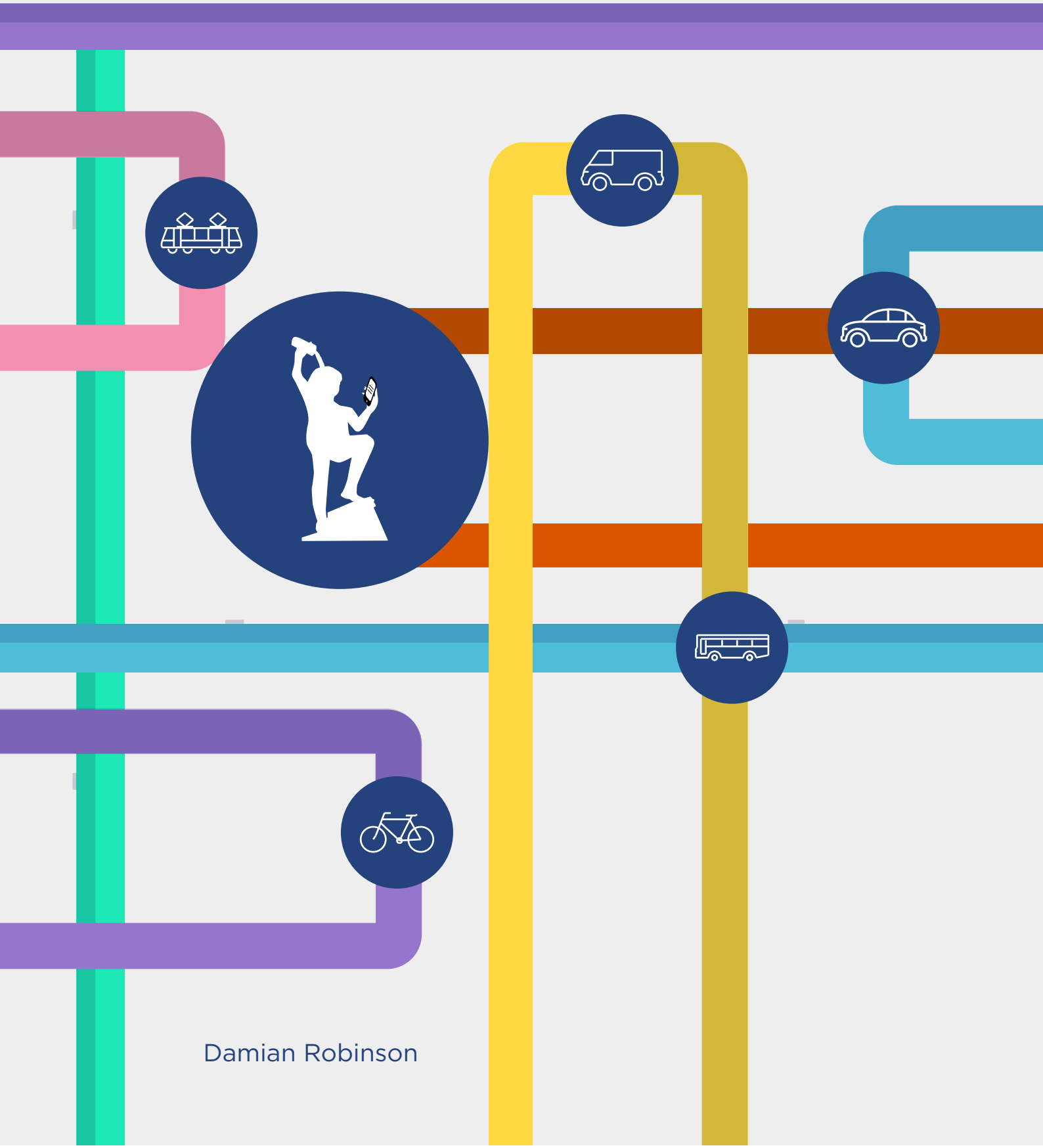

Damian Robinson

# Foreword and acknowledgements

I chose to purse this thesis topic, despite the hurdles and setbacks, because I am curious about the new innovations that will disrupt and change the personal mobility system in way that is more efficient and sustainable, but most importantly more personalised to individual needs and choices.

There are many upcoming trends in mobility that will break the mould, some realised, and others conceptualised. With this thesis I aim to put a critical and insightful research into MaaS, to better understand its reception towards the public. Moreover, I would like to apply my curiosity of mobility preferences by taking into consideration the diversity of attitudes and behaviours towards individualised and shared mobility.

The dominant theme in policy literature emphasises shared services, and however, I seek also consider and understand the reception towards more individualised and longer-term possession of transport modes. I seek to better understand factors that account for its curiosity and favourability and community this in accessible terms and descriptions to a wider audience. The end goal is to advance my knowledge in this rapidly growing field and apply it in in whatever way I can.

With the submission of my thesis I have finalised the final step to graduate from Master Transportation Sciences at Hasselt University, Belgium. I thank my family and friends for all the encouragement and practical support. I cannot image reaching to this stage would have been possible without them.

I want to thank my family back home, to Mummy and Roger in trying their best to give their support. Most importantly I thank my uncle Nicholas for his practical but most critical support that enabled me to begin my studies again. I am deeply grateful and will be forever thankful for you and Carolyn's faith in my potential in this academic pursuit. Taking the leap to end up in Belgium (again) was the first step.

Ik wil de familie aan deze kant van de oceaan hartelijk bedanken: Vincent, Klaartje en Jorg voor hun onschatbare aanmoediging en steun. Ik ben ook dankbaar voor het zorgvuldige proeflezen van mijn enquêtes die iedereen soms een beetje gek maakte.

The progress I've made on my thesis wouldn't been possible without the 25 people who tested survey and the 111 persons from Leuven who completed the final survey. I thank them also for their insightful comments, after they took their valuable time (collectively 41 hours) in filling my survey. I also deeply thank suggestions from Katrien Declercq and Felipe in developing my approach for my statistical analysis. I also thank Joshua for his creativity in designing the cover illustration. I can't forget my friends Manuel, Nora, and Bart for the encouragement to get to where I am today.

I thank Prof An Neven, my supervisor, who introduced me to the concept of the integrated mobility platform of Mobility as a Service (MaaS), and allowed me to better ground many originally incoherent ideas of inter- and multimodality in to one overarching and workable concept. Though it still took a lot of effort to make sense of MaaS in a clearer way. I extend my gratitude to both my supervisor Prof Neven, and promoter, Prof Davy Janssens', careful and throughout examination of this report and my upcoming presentation in their evaluation.

# Summary


### *Background and problem*

The urban mobility system as we know it, is on the verge of a major transformation as more innovative transport solutions are emerging. Mobility as a Service (or MaaS) is one such transport solution where the end-user gains access to mobility (in form of services) instead of investing in vehicle ownership or separate transport means. Furthermore, the traditional services of public transportation are complemented with shared mobility services that allow for flexible intermodal travel. In this thesis, available literature is first reviewed with respect to the different subdomains of MaaS (end-user features, integration levels, business ecosystems and available transport services). The literature review showed that end-user preferences and behavioural impact from a more holistic consideration of diverse transport services are understudied.

### *Research objectives and approach*

A broader framework of transport services and underlying business models within the MaaS paradigm was developed from a review of literature. This lead to the formulation of research questions that dealt with (1) the type of transport services that may enable transport usership; (2) understanding how varying concepts of 'ride providing' and 'vehicle providing' services influence preferences; (3) investigating if the type of 'vehicle providing' service in terms of free-floating and stations systems influences MaaS and usership favourability; (4) studying the preferences to the type of vehicles and the duration service model (shorter vs longer term possession) influences MaaS and usership favourability; (5) investigating the preference for MaaS influenced on pre-bundled mobility packages compared to a pay-peruse service model; and lastly (6) defining end-user preferences for the provider of a MaaS platform.

The chosen research design involves the design of an online survey that asks for socioeconomic attributes, as well as attitudinal evaluations of new mobility concepts and questions that determines one's mobility type. Mobility type attitudinal evaluations then allowed for a clustering approach to be done and segments individuals into predefined groups. A survey instrument was designed tested among a diverse group of individuals and a final survey was targeted among adults living in Leuven, Belgium. Respondents completed 111 surveys that was used to support the analysis and discussion. A limitation of the study was the lack of responses and issues determining relationships between variables.

### *Results and conclusions*

The results from the segmentation provided arguably distinct preferences towards MaaS in general and individual services. Segments that may have the most potential for MaaS providers and new mobility services include Image Improvers, Active Aspirers, and Car-free Choosers. A follow up survey for a self-assessment of assigned segments and they agreed to their profiles in some way by 60% of those second survey takers. Segmentation should be considered in public policy to better forecast and prepare the rapidly changing mobility sector with more diverse with new mobility services. The dichotomy between two groups of car owners and drivers and public transport users is being replaced by multimodal travel behaviour by the increasing use of active modes, namely cycling, flexible vehicle access business models (e.g. contract free car and bike leases, short-term use car and bike sharing), and on demand ride sharing, flexible route micro-transit, and private taxi rides. With the diversity of new options, it the potential to reveal new insights is large.

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# 1 Introduction: the research problem

The basis and the aim of this thesis -which focuses on Mobility as a Service (MaaS)- is laid out in this chapter. Firstly (in subchapter 1.1), the introduction to MaaS provides a context to the research problem (subsection 1.2) and its significance. Subsequently, in subsection 1.3 the thesis aim- and research objectives are addressed. The last subsection (1.4) provides an overview of subsequent chapters.

## 1.1 Mobility services like MaaS change the landscape of urban transportation

The urban mobility system is on the verge of a major transition described as the "next paradigm change in transportation" (Giesecke, Surakka, & Hakonen, 2016). To address the growing traffic congestion with its hazardous environmental effects there are increasingly efficient and **innovative transport solutions becoming available that are offered as a service** as they manage both mobility demand and supply for various means of travel (Feigon & Murphy, 2016). Furthermore, the traditional services of public transportation are complemented by shared mobility services that allow for flexible intermodal travel (Hildebrandt et al., 2015).

These advances are now encapsulated with the catchphrase "**Mobility as a Service" (MaaS)**. The term MaaS only first appeared in published material from Hietanen (2014) when referred as an integrator of transport services. MaaS is defined as the "**integration of transport services into a single mobility service**" (MaaS Alliance, 2017). People use the service through an **integrated digital mobility service** platform allowing travellers to plan and undertake flexible travel using integrated transport services, as illustrated in Figure 1 (Jittrapirom et al., 2017; Kamargianni, Li, Matyas, & Schäfer, 2016). According to Aapaoja, Eckhardt, & Nykänen (2017) MaaS "can be defined and approached from many different points of view, since it is still emerging".

MaaS is described to make transport mode ownership, particularly for cars, redundant because of the idealised concept being able to efficiently connect a diversity of transport services through a single and digitised service platform (Hietanen, 2014). This is said to be made possible because of recent advances in digitalization and interconnectedness of transport systems that aims for an end-user oriented approach based on service personalisation and customisation (Aapaoja et al., 2017), made possible by a single and digitised service platform, for which MaaS aspires to be (Hietanen, 2014).

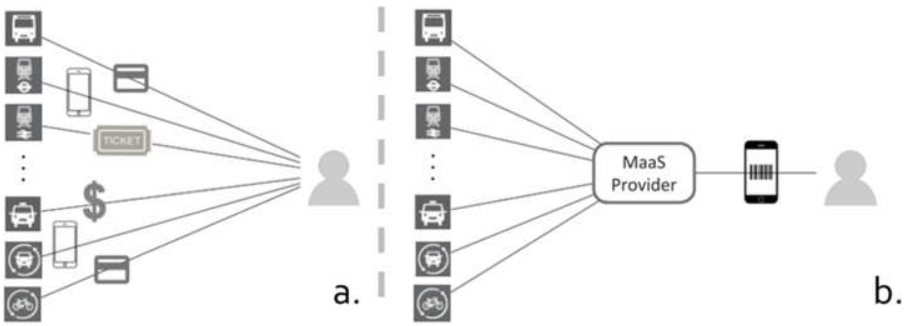



**Figure 1 – Travel planning and execution without (a) and with (b) MaaS (Matyas & Kamargianni, 2017)**

Transport- or mobility services include public transport (PT), car rentals, car sharing, and bike sharing systems. However, digitally connected, and personalised mobility services are emerging around the world. They integrate current mobility services, for example multi-operator PT networks and car

and bike sharing systems. More recently there are services that digitally supply vehicles based on demand, such as ride-hailing, shared taxis or micro-transit minibuses (Mulley & Nelson, 2009).

## 1.2 Defining the research problem: mobility services within MaaS

In current literature, it is argued that there is an insufficient focus on the potential change in travel behaviour that MaaS can have in relation to mobility services. Therefore, a broader view towards a more diverse and innovative slate of transport services is lacking, as described by Giesecke et al. (2016) and Kamargianni (2016). Travel behaviour is defined as the action and the means taken (including trip frequency, distances, and modal or transport service choice) when travelling (Haustein & Hunecke, 2013). Although a full comprehensive literature review is provided in chapter 2, there are five studies that in some way or another that researched MaaS through the preferred scope (end-user behaviour in relation to transportation services) and therefore will be summarised as follows.

Firstly, Mayas and Kamargianni (2017) investigated the impact of MaaS on travel behaviour for a hypothetical MaaS offer in London. They generally stated that research investigating the behavioural response from MaaS should include all available mobility services. However, they limited their survey only to existing transport modes in the city. In addition to the London study, Ho, Hensher, Mulley, & Wong (2017) pursued a similar methodology in Sydney (that is defined in detail in the literature review chapter). However, currently available transport services for the city (*except* for car sharing services) were described in a hypothetical scenario to better account for "future service possibilities" (Ho et al., 2017). Their development of a hypothetical transport service provides motivation for this study to investigate transport services that are not currently available.

Similar to the Sydney study, the International Transport Forum's (ITF, 2017) carried out a hypothetical service within the MaaS framework in Helsinki. Their investigation was based on a survey of travel choices of ride-hailing services in combination with rail based PT. Electronic ride-hailing is the demand responsive hiring of vehicles with a driver used by a single passenger or multiple passengers, much like a taxi service organised via a digital interface (Shaheen, Cohen, & Zohdy, 2016). However, apart from PT, they limited other transport services meaning that transport services such as bike sharing systems and individual use ride-hailed taxis use were not considered.

Other MaaS studies that focused on the available transport services of a city included an attitudinal survey in London that only considered car-sharing in the context of shared mobility services together with PT (Kamargianni, Matyas, Li, & Muscat, 2018). This approach is also evident in the only published findings from the MaaS pilot in Gothenburg that only tested the potential behavioural impact on already publicly available transport services (Karlsson, Sochor, & Strömberg, 2016; Sochor, Strömberg, & Karlsson, 2015b).

In conclusion, even though MaaS aims for a platform facilitating the integration of travel modes and services for flexible door-to-door travel, a deeper investigation on "future service possibilities" should be a worthwhile approach. Based on the limited literature available for this emerging topic a comprehensive consideration and framework was not evident. With this in regard, the research problem is defined as:

**There is gap of academic knowledge about the preference of MaaS based on a framework of transport services by possible end-users based on individual factors.**

### 1.2.1 Significance of resolving the research problem

The results this master thesis will generally contribute to the "small but growing academic literature specific of MaaS" (Ho et al., 2017). More practically, understanding MaaS in terms of the individual transport services that it may offer could better guide public policy and MaaS business models. Further, the gathered knowledge can add to the potential of the MaaS framework to be a platform for new and innovative mobility services to contend with each other competitively (Van Audenhove, Koriichuk, Dauby, & Pourbarx, 2014).

The impact on travel behaviour could be even more significant when new or more convenient and cost-effective mobility services become available through a MaaS platform (Kamargianni & Matyas, 2017). As a result, there is a potential to gain knowledge of the impact of novel transport services on travel behaviour. There are already new transport services, such as on demand taxis and shuttles and shared fleets of bikes and cars, that are increasingly publicly available in cities around the world that challenge (or even disrupt) traditional services.

The possible disruption in the transportation sector would be even more evident when autonomous vehicles (AV) becomes publicly available, and where this technology is said to be the greatest source to a significant change in the mobility system and behaviour (Hensher, 2017; Sprei, 2017). New AV technology may threaten sustainable mobility and urban planning goals as articulated by a group of sustainable mobility advocacy groups already to posit that on-demand AVs operating in urban areas should only be in "shared fleets" (SharedMobilityPrinciples.org, 2017).

This was also expressed by the network of European cities and regions (Polis) that more research is needed to investigate the behavioural impact of MaaS (Polis, 2017). More importantly the impact of more innovative services termed new mobility services (NMS) (Schade, Krail, & Kühn, 2014) could also be investigated within this framework. Further, understanding the impact on behaviour from the MaaS platform can pose a question on how MaaS, as an integrator of mobility services and a facilitator of multimodal sustainable travel, can compete with monomodal private AV fleets dubbed as Car as a Service (Heinkel, 2016).

Researching MaaS in terms of travel behaviour produces a solid basis to guide public policy and MaaS business strategies. Moreover, this approach importantly provides novel insights into the impact of transport service patronage through a MaaS platform. In terms of public policy, certain types of emerging transport services may challenge urban mobility policy goals by advocacy groups and governments that focuses more on shared mobility as opposed to individually used vehicles (Feigon & Murphy, 2016).

## 1.3 Research aim and objectives

In the review of the studies above, a comprehensive and systematic approach to base the inclusion of individual transport services was not apparent. Innovative new mobility services delivered through a MaaS end-user platform may influence travel behaviour in ways not yet fully understood. With the justification that the behavioural impact of MaaS is understudied in relation to a comprehensive framework of transport services, the *aim of this study* is defined as:

**Investigating Mobility as a Service within comprehensive framework of transport services.**

The goal of defining research objectives (RO) at this stage is to provide a guide for the development of the literature review presented in the following chapter, pursuant to the aim of the

study. A study that aims to more comprehensively investigate mobility services within MaaS will first have to designate the scope of both individual mobility services and a MaaS platform. Thus, the first research objective is stated to investigate **how MaaS will be delivered to end-users**:

*RO1: Defining Mobility as a Service from the perspective of the end-user.*

As described in the problem statement, the impact of new mobility services on mobility behaviour could be better related **to the influence of traditional mobility services (e.g. PT), new mobility services (NMS), and the ownership of transport modes** (e.g. cars and bikes). With these considerations the *scope* of the thesis is set, which defines the inclusion criterion of mobility services eligible for review:

*RO2: Developing a framework of publicly available transport services.*

The potential impact of MaaS and mobility services on travel behaviour would depend on **personal factors of individuals in relation to the idea of MaaS and individual services**. In other words, personal attributes may dictate preferences to mobility services and a willingness to forgo transport ownership within MaaS. Moreover, individual may be generalised into groups that share common significant attributes. Therefore, a research design based on the concept of investigation, i.e. the end-user and segmented preferences, of MaaS and mobility services, will also have to be characterized:

*RO3: Developing a research design that combines a MaaS and transport service framework to explain preferences based on factors specific to the individual.*

## 1.4 Thesis approach and structure

The previous subsections provide a basis in defining the research aim and objectives. This guides the literature review on the following page (chapter 2) that aims to objectively summarise relevant literature in relation to the three ROs that leads to the formulation of research questions and a research design. Chapter three is the methodology and aims to facilitate the research questions derived from the analysis of chapter two in relation to the case city study and sample population. In the final chapter conclusions of the thesis part 1 will be given. Figure 2 provides an overview report sections.

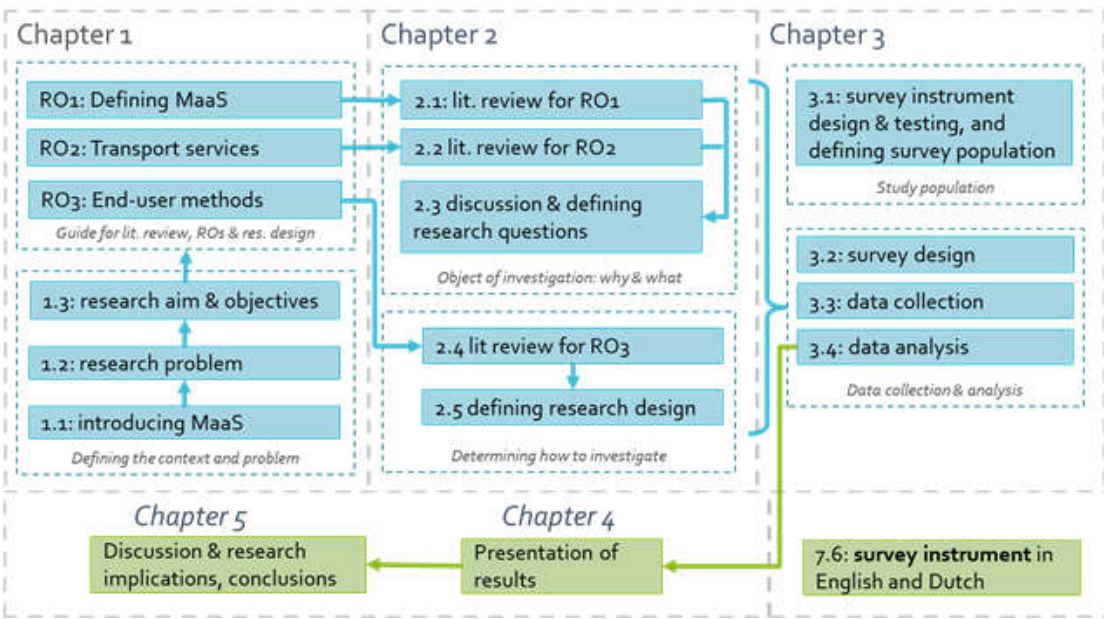



Figure 2 - Thesis chapter structure

# 2 Literature review & research framework

In this chapter the theoretical and methodological aspects of recent literature are reviewed in meeting research objectives that were previously defined. The first two subsections (2.1-2.2) cater for the research objectives RO1-RO2, dealing with MaaS and transport services respectively. The third subsection (2.3) provides a discussion and outlays an investigative framework on the topic of investigation (MaaS and transport services) that produces research questions. The chapter continues with subsection 2.4 that reviews methodological approaches that seeks to resolve the research questions defined. Following the review of methods used in current research, this chapter is concluded by discussing and defining the research design of this thesis.

## 2.1 Mobility as a Service: its development and frameworks

Defining Mobility as a Service (MaaS) as offered to end-users may prove to be a challenge as conflicting definitions of MaaS are used (Giesecke et al., 2016). The aim of this subchapter is to review recent literature to clarify RO1 and gain further understanding of the MaaS definition, its development as well as other terms which describe integrated mobility (subsection 2.1.1). Secondly (2.1.2), MaaS will also be conceptualised as a service model ecosystem, instead of as a single end-user focused definition, which considers underlying business models of the concept (2.1.3).

### 2.1.1 Transport service integration platforms: an old and new story

#### MaaS and the development of integrated mobility

The notion of travellers relying on various transport services for their mobility needs is not a new one (Schuppan, Kettner, Delatte, & Schwedes, 2014). This is especially the case when considering the first or last-mile accessibility problems of public transportation networks (Tilahun, Thakuriah, Li, & Keita, 2016). For example, local authorities have developed 'park and ride' (P+R) facilities that allow people to park their cars or bikes to take PT (Gan, 2015). Increasingly, travel information has become digitised and available on smartphones for real-time planning and routing information for various modes of transport (Kramers, 2014).

An interesting parallel of the MaaS service model is the role of a mobility manager (Mulley, 2017), long described by the (US Department of Transportation, 1991):

> *"The 'Mobility Manager' is a mechanism for creating a market for local transportation by matching the preferences of users with service suppliers, (…) providing a clearinghouse for individual and organisational financial transactions. (…) The Mobility Manager accomplishes its goals by linking together all travel (…) at an informational level and, in most cases, at a transactional level as well."*

The mobility manager concept provides a useful reference on how MaaS could be described. Recent technological developments have automated the mobility manager as a professional manual service into a digital platform that is provided 'as a service'. The 'as-a-Service' paradigm first emerged in the information technology (IT) domain. It allowed companies to have access software and IT infrastructure as a service accessed through so called cloud based solutions without having the product installed on their premises (Kiblawi & Khalifeh, 2015). Based on an in-depth review (as of May 2018) from online academic search-engines, the first MaaS reference described individual services that detached users from the need of private car ownership through car sharing (Meurer, 2001; Weiller & Neely, 2013).

The digitally integrated mobility service paradigm of MaaS only emerged in 2014 in a professional transport magazine (Hietanen, 2014) and then in academic research, from peer-reviewed journals and conference articles from the year 2015 onwards. According to Canzler & Knie's (2016) definition of an integrated mobility service is also limited and vague. However, literature that describes the concept of end-user mobility integration platforms has been long termed as a '*combined mobility platform*' (Lane & McGuire, 2015; UITP, 2011a), a '*mobility broker'* (Sochor, Karlsson, & Strömberg, 2016) and a '*one-stop-shop mobility service provider*'(Schade et al., 2014).

Similar to MaaS, the term 'Transportation as a Service' (TaaS) is also referred to in literature and focuses on mobility through car-sharing services and personal or postulated shared AV demand-responsive services without car ownership of the vehicle (Arbib & Seba, 2017; Cusumano, 2014). This shift from vehicle ownership to using a shared fleet of vehicles can be termed as 'usership' (Wittmann, 2013).

In addition to digitally integrated handheld travel information for multimodal (providing specific travel alternatives) and intermodal (combing travel modes for a specific trip) journeys (e.g. Google Maps) (Mulley, 2017), MaaS, aims to integrate billing and service bundling. MaaS realises – beyond providing advanced travel information – the "convergence of various technologies" (Sprei, 2017). This means that the increasingly diverse slate of new mobility services that can be adaptive to demand and are digitally integrated (Canzler & Knie, 2016).

### MaaS' benefits as an integrated mobility service

MaaS streamlines access to a variety of mobility services. The benefit to the end user is an amelioration of transaction costs. Transaction costs are the cost in effort, time, and money incurred in overcoming inefficiencies in market transaction and these costs are especially evident when planning and executing travel using separate mobility services (Canzler & Knie, 2016; Transport Systems Catapult, 2016). A major theme in MaaS is that the billing for the individual use of mobility services is done into a single account, either through mobility service bundles based on 'pay as you go' or subscription packages (Jittrapirom et al., 2017; Kamargianni et al., 2016).

By minimising the transaction costs, the MaaS concept is said to inherently recognise the theory of the disutility of travel (reference). This theory states that the end goal for the traveller is to reach the destination by reducing the disutility incurred by the traveller (Mulley, 2017). Since MaaS provides multimodal and intermodal travel alternatives, it reduces the disutility by diminishing the transaction costs of journey.

MaaS provides travellers with real time travel information, seamless (without having to purchase individual tickets) mode access and can therefore efficiently plan, evaluate, and perform a journey based on personal preferences such as available time, convenience, and budget (Figure 3.a) (Giesecke et al., 2016; Jonuschat, Stephan, & Schelewsky, 2015). MaaS can also facilitate diverse travel behaviours since travellers can consider transport alternatives for multimodal travel, or by combining travel modes for intermodal journeys (Figure 3.b) (Ambrosino, Nelson, Boero, & Pettinelli, 2016; Willing, Brandt, & Neumann, 2017) by facilitating multimodal travel centred on end-user choice that balances cost and convenience.

Dacko & Spalteholz (2014) investigated the behavioural impact of better access sustainable mobility by an integrated information and for diverse transport modes. They highlighted that car drivers are willing to adopt a non-car ownership lifestyle once they are bestowed with reliable information and

**increasing travel mode variability** beyond traditional public transport that reduces the perceived lack of control without a car being at their full disposal.

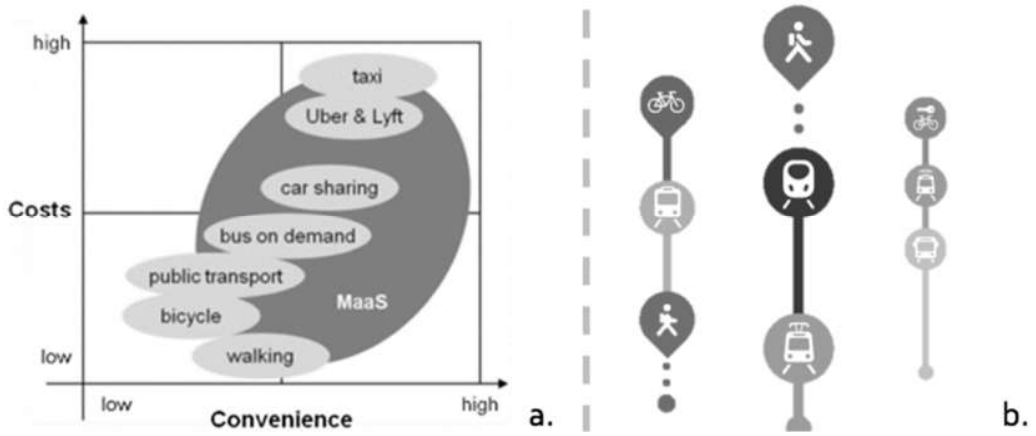



Figure 3 – a. the MaaS framework balancing user circumstances of cost and convenience (Giesecke et al., 2016); b. intermodal travel combining various travel modes (Qixxit, 2016)

### 2.1.2 Interdomain frameworks for MaaS: CHIPs and the ecosystem

Until now MaaS has been described in relation to how an end-user, the traveller, can benefit from such a service. However, beyond the traveller, MaaS is understood in **broader terms** for what brings together different domains **(i.e. interdomain frameworks**) (Kamargianni & Matyas, 2017; Sumantran, Fine, & Gonsalvez, 2017; Transport Systems Catapult, 2016).

One such framework describes the enabling factors of MaaS as a "**connected, heterogeneous, intelligent, and personalized architecture (CHIP)"** (Sumantran et al., 2017). A *connected* system links physical infrastructure (i.e. vehicles) with digital tools that allows access to *heterogeneous* mobility options. The system is *intelligent* insofar as delivering a *personalised* mobility experience to an end-user. The CHIP framework is shown in Figure 4 on the next page.

On the other hand, Matyas & Kamargianni (2017) describe the framework as an ecosystem that encompasses **overlapping and interconnected domains: business, technology, end users, and policy**, which mirrors the framework in the report from Transport Systems Catapult (2016). These domains are overviewed in Figure 5 (also on the next page) that outlines various elements for each of the four MaaS themes that interface at different levels. At the centre (of the figure) is the end-user who interacts with the technology (second level) and rests on the various business models (third level) which in turn is based on a policy (fourth level).

#### End-user service features and technology

Based on an analysis of 15 MaaS schemes Kamargianni et al. (Kamargianni et al., 2016) defined components of an end-user MaaS platform based on levels of travel mode integration and digitalisation:

i. ICT integration for a digital traveller assistant (i.e. travel information),
ii. ticket integration for seamless access to a heterogeneous transport service supply,
iii. payment integration enabling hindrance free access through electronic tickets, and
iv. mobility subscription packages for bundled allowances transport mode access.

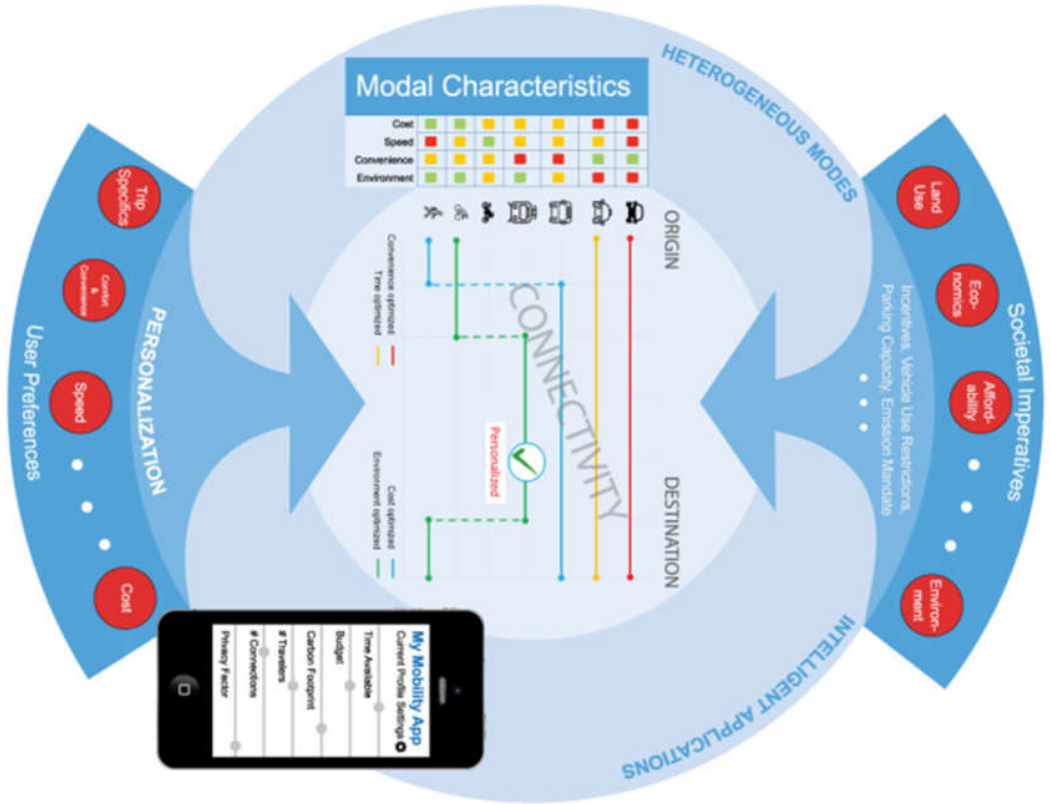



Figure 4 – The connected, heterogenous, intelligent, and personalised framework (Sumantran et al., 2017)

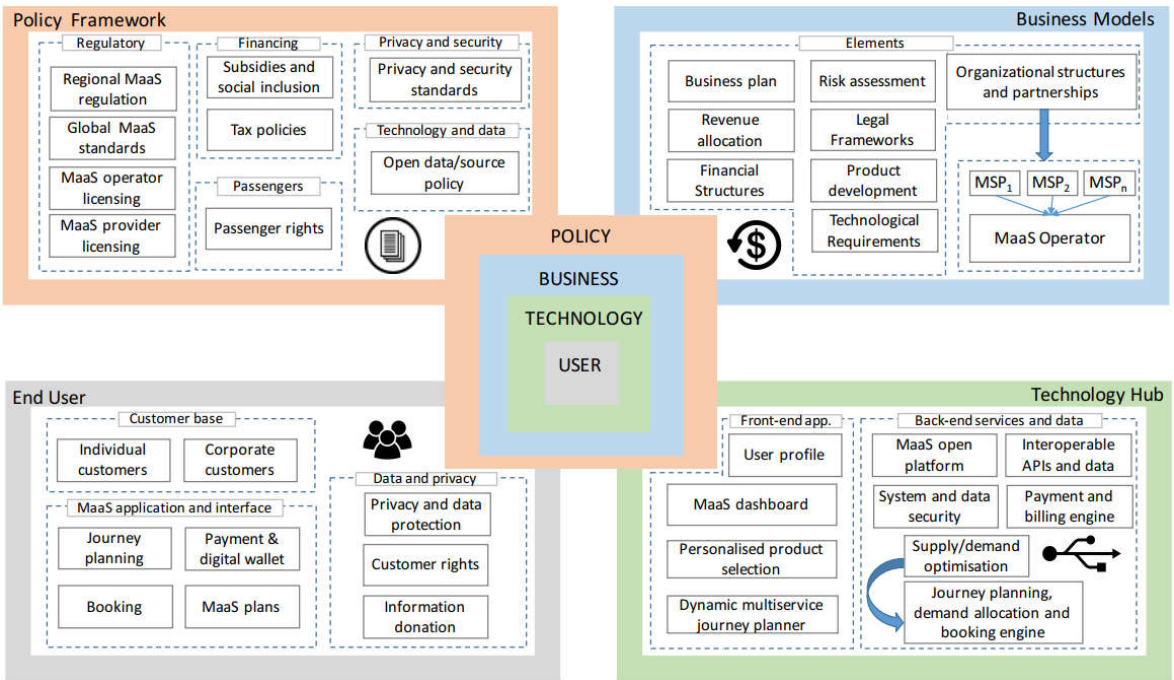



Figure 5 – Mobility as a Service ecosystem framework sourced from Matyas & Kamargianni (2017)

The features above are shown on the first column of Table 1 (next page) that describes these features (second column). Specific examples of MaaS schemes with their scores (overall minimum of 2 and a maximum of 10) are shown on the table. The total **score was based on five components** as presented in each scheme. The score is derived from firstly a transport-mode integration sub-score that provides a point for each available transport mode. Secondly, **the score increases when an integration feature**, **as listed above, is present**.

Jittrapirom et al. (2017) also **classified the 'available functionalities'** in their overview of 12 MaaS schemes, but they did not use it to classify MaaS schemes. Instead, the authors defined functionalities in more detail such real-time information for PT delays, road congestion, and departure and transit stop notifications i.e. an alert to know when to board and depart a PT vehicle. Sochor, Karlsson, & Strömberg (2016) and Giesecke et al. (2016) also considered other features most notably the inclusion of a delivery and courier service, for example home delivered groceries, that allows people to avoid a journey to pick up something.

### MaaS integration levels

The ranking and rating of schemes by Kamargianni et al. (2016) was founded on a four-level Maas classification system based on the presence of features. A pattern was observed, and schemes were grouped together as follows (shown on column 3 in Table 1):

A. **"Partial integration":** when at least one feature is available: ticket integration and ICT integration; or when there are at least two features: integration of payment and travel information and ticketing and travel information
B. **"Advanced integration":** where transport modes are highly digitally integrated for multi-mode ticketing and access through a pay-for-use system that is facilitated through a journey planner.
C. **"Advanced integration *with a mobility package*":** that includes all the features above, but then includes a mobility package that bundles services to align to varying travel needs.

Also shown in Table 1 (column 4) are selected examples of MaaS systems that were reviewed by Kamargianni et al. (2016) and includes their ranking score. **The "Helsinki model" received the highest score with a maximum of ten**. This model, marketed as Whim, is currently publicly available in the said city as of late 2016 (Hensher, 2017). Whim promotes themselves as the first MaaS provider marketed (MaaS Global, 2017) and they offer various monthly subscription packages and a "pay as you go" option, that follows a pilot study in the city (Jäppinen, Toivonen, & Salonen, 2013).

The latter package of 'pay-per-use' (Jittrapirom et al., 2017) may be regarded as a service without a subscription, in line with Kamargianni's et al. (2016) middle-level 'advanced integration' classification. Figure 6 (pg. 11) is an example of promotional material for the different types of subscriptions. When Whim was launched in the city, the owners of the service observed that **people were reluctant to sign-up immediately to subscription** but instead opted for 'pay-as-you-go' option (ITS International, 2017). This experience from Whim in Helsinki lead to only initially introduce a 'pay-as-you-go' system for their launch in the West-Midlands of the UK.

Table 1 – MaaS integration features and classification of schemes with examples

<table>
<tr><th>1. Integration feature</th><th>2. Description of feature</th><th colspan="3">3. Classification scheme</th><th colspan="2">4. Examples of schemes their description</th></tr>
<tr><td>i. ICT integration</td><td>Traveller assistant (intermodal) journey planning</td><td rowspan="2">A. Partial integration<br>B. Advanced integration</td><td rowspan="3">C. Advanced integration with a mobility package</td><td rowspan="3"></td><td><u>ICT integration only i.e. diverse mode traveller information</u>: in the case of Qixxit (score = 2) in Germany and the TransitApp in the US travel information for multi and intermodal travel integrates travel modes and provide route, schedule, and wayfinding information though a web and mobile app.</td><td rowspan="2">Two features of (i) payment and travel information integration and (ii) Ticketing integration and travel information provides an example of Moovel (score = 3) in Germany.</td></tr>
<tr><td>ii. Ticket or mode access integration</td><td>Modes that can be accessed through a single ticket</td><td><u>Ticket integration only:</u> in the case of the STIB+Cambio (score = 4) in Brussels (Belgium) where PT and car sharing are accessible from a single contactless smartcard of MOBIB; however, ticketing, travel information, and subscriptions are not integrated.</td></tr>
<tr><td>iii. Payment integration</td><td>Travel costs are billed to a single account</td><td colspan="3">Advanced integration MaaS that includes ICT, ticket and payment integration features i.e. Jittrapirom’s et al. (2017) ‘one platform’): where transport modes options are highly diverse and are well integrated for seamless mode booking and access that is facilitated though a journey planner. A notable example is Hannovermobil mobility shop (score = 7) in Germany (UITP, 2014).</td></tr>
<tr><td>iv. Mobility subscription packages</td><td>Prearranged mobility packages that is fitting to users’ needs</td><td colspan="3">Advanced integration (and customisation) with a mobility package MaaS (all integrations features present):<br>(1) UBiGO (score = 9) in Gothenburg (Sweden) 6-month pilot with 195 participants for where study is documented across the various themes including user behavioural change, the mobility broker, transport service provides, and society (Karlsson et al., 2016; Sochor et al., 2016; Sochor, Strömberg, & Karlsson, 2015a).<br>(2) Through the “Helsinki Model” or Whim (score = 10) mobile app by MaaS Global that is available in Helsinki (Finland) (MaaS Global, 2017) that utilises “mobility currency” or points system to purchase mobility options outside package (Jittrapirom et al., 2017).</td></tr>
</table>

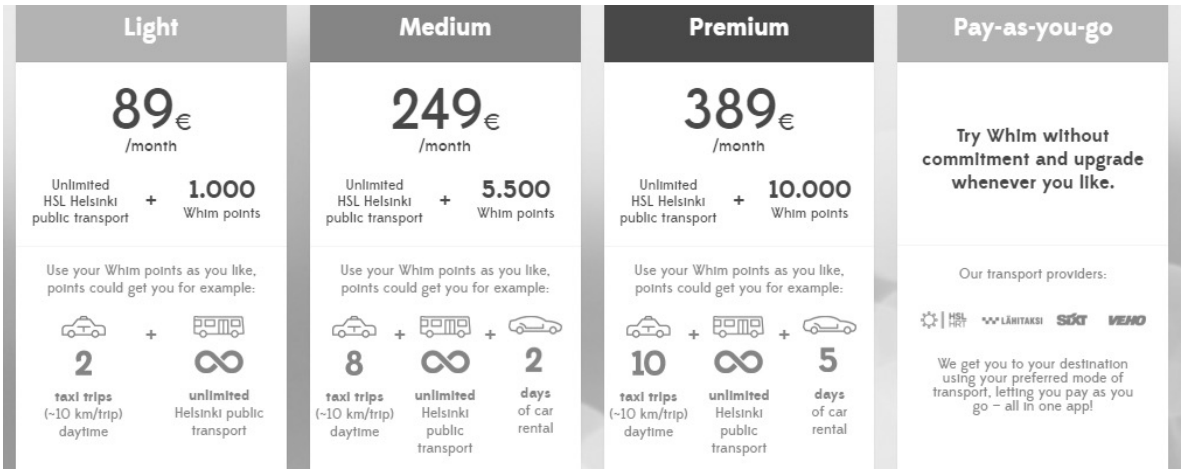


Figure 6 – An example of MaaS subscriptions for Helsinki, Finland (MaaS Global, 2017)

### MaaS business models and policy

MaaS integration features and levels in relation to the supporting technology domain were described in 2.1.2, and in this section the business models and policies that underpin MaaS' deployment is reviewed to complete the ecosystem as depicted in Figure 2. A business model represents the hallmarks, structure, and regulation of transactions designed to create value for the customers and the company (Amit & Zott, 2001).

A MaaS platform is supported by an underlying business model geared towards customers (business to customers – B2C) or companies (business to business – B2B) (Giesecke et al., 2016; Kamargianni & Matyas, 2017). B2B MaaS has developed in places where mobility employment benefits (e.g. PT cost reimbursement, company car and fuel card provisioning) are part of salary packages (Zijlstra & Vanoutrive, 2017).

MaaS schemes can also be defined as such, by their underlying business model. Kamargianni & Matyas (2017) regard higher integration levels of MaaS as a "*aggregator of third party services*" business model (Van Audenhove et al., 2014). Other business models by the authors include an "*integrator of own services*" and a "*single mode specialist*". An integrator of own services can be a mobility authority for a city or region that organises PT and shared mobility services. A single mode specialist can be a private company or PT service that creates an integrated transport package for other available transport services in an area.

An important business theme for MaaS is the possibility of separate MaaS operators or providers all competing for travellers by offering various types of mobility bundles and (integrated) features (Kamargianni & Matyas, 2017). Subscription and the bundling of MaaS packages are akin to how various companies provide bundles of home telecommunication (e.g. land/mobile telephone and internet) and entertainment television packages (Goodall, Dovey, Bornstein, & Bonthron, 2017; Ho et al., 2017).

According to the Polis report on MaaS regulation, there is a possibility of public authorities (e.g. PT operators, and city and regional authorities) to be the supplier of a MaaS platform that is centred on PT

(Polis, 2017). An example, reviewed from the MaaS schemes is Hannovermobil organised by the GVH (Großraum-Verkehr Hannover) Hannover's PT authority (UITP, 2014). PT or transportation authorities are governmental entities that organise transport services in their jurisdiction and are a possible driver of developing MaaS platforms according to the UITP (2017). The UITP is a global organisation for PT operators, authorities, and digital platforms.

Private companies also seek to integrate transport services without being directly involved in the delivery of the transport service. Jittrapirom et al. (2017) classified MaaS based on who organised the service, ten out of the twelve MaaS schemes reviewed, are public-private partnerships. One was privately organised, and one publicly organised. Furthermore, six were third-party aggregators of transport services, therefore not directly involved with a mobility service, three are organised by PT operators and two were established by a regional or city government. A dichotomy of public versus private MaaS platforms can then be interlaced with policies that regulate MaaS.

## 2.2 Reviewing transport services

To develop a solid framework for transport services (RO2) a definition of transport or mobility services and a structure to categorise different services is needed. In addition, considerations for transport services beyond what is currently offered are approached in this subchapter (thus taking a more hypothetical path in considering services not yet available in MaaS). Lastly, an appraisal is done on transport services reviewed in literature from real-world MaaS schemes which was introduced in the problem definition.

### 2.2.1 Transport services definitions and framework

The terminology "transport" and "mobility" are synonymous as they are used interchangeable in literature. However, when describing contemporary services, the term *mobility services* is often used (Ambrosino et al., 2016; Cohen & Kietzmann, 2014; Sarasini, Langeland, & Julsrud, 2015). This use of the term mobility could follow the broader MaaS paradigm deemphasise the means of transport but rather the mobility the service provides. In other words, mobility describes traveling from one location to another, whereas transportation relates more towards to the means (vehicles and infrastructure) of travel (Canzler & Knie, 2016).

To better ground an investigation, following RO2, a mobility service framework was developed, as shown on Table 2 (next page). This structure guides the integration of transport services through a hypothetical integrated mobility platform. The collective and individual access dichotomy is motivated by the combined mobility platform of the UITP (2016). Another dichotomy is found between the more recent or emerging mobility services compared to other long-established services that are more recognisable among the public since more advanced services may only be limited to certain cities.

This dichotomy is defined as "new mobility services" (NMS) (Cohen & Kietzmann, 2014; Feigon & Murphy, 2016; Sarasini et al., 2015) contrasted to what can be termed as traditional mobility services (TMS). TMS includes various forms of public transport (PT) that are based on fixed routes and schedules, taxi services, and vehicle rental services. On the other hand, NMS includes bike- and car sharing systems as well as on-demand app-based responsive services that include ride-sharing or ride-hailing taxis or minivans (Ambrosino et al., 2016; Rayle, Dai, Chan, Cervero, & Shaheen, 2016).

Table 2 – Preliminary overview of mobility services within the MaaS concept

| | Publicly accessible transport service based on access | |
|---|---|---|
| | *Collective* | *Individual* |
| *Traditional mobility services* | Fixed route & scheduled PT e.g. buses, trams, and trains | - Taxis<br>- Vehicle rentals |
| *New mobility services* | On demand ride hailing that could either be:<br>- shared taxis or<br>- micro-transit shuttles | - Ride hailing personal taxis<br>- Car and bike sharing ( station based or free-floating systems) |

### 2.2.2 Reviewing contemporary transport service advancements

With a working framework of transport services defined, the following subheadings describe mobility services in general terms. Further, this overview briefly reviews literature that describes possible future or emerging trends that may impact the demand of the service.

#### Traditional mobility services

*Collective transport services*

TMS are synonymous with public transport (PT) and are usually public entities that have sole authority to provide transport usually for a defined type of vehicle (either trains, buses, and trams) in a **defined jurisdiction throughout a fixed route and schedule** (Litman & Burwell, 2006). When PT is available in an area, which is usually in urban areas, their services are heavily subsidised by the state as their services are viewed as a public good catering persons who are seen as 'transit captive'(De Witte, Macharis, & Mairesse, 2008).

*Individual access services*

Taxi services: Urban taxi services are in most cases a heavily regulated transport supply with stringent entries into the market by drivers to operate (Rayle et al., 2016). Drivers usually need to be licensed and in some jurisdictions. Taxi drivers are often **organised into labour associations** that challenge technologies threaten traditional service models, namely from third-party technology companies that connect drivers of taxis with passengers through a digital platform such as the services of Lyft and Uber (Feigon & Murphy, 2016).

Traditionally, taxis are **hailed from taxi waiting bays in city centres** and other transport terminals such as airports and train stations. In some places taxis also drive around in tune to high-demand periods and areas so they can be hailed by passengers from the street. Taxis can also be booked in advance, mostly over the phone, but increasingly this can be organised through online (mobile) interfaces (Frazzani, Grea, & Zamboni, 2016).

Vehicle rental and leasing: Vehicle rentals are long established services that especially allow persons visiting an area or in temporary need to have access to a car. Rental services also offer larger vehicles like minivans and bikes. Even though the word **rental** is probably to most people synonym to the rental of cars, it can go **beyond automobiles and include bicycles, electric bikes, and other smaller vehicles** (MaaS Alliance,

2017). Rentals are increasingly digitised, meaning their service can be booked in advance. Their distinction between car and bike sharing services can be blurred. Further, private car owners can rent their vehicles on online platforms (Martin, 2016).

### New mobility services

The first two subsections describe collective and individual service models whereas the third and last subsection overviews a possible gamechanger in mobility though AV technology.

#### *On demand collective services*

Ride-sharing: ridesharing broadly describes when a car journey shared ride between drivers and passengers with similar origins and destinations. It is also referred to as carpooling and has a long history, though not as an organised system (Shaheen et al., 2016). Ridesharing participants share travel costs and may even save time when high occupancy vehicle (HOV) lanes are available. Emerging forms of ride-sharing utilises technology to arrange occupants with the same origin-destination as with a driver electronically, and to complete the sharing of costs externally, as with the increasingly well-known service of BlaBlaCar (Ambrosino et al., 2016). Beyond sharing an already pre-defined journey, ride sharing can be like a taxi service when a driver who offers a ride-sharing through a digital platform such as UberPOOL and Lyft Line, which are well known services in the US (Cohen & Kietzmann, 2014; Shaheen, Chan, & Bansal, 2015).

Micro-transit: Micro-transit incorporates flexible routing and/or scheduling and like newer ride-sharing systems, are demand responsive. Platforms are digitised and allows end-users to arrange journeys and then an algorithm computes the most efficient route to connect with other travellers on the same route all while considering tolerance levels for journey times and route deviations (Rayle et al., 2016; Shaheen et al., 2015).

#### *Individual services*

Ride sourcing: Ride sourcing services can be designed to serve individuals in the same way that a taxi can be hailed and hired. Well known services include Lyft and Uber, and are also referred to as transportation network companies (TNCs) (Rayle et al., 2016). TNCs provide prearranged and on-demand services like what was explained for digitised ride sharing. Smartphone apps are commonly used for planning and electronic payment. Even though research on the behavioural response to ride sourcing (both pooled and individual) is limited surveys tend to reveal that such services have allowed people to be less reliant on public transportation but also on private car use, especially within city centre contexts (Rayle et al., 2016).

Car-sharing systems: these services allows individuals to have temporary access, and like car rental services the costs and responsibilities of ownership such as the direct costs of maintenance, insurance, fuel, are forgone (Shaheen et al., 2015). Using a vehicle from a car sharing system involves access through a membership or subscription service for a specific company or organisation that maintains a fleet of cars and light vans and trucks. Carshare users then usually pay for usage, usually in the form of a fixed fee per use, and a cost commuted for time and distance during the duration of the vehicle's use (Becker, Ciari, & Axhausen, 2017).

Car sharing systems are traditionally distributed from specific points of access and return which are described as fixed station systems (Münzel, Boon, Frenken, & Vaskelainen, 2017). Vehicle fleets are

strategically distributed through convenient nodes in urban areas, such as parking lots, PT stations, and downtown areas (Becker et al., 2017). Contemporary and 'flexible or free-floating' systems are organised through smartphone based booking and differ from 'fixed stations' systems since they can be collected and returned at any location in specific area (Schade et al., 2014).

Bike sharing systems: With bikesharing, individuals gain access to bicycles on an "as-needed" basis without the costs and responsibilities of bike ownership. Since information technology-based bikesharing emerged ten years ago, three models have taken form: station based-, dockless- and hybrid bikesharing. Station-based bikesharing, allows users access bicycles via unattended kiosks offering one-way service (i.e., bicycles can be returned to any kiosk. In dockless (or free-floating) bikesharing users can check out a bicycle and return it to any location within a predefined geographic region. Hybrid bikesharing enables travellers even more flexibility by allowing both the pick-up and bicycle return in both kiosk and non-kiosk locations.

Bikesharing complements and/or competes with public transit depending on the context and local factors; nevertheless, more research is needed. One geospatial study found that in response to bikesharing shifts away from public transportation were most prominent in high-density urban cores while shifts toward public transportation tended to be more prevalent in lower-density regions. This suggests that in in larger metropolitan regions (with higher densities and more robust public transit networks), public bikesharing may offer faster, cheaper, and more direct connections compared to short distance transit trips and provides relief to crowded public transit lines during peak periods. In smaller metropolitan areas (with lower densities and less robust public transit networks) public bikesharing may serve as a first-and-last-mile connector being more complementary to PT.

*Automated vehicles*

Researchers of MaaS have even made the pronouncement that "the shift to a truly integrated shared mobility ecosystem will facilitate the transition to shared automated mobility and MaaS may be only fully realised when automated vehicles are available" (Y. Li & Voege, 2017). The introduction of automated vehicles (AVs) into the personal transport system would potentially be the greatest disruptor of the new mobility- and emerging MaaS sector. Policy makers have foreseen two major scenarios for AVs (ITDP, 2017): as personal vehicles and as demand responsive ridesharing. Even though AVs are currently (anno 2018) still under development, their emergence hit milestone when for the first time, through a pilot, AV shuttles where made available to the public in Swiss town of Sion through regular service complementary PT network (Uhlemann, 2016) and expected public launch of the Waymo and Uber autonomous services in the south-western (e.g. California and Arizona) United States between 2018-19 (Shaheen, Totte, & Stocker, 2018).

Future behavioural change from AVs can be hypothesised from anecdotal results, though other studies have investigated their appeal (e.g. Krueger, Rashidi, & Rose, 2016). One notable experiment gave 13 car users who were given a chauffeur, but paid for fuel costs, had their travel habits monitored (Mervis, 2017). When comparing travel behaviour before and after the experiment, the subjects travelled on average 76% further. Other patterns were observed: retirees more than tripled their evening driving and nearly doubled the number of longer trips. Three-fourths of the supposedly car-shunning millennials clocked in more miles. In addition, one-fifth of all trips had no passengers. Subjects with children were especially likely to send the chauffeur to pick up friends and family as they sat in their offices.

### 2.2.3 Transport services within MaaS schemes

Transport services were elucidated in the previous two subsections on NMS and TMS. Before, the MaaS integration features and levels were reviewed to better define the characteristics that constitute MaaS. The goal of this section is to summarize in detail individual MaaS schemes that were reviewed by Jittrapirom et al. (2017) and Kamargianni et al. (2016). However, as lower service integration schemes "*cannot exploit the full benefit of integrated mobility*" (Kamargianni et al., 2016) this summary will be limited to advanced integration MaaS schemes, regardless of the availability of a subscription. Advanced integration schemes have at least three of the four features: integrated travel planning and information, ticketing for mode access, and billing.

A second scope for this summary is to exclude services that do not directly offer their service to the public, therefore excluding business-to-business (B2B) schemes of which three were identified by the review of Kamargianni et al. (2016). This scope is justified since the thesis will focus on MaaS that is publicly accessible. Thirdly, since the focus of this summary is to account for transport services in current MaaS schemes, a comparison will only be possible when transport services are uniformly available for a specific geographic area. Three schemes identified by Jittrapirom et al. (2017) were excluded since they were available in many different urban regions and countries with different transport services. Since the goal of the study is to investigate transport services in relation to MaaS, a succinct approach to consider schemes where transport services are equally available for participants is chosen.

With the scope defined for this part of literature review, the total number of unique MaaS schemes identified by Jittrapirom et al. (2017) and Kamargianni et al. (2016) is seven. One new scheme (Tuup in Finland) was also within the scope of this summary was only identified by Jittrapirom et al. (2017) and one common scheme, SHIFT in Las Vegas that was within the scope was excluded later because it never became operationalised beyond initial testing (Lund, Koglin, & Kerttu, 2017). The results of this review are overviewed in Table 3 (next page). In terms of the characteristics of MaaS services are all schemes were in Europe, and most schemes have a pay-for-use transport usage model whereas one had a subscription based service (MaaS Global, 2017)(MaaS Global's Whim service). The UbiGo scheme was in fact an in-depth experiment in the form of a 6 month "field operational test" (Sochor et al., 2015b) that used a fixed mobility budget that allowed participants of the study could use for different transport services.

Most schemes are currently operational, and a slight majority are organised independently of local authorities, i.e. third-party aggregators. Although, some schemes that are organised by local PT and mobility authorities are also well apparent. A clear pattern emerges when comparing the transport service availability based on the dichotomy of NMS vs TMS. PT services are always represented, but conventional services of car rentals and longer-term bike rentals were not evident. In terms of ride-hailing, the only service that clearly provides this is the Tuup service in Finland (Aapaoja et al., 2017). The inclusion of free-floating car-sharing services through MaaS platforms was only observed from the WienMobil platform in Vienna. There is no evidence that any of the reviewed MaaS schemes include free-floating bike sharing services, even after a review of websites of each scheme was conducted.

Table 3 – Transport services within MaaS real-world schemes and research

| MaaS scheme | Country | Billing | Status | Operator | TMS | | | | | NMS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Collective | | Individual | | | Collective | | Individual | | | | |
| | | | | | | | | | | | | | Sharing | | | |
| | | | | | PT | | Rentals | | | | | | Cars | | Bikes | |
| | | | | | Rail | Urban | Autos | Bikes, etc | Taxi | Ride sharing | Micro transit | Ride sourcing | Fixed station | Free floating | Fixed station | Free floating |
| Whim Helsinki | FI | s[1] | o[2] | a[3] | ✓ | ✓ | ✓ | | ✓ | | | | ✓ | | ✓ | |
| UbiGo | SE | b[4] | c[5] | a | | ✓ | ✓ | | ✓ | | | | ✓ | | ✓ | |
| Smile/ WienMobil | AT | p[6] | o | l[7] | ✓ | ✓ | | | ✓ | | | | ✓ | ✓ | ✓ | |
| Optymod'Lyon | FR | p | c | l | ✓ | ✓ | | | | | | | ✓ | | ✓ | |
| Hannovermodil | DE | p | o | l | ✓ | ✓ | | | | | | | ✓ | | ✓ | |
| EMMA | FR | s | o | l | ✓ | ✓ | | | | | | | ✓ | | ✓ | |
| Tuup | FI | p | o | a | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |

[1] Includes mobility subscription packages and pay-per-use
[2] Currently operational
[3] Third party aggregator of services independent of local transport services
[4] As a pilot study with people testing out a fixed subscription within the context of a mobility budget
[5] Concluded pilot study
[6] Pay-per-use systems
[7] Scheme is organised by local city mobility or public transport authority

## 2.3 Unravelling MaaS and transport services: an investigative framework

Chapter 1 postulated three ROs, which act as a guide to demarcate the literature review in the development for this chapter. The first two ROs catered for the 'what' and 'why' that carried forward a review of literature. At this stage this section develops research question (RQs) that aim resolve out gaps of knowledge.

The catchphrase of MaaS has captivated the imagination of many in the mobility sector – however based on the review it is unclear that the concept will have a mass appeal. The concept is positioned on the main themes of a possible future mobility system that is **centred on usership, digitalisation, and new and more diverse travel options**. By the term 'usership' the emphasis is place on the lack of ownership but more towards access (Butzin & Rabadjieva, 2018).

While the literature review allowed for an overview of MaaS definitions, related concepts, and broader frameworks, the aim here is to unpack these terms and settle on a workable concept that is on one hand critical to the conceptualisation of MaaS and on the other, allows for a robust research design to test the assumptions based on a more deliberate framework.

From the review centred on the development of the MaaS concept, it is evident that MaaS derives from a long-established concept of the mobility manager that supplies transport as a service. That concept has now been realised as a digital platform that efficiently enables mobility through a usership concept. Early references to a mobility service focused on the idea of transforming the car industry into one based on a service model for car-sharing and ride-hailing systems, rather than supplying it as a product. This departs from the conception that MaaS **focuses on integrating various modes of transport**, as was first seen in the introduction.

For the purpose, of this study, **usership is facilitated by a MaaS service providing a ride** (e.g. PT, taxis, & demand-responsive transport) **or access to a vehicle** (e.g. cars and bikes) by connecting end-users with individual service providers. Such ride vs. vehicle distinction was not evident in literature and this indicates and reinforces the position that is put forward that MaaS research lacks an in-depth analysis of the role of the type transport services, beyond what may be available to specific areas. Further the dichotomy provides accessible terminology to describe what kind of services MaaS can provide.

Before the term MaaS became increasingly synonymous with an integrated mobility service, other terms described essentially what MaaS aims for, e.g. a combined mobility platform. However, the descriptions seen in these sources all focus on traditional PT as being the main actor of an integrated service. The combined mobility paradigm resolves problems in last-or-first mile PT network accessibility and incentives the use of shared mobility systems such as car and bike sharing. In this theoretical framework, MaaS is given a broader meaning **that incorporates single transport services and well as a platform** for the integration of transport services within its framework.

A wider consideration removes the assumption that MaaS (as an integrated mobility platform of many modes) centres on traditional public transport. This allows a research design to better assess if MaaS will sufficiently **enable usership with the variable of the type of transport service on offer**. This can test what is important for end-users will when considering mobility through transport usership. In its turn this can increase the likelihood of MaaS subscription schemes including unlimited urban public transport, and a variety of assumptions of the appeal of other types of transport services (e.g. ride hailing) in a subscription model.

This wider scope provides the latitude to consider the possibility of MaaS schemes without traditional transport services. Even though the reviewed MaaS schemes were in fact all based on a platform that integrates innovative modes with PT. The delineation of transport services, in subsection 2.2, allows a wider perspective on the role of single transport services to enable usership, as suggested by Ho et al. (2017). That is compared to an integrated mobility system where intermodality is an important feature.

This allows MaaS as an integrated mobility platform organised by conventional PT authorities to be tested. In the review of transport services, it became evident that **public transport authorities played a dominant role in enabling an integrated mobility service**. However, in the same review, a notable example was given where a new mobility service, in the form of a ride-hailing minibuses, is the driver behind the MaaS platform of Tuup in Finland. Thus, a private NMS can be the driver behind a MaaS platform, making their service central to the MaaS bundle. Moreover, preferences may reveal that the ideal MaaS provider is a third-party provider that maximises the choices of services available. This can allow for the testing of a favourability of MaaS providing

A wider MaaS framework is more aligned to the connected, heterogeneous, intelligent, and personalized (CHIP) model (Sumantran et al., 2017) that is neutral on how diverse the available transport services are. This also follows the three types of mobility business models developed by Van Audenhove et al. (2014). They outline **three service models** based on being an '*aggregator of third party services'* (e.g. Whim), or an '*integrator of own services'* (e.g. EMMA in France integrating PT and shared mobility services organised by the city government) or a '*single mode specialist*' that can additionally be an aggregator of 3rd party services (e.g. Tuup providing a demand-responsive minibus service but also integrates third-services and WienMobil providing public services but also free-floating car-sharing services from 3rd parties). These differences of mobility business models fit better into the definition of MaaS that is advanced in this framework.

These considerations are even more apparent when regarding free-floating NMS and the potential of AVs services to become dominant modes of transport. Fleets of shared autonomous vehicles for individual or shared use may offer a more attractive form of transport given its possible offer of flexible and door-to-door travel. However, despite emerging transport service concepts being described, in the case of AVs they are only deployed and accessible to the public through very limited pilot implementations. Therefore, **only publicly non-piloted available transport services will be included** and define the scope of possible NMS that would be included in the research design, and therefore *this excludes AVs*. However, the concept of ride-hailing taxis and shuttles driving by people can be used as a proxy for a future possibility involving fleets of AVs.

With the previous points being taken into consideration, the research design will define **MaaS from the perspective of the end-user** with the MaaS integration features that were defined by Kamargianni et al. (2016). Namely, the end-user will interface with the MaaS platform through a smartphone app, be billed for all journeys through a single account, and have the possibility for the service to be based on a subscription model. This was already stated when reviewing possible transport services within MaaS schemes. With consideration to the points advanced, **the following research questions are defined in relation to (segmented) end-user characteristics**:

**RQ1:** Would preferences towards the general concept of MaaS can be related to preferences towards individual mobility services?

RQ2: Will preferences differ between 'ride providing' and 'vehicle providing' services?
RQ3: Do preferences to the type of vehicles and the duration service model (shorter vs longer term possession) influences MaaS and usership favourability?
RQ4: Would the MaaS concept facilitate car and bike usership instead of ownership?

## 2.4 Investigating end-users for MaaS: findings and approaches

This subsection reviews recent literature with regard on how to develop a research design to assess the behavioural impact of MaaS (RO3). When MaaS is introduced in each area the travel behaviour of its inhabitants would depend on personal attributions towards the idea of MaaS as well individual transport services. The following subheadings provides published and mostly academically produced work on the behavioural impact of MaaS.

### 2.4.1 MaaS pilots

End-user behavioural research for MaaS is only sporadically available, the first important publication in this field is based on the six-month UbiGo MaaS "field operation test" (conducted from 2013 to 2014) with 83 households who voluntarily participated in Swedish city of Gothenburg (Sochor et al., 2016). This study investigated an advanced integration level of MaaS since the service is based on a mobility package or budget. The pilot study was based on the theoretical concept of 'trialability' that tests diffusion of innovations theory on enabling more sustainable travel behaviour (Strömberg, Rexfelt, Karlsson, & Sochor, 2016). Their findings were published across three academic publications (Karlsson et al., 2016; Sochor et al., 2015b, 2015a). The study itself was preceded by a questionnaire to gauge the motivation for participation, and then a post-pilot survey about changes in attitudes towards mobility. Curiosity was found to be the major determinant for initially registering for the trail while convenience and economic advantages (from a later questionnaire) were identified as the main determinants for continuation in the pilot study.

The results and analysis provided significant insights into the behavioural change by persons who regularly travel by the car since 41% of households had daily personal access to a car. This segment agreed to set aside the use of personal cars during the pilot study. During the study, behavioural changes, that were self-recorded through travel diaries and stated preference (SP) surveys, were observed: private car use decreased by 50%, while carsharing increased 200%, cycling (from already owned bikes) increased by 35%. The following percentages represent the proportion of participants that had a positive change in the use of a transport mode: PT use, through local buses, express buses, and trains, increased by 35, 100, and 20 percent, respectively, and travel by carsharing, car rental, and taxi increased by 57, 28, and 20 percent, respectively. These data illustrate that the introduction of MaaS in each area can create major shifts in both use of- and attitude towards transportation modes.

### 2.4.2 Psychosocial-attitudinal based studies

An attitude is the result of a personal evaluation towards behaviours or an object and can be measured on the degree of an individual's approval or disfavour (Ajzen & Fishbein, 2005). It is a multifaceted construct based on reasoned, affective, and volitional determinants (Fishbein & Ajzen, 1975, p. 288). Attitudinal factors were included in mobility research from the 90s and have their basis on the psychological cognition theory (Şimşekoğlu, Nordfjærn, & Rundmo, 2015). Attitudes towards MaaS before, during, and after the MaaS Gothenburg trial was also extensively surveyed and reported (Sochor et al., 2015b). The outcome of the Gothenburg study was described above in the MaaS pilot study subsection (2.3.1).

One study investigated attitudes and preferences in more detail, towards sharing mobility in general and an integrating mobility service i.e. MaaS was investigated in Greater London (Kamargianni et al., 2018). That study in London was part of a larger investigation that is described in more detail in the forthcoming subsection. Investigating MaaS related attitudes and preferences in the said cite aims to guide policy for the city in the report prepared for Transport for London (Kamargianni et al., 2018). Consequently, the study was said to be representative of the target population based on gender, age, geographical distribution, and driving licence possession. The inclusion criteria for the study were persons over the age of 18 with web access. Their study drew from 1570 individuals, out of an estimated overall population of 8.8 million.

They investigated car ownership in London based on the evaluations of statements relating to attitudes towards the car and perceptions of car ownership by persons who do not own one. The report goes on to gauge attitudes towards shared mobility, namely car and bike sharing systems based on car-ownership status. From their sample younger persons (termed Millennials <40 years) are most open to sharing. Most importantly they assessed the idea of MaaS based on what will motivate persons to subscribed, including special offers (e.g. restaurant discounts) and actual discounts towards the cost of mobility. Receiving discounts as a reward for more sustainable travel behaviour like more cycling miles were also highly favoured.

A majority of their sample (52%) stated that "they would worry about running out of their subscribed amount of travel" and 49% stated they "would feel trapped by subscribing to MaaS" when comparing it to telecom subscriptions, that that was less of a concerned by millennials. In terms of trying out new transport modes because of MaaS, 40% agreed they would, compared to 39%, while 21% was neutral. Older persons were more likely to disagree with that statement (Kamargianni et al., 2018).

The London attitudinal study more specifically dealt with the "uncertain" question of impact on car ownership through MaaS. This based on the evaluation of statements such as "MaaS would help me depend less on my car" and more to the point with "I would be willing to sell my car if I had unlimited access to car sharing" with positive, neutral, and negative responses of 47%, 20%, & 33%, and 61%, 13%, & 26%, respectively from both statements. The question was also asked to non-car owners, about the role MaaS may place in delaying a purchase of a car. Apart from car use, the impact of PT use was also investigated, as shown from the results from the statement of how journeys may be affected using MaaS. This is also an important policy question given the role MaaS may play in making new mobility services more accessible in place of PT.

### 2.4.3 Discrete choice experiments

A SP method questions individual about preferences to informational constructs (Hensher & Greene, 2003). Further, discrete choice experiments (DCE) provide a statistical method to quantify how components in a choice set (a combination of elements) are influential to each other, compared to other choice sets (Hensher & Greene, 2003). SP choice techniques can gather preferences of services based on an array of hypothetical service features that are not yet available in the market (Louviere, Flynn, & Carson, 2010). Hypothetical alternatives defined by an alternating set of attributes made up of subcomponents (Hensher & Greene, 2003). MaaS subscriptions are a case of service bundling -- combining mobility services (as levels) and its features (as attributes), and this is integrated into a DCE.

The DCE method was applied as hypothetical scenarios by Mayas and Kamargianni (2017) in London and by Ho, Hensher, Mulley, & Wong (2017) in Sydney. A master's thesis by Ratilainen (2017) study was applied in Helsinki, Finland, though it did not use a revealed preference (RP) design (as explained below). In these three referenced studies, bundled mobility services were monetised and therefore it provided an opportunity to compute measures of the willingness-to-pay (WTP) to subscribe.

The London and Sydney study used a **revealed preference (RP)** design that was combined with the SP based DCE. The RP approach allowed to resolve the issue of customising MaaS subscriptions based on previous attributes. This can be advantageous when MaaS service levels (e.g. type of transport mode) and attributes (specific features) can include aspects not relevant to the respondent. For example, the inclusion of car-sharing services when the respondent does not have a driver's license. The two MaaS DCE studies referenced, presented bundles that are based on the respondents' actual mobility behaviour. In other words, the SP DCE is customised per respondent.

**The study in London by Mayas and Kamargianni (2017) excluded car rental, ride sharing and demand responsive transport whereas the study by Ho et al. (2017) included these modes**. The Syndey study created a hypothetical car-sharing service and had a larger sample, of 252 respondents, compared to 80 in London, however, both were based on convenience sampling. In the Sydney study it was **observed that MaaS plans were not particularly attractive to existing PT users**. They suggested that studies could better consider preferences to single modes outside of a MaaS plan. Further, they alluded that preferences to MaaS plans could be based on the household since mobility decisions are more often household based. Mayas and Kamargianni (2017) concluded that PT had an influencing effect on both flexible and fixed plans. Their studies were published as conference proceedings and both state that further surveys, methodological refinement, and new analysis to draw new conclusions are forthcoming.

ITF (2017) also relied on a choice task experiment to investigate MaaS subscription bundles based on available transport modes in Helsinki. They used a choice-based SP survey to evaluate transport mode preferences for journeys (ITF, 2017). This is different since projected travel behaviour was investigated and not an evaluation of MaaS plans. The study relied only on a small sample of 20 people though the authors state the sample was representative of the case study city, to model their agent-based model. The **small sample size may be indicative of the difficulty to develop research designs** that considers services not yet available and well known. ITF study involved the use of a focus group discussion, explanations, and a SP survey that all lasted two hours.

### 2.4.4 MaaS preferences and clustering end-user mobility topologies

The potential use of mobility based segmentation to supplement an analysis of preferences from a survey was motivated by the paper by Hinkeldein, Schoenduwe, Graff, & Hoffmann (2015) of "*Who Would Use Integrated Sustainable Mobility Services – And Why?*". Lund et al. (2017) references this same study that can **identify "mobility typologies" in the MaaS context**. In the analysis by Hinkeldein et al. (2015), they related the clusters to preferences to innovative mobility services. However, their study was not related to the MaaS concept but in fact to electric car-sharing services since premise of the study lies on the attitudinal response of "I'm planning to use free floating car sharing with electric vehicles within the next 6 to 12 months".

Hinkeldein's et al. (2015) study nevertheless motivates the **application of segmentation to understand the profiles of potential MaaS end-users** beyond simple economic and sociodemographic profiles. In terms of an integrated mobility service, applying a methodological framework of profiles can benefit the analysis of end-user preferences of statistically validated distinctions between groups based on their affinity to the car, PT, train, environmental, and opening to technological innovations. As an illustration Table 4 (next page) overviews the labels applied to clusters identified for mobility related themes.

### Reviewing mobility segmentation attributes

Personal factors for MaaS or transport service preferences can be defined on current or desired mobility behavioural, socio-psychological and demographic factors (Hensher, Rose, & Greene, 2007). Segmentation aims to group people based on common attributes (Haustein & Hunecke, 2013; Rodriguez Cote & Diana, 2017). Segmentation is said to be an established means to investigate travel behaviour in transportation research (Haufe, Millonig, & Markvica, 2016). Studies have used the approach to investigate the preference of a particular transport mode, for example cycling (Damant-Sirois & El-Geneidy, 2015; Z. Li, Wang, Yang, & Ragland, 2013) and for AVs (Krueger et al., 2016). Table 4 on the next page illustrates the profile labels chosen by studies.

Grouping individuals aims to resolve the "maximising average effect" of investigating heterogeneous groups based on mobility collectively (Hunecke, Haustein, Böhler, & Grischkat, 2010). Segmentation of individuals can take two broad approaches: either *a priori* or *post hoc* (Anable, 2013). An **a priori** approach involves the placement of a respondent into a **predefined** segment. Conversely, **post hoc** segmentation involves the development of groups of individuals based on a statistical approach analysis of the **commonality** of individual attributes.

In their review, Haustein & Hunecke (2013) defined general attributes to segment mobility:

- **Travel behaviour:** actual patterns of mobility and transport mode use frequency to develop multimodality clusters, e.g. Diana & Mokhtarian (2009)
- **Attitudinal evaluations**: psychosocial constructs based on behavioural cognition models that segment based on "mobility typologies" e.g. Hinkeldein et al. (2015) and Anable (2015). Variables often derive from the sociopsychological models of the theory of planned behaviour (TPB) and norm-activation model that are based on constraints of behavioural attitudes, intentions, social and personal norms, affective motivations, habitual influences (Anable, 2005; Molin, Mokhtarian, & Kroesen, 2016).
- **Spatial factors:** seldom used in cluster analysis though may be an explanatory variable (e.g. Hunecke et al., 2010)
- **Socio-demographic variables:** described an early segmentation approach (e.g. Anable, 2015) though used in lifestyle segmentation studies when combined with attitudinal attributes (Hunecke et al., 2010).

Based on the review of by Hinkeldein et al. (2015) attitudinal attributes are based on well researched and developed approaches, as they dominate mobility segmentation approach in 21 out of 23 studies they reviewed. More Recent literature is shown to emphasise clustering based on both mobility attitudes and behaviours.

Table 4 – Examples of mobility segmentation profiles

| Study | Segmentation labels | |
|---|---|---|
| Diana & Mokhtarian (2009) | *French sample:*<br>- Car-oriented<br>- Transit-oriented<br>- Neither-oriented<br>- Both-oriented | *US sample:*<br>- Heavily car-oriented<br>- Rather car-oriented<br>- More transit-oriented<br>- Light travellers |
| Pronello & Camusso (2011) | - Travel pleasure addicts<br>- Paying ecologists | - Time addicts<br>- Timeservers |
| Anable (2013) SEGMENT EU project | - Car-free Choosers<br>- Malcontented Motorists<br>- PT Dependents<br>- Car Contemplators | - Image Improvers<br>- Devoted Drivers<br>- Active Aspirers<br>- Practical Travellers |
| Z. Li, Wang, Yang, & Ragland (2013) | - High-income easy-working<br>- High-income hard-working | - Young white collar<br>- Young blue collar<br>- Low-income |
| Grischkat, Hunecke, Böhler, & Haustein (2014) | - Public Transport Rejecters<br>- Car-Individualists | - Eco-Sensitised Public Transport Users<br>- Self-Determined Mobile Persons |
| Hinkeldein et al. (2015) | - Traditional car-lovers<br>- Flexible car-lovers<br>- Urban oriented PT lovers<br>- Conventional bicycle-lovers | - Ecological public transport- and bicycle-lovers<br>- Innovative technology- loving multioptionals |
| Haustein & Nielsen (2016) | - Convenience drivers<br>- Busy green drivers<br>- Price-oriented PT-users<br>- Price-oriented pedestrians | - Green PT-users<br>- Practical cyclists<br>- Green cyclists<br>- Green pedestrians |

## The European SEGMENT project: mobility segmentation

The publications referenced so far, with segment titles overviewed are academic papers and do not go into detail in the wording statements used in their respondents' **evaluation of attitudinal constructs**. However, one study carried out in 6 European cities, called the *SEGMENT* project, strives for "replicable and transferable market segmentation model" (Anable & Aditjandra, 2011). The study, as reported by Anable (2013), condensed 10,000 attitudinal statements from 100 surveys developed from 6 European cities. The theoretical basis of their study is based on the Theory of Planned Behaviour (TPB).

SEGMENT provides an in-depth explanation of their analysis that is based on the Theory of Planned Behaviour (TPB) and full availability of the questions used in their surveys and the procedure to assign individuals to a segment. Two peer-reviewed article implemented the approach in a study investigating the impact of smartphone based travel information on the modal-shift to sustainable modes of travel and modelling segment profiles based on mobility behaviour (Semanjski & Gautama, 2016; Semanjski, Lopez Aguirre, De Mol, & Gautama, 2016).

*The Theory of Planned Behaviour*

Mobility behaviour research often base their theoretical framework on cognitive models such as the psychological constructs from the model of Theory of Planned Behaviour (TPB) or variations of it. Motivational models advance a theoretical basis for a behavioural enaction, and the TPB elaborates the construct of intention on the basis of the theory of reasoned action's emphasis that motivation to perform a specific action in a reasoned and deliberate manner (Van Acker, Van Wee, & Witlox, 2010). The TPB includes in its process model the construct of a perceived behavioural control (PBC) which is the meditative factor for normative (social and personal norms) and intentional processes (Ajzen & Fishbein, 2005).

In the process diagram of the TPB, as shown in Figure 7, the influences of attitudes and social norms are towards intention. Concurrently the influences of PBC on intention and behaviour, and lastly intention on behaviour. Within the TPB model PBC, after firstly attitude and secondly social norm, is the third determinant of intention however other predictive constructs that influence the development of a behavioural intention are affect and personal norms (Ajzen & Fishbein, 2005). PBC incorporates internal (individual skills, knowledge, and a capacity of planning) and external (or situational) factors (Armitage & Conner, 2000). Individual factors of PBC however may conflict thus reducing its effect. For example, if someone has the skills (spatial awareness) of understanding a bus network, but the frequency of the bus is too low.

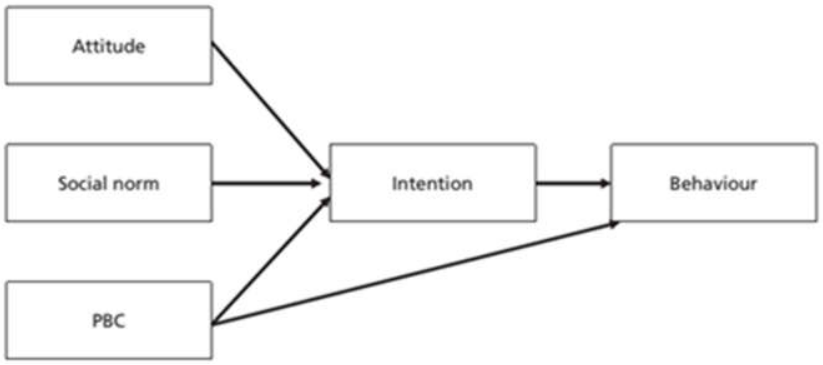



Figure 7 - The TPB process model from Dijst et al. (2013)

TPB has been challenged because of the constructs influencing intentions are limited when factors such as norms (Nordfjaern & Rundmo, 2015), and affect and desire (Steg, 2005). Habits (Şimşekoğlu et al., 2015) are not considered when they do in fact have an influence, except during a behavioural enaction process. Nevertheless, the TPB's PBC allows the dimension of perceived control and intention to be quantified, and therefore assesses the instrumental factors as this too is proximal to an intention to use alternative mobility modes (Mokhtarian, Salomon, & Singer, 2015).

*The development of clusters in SEGMENT*

The SEGMENT analysis saw one important pattern based on car users and non-users, and then when treating data with this dichotomy they analysed relationships using a "hierarchical cluster procedure (Wards method, squared Euclidian distances)" to cluster the larger group of questions. To reduce the number of questions by retaining those with greatest predictive capability a "k-means procedure (no-update method) followed by an "applied discriminant analysis" that resulted in the 18 "Golden Questions" which are attitudinal statements where respondent evaluate them based on a 6-

point Likert scale (Anable & Aditjandra, 2011). These questions are listed in section 7.6 of the Appendix in English and Dutch.

*Descriptions of SEGMENT clusters*

The Golden Questions are then used to gauge in which one of the **8 attitudinal segments** they fit best: 5 for car-using segments and 3 non-car using segments. Each segment accounts for preferences and attitudes towards driving, cycling, walking, and bus use, sustainability, fitness or health, individual choice for car-use, and the environment. The study revealed the strongest predictors of segment membership, most notably current and intended car driving, motivations for to car driving, preferences to other modes (i.e. cycling and PT). The eight possible segments which, as summarised below based on the descriptions of Anable & Wright (2011) and Semanjski & Gautama (2016) and are explained in detail in subsection 7.5 of the appendix.

**'Car drivers': have driven a car in the last 12 months:**

1. Devoted Drivers (DD) have a very low intention to reduce car use; high symbolic attachment to the car as means to demonstrate success. No or very low use of other modes based on their attitude of their inefficiency and is unconcerned by the benefits on their health and the environment.
2. Image Improvers (IMs) enjoy driving as a means of self-expression, and unwilling to reduce its use, though not as strong as DDs. They disfavour PT, but tolerate cycling, because like cars it is a means of expressing themselves, but instead for an innate propensity for keeping fit all while having neutral to moderate environmental attitudes.
3. Malcontented Motorists (MMs) dislike driving, finding it stressful, with a 'moderately strong' intention to reduce car use, but not in favour of PT, but instead cycling, though not much motivated about concerns of the environment.
4. Active Aspires (AAs) are car drivers but highly motivated to curtail its use in place of active modes, primarily cycling, but not through PT since they highly disfavour it. That goal is justified by their high environment concern and their view that cycling provides more freedom and is beneficial to their health.
5. Practical Travellers (PRs) only use the car when necessary and by large travels with the bike, and when it is convenient, with PT or by walking. They not driven by concerns over the environment but view local congestion as problematic. They are more highly educated and have more flexible jobs.

**'Non-car drivers': have not driven a car in the last 12 months**

6. Car Contemplators (CCs), for reasons because of a lack of driver's licence or car, do not drive but they would rather use for symbolic reasons in a desire to express success. They do not view PT and cycling positively, though are more open to walking. They are largely not motivated by concerns about the environment.
7. PT Dependents (PDs) as the name suggests use PT though they do not highly regard its efficiency. They are more likely to walk than cycle and are not as motivated by the environment. Overall are the least likely to start driving and elderly people are likely to have this profile.
8. Car-free Choosers (CFs) dislike driving because of their belief of it causing unhealthy lifestyles and instead prefer all other modes, without any preference. They mobility choice is also highly motivated by their concern about the environment. This group are more likely to be female.

## 2.5 Defining the research design

The review in subsection 2.4 provides various approaches to investigate the behavioural impact of MaaS. A first research approach was used in the UbiGo MaaS pilot and provided probably the most effective overview of the possible behavioural change from a MaaS platform. Even though a pilot study approach is beyond the scope of this study, conclusions can be drawn from the UbiGo study. Firstly, even though participants to the experiment had diverse travel behaviours and some had access to personal cars, everyone who would have signed up would have a motivation to reduce car use. This indicates a self-selection bias which can overrepresent those who are open to new and sustainable concepts. This would also have been the case for other studies that had a convenient sampling approach, contrary to the London studies. The goal of this thesis is to also define a target population and aim for a representative sample.

The MaaS attitudinal study in the case of the London example provide an approach to test preferences of individual MaaS features. This approach allowed for new concepts to be explained to people, without overloading them with a complex choice task to choose new services from a bundle. The challenge of designing a DCE survey based on a more comprehensive consideration of transport services is evident from the method used in the London and Sydney DCE. Their approach included a RP component to consider the individual's mobility behaviour when designing a choice set to the individual. This personalisation of the choice set to the participant reduces the difficulty of making a choice based on new concepts. However, it will be beyond the resources available for this research to include a RP component while also aiming for a representative sample for a defined geographical area.

Further, The DCE is based on well-defined levels and attributes of transport services and may not suited for an exploratory analysis of transport mode preferences which this thesis advances. Nevertheless, a DCE still has the advantage of discerning the effect upon one variable given the manipulation of the levels of other attributes (Hensher, Rose, & Greene, 2007). However, since this approach goes beyond the scope of this study, the proposed alternative allows participants to define which type of transport service is most important to them within the MaaS concept.

The methods used by both studies in London (Mayas & Kamargianni, 2017) and Sydney (Ho et al., 2017) compared self-selected bundles over an evaluation made from a DCE though a RP analysis and was more effective in determining measures of willingness-to-pay. However, for this thesis an approach that also monetises preferences to MaaS transport services will not be possible since the cost of the service will be difficult to calculate for hypothetical bundle offers which may not be known in a target population's context.

Personal factors influencing general and specific preferences to MaaS and transport services can potentially be representative to different groups of people. In this regard, a segmentation approach for MaaS could better understand factors influencing preferences, which can be generalised by groups of people with similar characteristics. Analysing preferences to MaaS and transport services can be understood based on statistical segments instead to comparing to sociodemographic or mobility behaviour attributes. The conclusions drawn from the subject of investigation (MaaS and mobility services) may be more meaningful and methodologically reproducible. The socioeconomic and mobility behaviour attributes recorded from a survey will be based on distributions that will probably suffer the limitation of being unrepresentative because of the survey recruitment via social media that would be difficult to reproduce given its unsystematic approach.

Segments may therefore maximise the scientific validity of findings. However, segments will have to be defined which can be problematic since self-developed segments may lack statistical veracity since the source data may be limited. Therefore, to ensure the validity of results can endure scrutiny and be compared to future studies segmentation of participants will be carried out on an a priori approach which involves the placement of a respondent into a predefined segment. Once such study was based on analysing data across six European cities (Anable, 2013). This approach will allow the thesis to focus more on the survey design to assess MaaS and transport service preference. However, the survey will include attributes described Hinkeldein et al. (2015) study of the affinity information and communication technology in the form of mobile devices and the use of mobility apps.

In concluding this subsection, the previous subsections an investigative framework of MaaS and transport services was defined, and end-user research approaches and findings were reviewed. MaaS and features of a MaaS business model were reviewed. Further, the question of who supplies MaaS was discussed based on a review of business models. It is noteworthy that many of the concepts and publicly available MaaS and individual NMS are novel and therefore sources of literature explaining their operation would as a result be limited as well. This will then in turn limit the applied research on end-user preferences. It is advanced that more privately lead third party aggregators of MaaS such as Whim are very new services available in a few limited cities.

Much of the literature reviewed identified MaaS schemes that are provided public authorities that organise PT and provide more traditional forms of station-based (as opposed to free-floating) shared mobility services. However, as explained, there is an opportunity to investigate preferences at more detail towards an expanded framework of MaaS in terms of who organises it and what services are available. As a result, this study takes this approach and focuses on a wide as possible target population to assess preferences to MaaS and transports services. To understand preferences broadly the aim of research design is for a sample of individuals from a defined geographical area. Further, investigating individual characteristics will be complemented with developing mobility lifestyle profiles that incorporates non-transport related influences in an individual's overall mobility behaviour and preference.

# 3 Methodology

In the previous chapter a research design was outline after considering approaches from the literature review. The purpose of this chapter is to expand on conclusions made of the investigative approach by firstly (3.1) introducing geographical context and target population context of the study. Mobility policy and developments of MaaS is summarised and is used as a reference when discussing the results in terms of policy recommendations. Secondly (3.2), the survey design, testing, and finalisation is detailed. Thirdly (3.3), the data collection strategy is described and lastly (3.4) the approach taken and measures of validation of the assignment of a priori SEGMENT profiles.

## 3.1 Background to study area

This subsection reviews local policy and travel behaviour patterns for a future discussion based on the results from the survey. The geographical scope of this study is centred on the municipality of Leuven, which is the capital of Province of Flemish-Brabant located in Flanders, the Dutch speaking region of Belgium. The legally domiciled population of Leuven (i.e. within its municipal border) was 100,291 in 2017; and is distributed among 48,278 household (Statistics Flanders, 2018b). Leuven was chosen as the target area for collection because of the convenience to focus on an area that is largely urbanised and diverse in their mobility behaviour and use of transport modes.

Research has already been conducted in the city that involved testing a sustainable travel information app that analysed results based on developing segmented mobility profiles as shown on (Semanjski et al., 2016). There is also literature investigating Leuven as a model for a more sustainable urban mobility system (De Paep, Vandenbroeck, & Van Reeth, 2014). Overall, city policy aims to achieving a carbon neutral status by the year 2030 and this involves reducing the impact from mobility (Vandevyvere, Jones, & Aerts, 2013).

The context of this study is detailed in the following subsections that firstly describes national, regional, and local mobility policy for the city (3.1.1). This subsection then describes diverse transport and mobility patterns of city residents (outlined below in subsection 3.1.2). The aim of this review is to bring pertinent

### 3.1.1 Transport and mobility policy context

The road congestion problem and car-centric mobility in Belgium is illustrated by a review by INRIX's (2015) congestion data in 2015 that shows the country is the most congested European country. However, there are many developments that challenge the dominance of private car use. Company cars, compensation via travelled distance via various modes (via cars and bikes), and PT cost reimbursement are increasingly a part of remuneration packages organised in mobility budgets among employees (Zijlstra & Vanoutrive, 2017). Further, road congestion charging for all vehicles gains a broader appeal from policymakers. Measures to decrease car use are popular themes as congestion has increased by 35% in the last five years, as reported in local media (Hope, 2016). Furthermore, in comparison to other European countries, there are more diverse transport modes available in Belgium and increasing local PT patronage with the highest increase (114%) among European countries between 2000-12 (UITP, 2011b).

Public authorities in the country and region continue to invest in cycling infrastructure, PT network development, car and bike sharing networks (Nanninga et al., 2014). This has lead significant increases in the use of these shared mobility services, namely Cambio and Blue-bike (car and bike

sharing, respectively) based on data from the Network for Sustainable Mobility (Netwerk Duurzame Mobiliteit, 2017). However, **despite a more diverse modal-share, private car still dominants home-work journeys** for Flanders from 2009 to 2017 continue to be dominated by the car, at just under 70% (SVR, 2017). More specifically to the region, according to the latest traffic and travel patterns analysis of Flanders, the car dominates as the primary mode of transport (MOW, 2017). Car travel journeys, in terms of a percentage in proportion to other travel modes, accounts for 69.62% of mobility behaviour. The share of distance is higher at 82.30%.

For the purpose to highlight mobility behaviour in Belgium, Figure 8 shows a comparison of segmentation profiles based on mobility culture between a representative Belgian sample and the European average. It can be observed from the graph that even though driving dominants, there are different type of drivers, and more importantly significantly large groups of non-drivers with also varying behaviours. This type of heterogeneity seen at the national level allows the suggestion to made that a segmentation approach that not only considers actual behaviour but also underlying motivations may support a richer analysis when trying to explain possible variations the evolution of MaaS concepts.

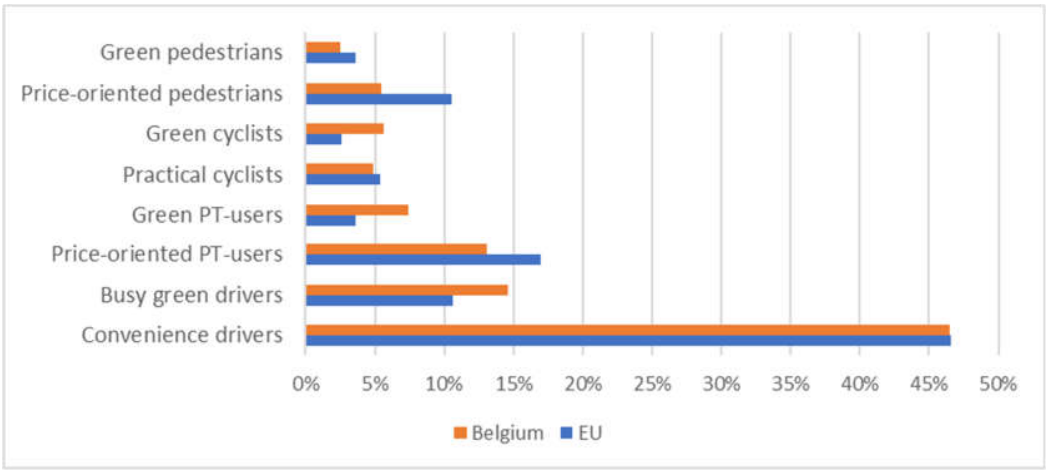



**Figure 8 – 'Mobility culture' segmentation profile distribution for Belgium compared to the EU**

The development of transport and mobility policy and infrastructure is executed at the regional level, including Flanders. The most important of transportation planning development in the region is the '**basic-accessibility**' (***basisbereikbaarheid***) policy (MOW, 2015). The policy has four levels of transport organisation for the region: firstly, with trains aiming for **a country and region wide accessibility** (*treinnet*), secondly a bus and tram network (from regional PT company of De Lijn) for accessibility from urban centres (*kernnet*); thirdly a supplementary network that connects to the second level (*aanvullend net*); and lastly a demand responsive transport network (*vervoer op maat*).

The basic-accessibility policy aims for all areas, from city to suburban and rural areas, to have a minimum service levels of (car-less) mobility based on a higher goal of better accessibility to jobs and services. The first two levels are also aiming to be coordinated so intermodal travel can be done without long waiting times between a ride and a train. Policy at the local level advocates for a dense network of shared mobility neighbourhood centres (termed a *mobipunt*) in urban areas (Autodelen.net, 2017).

### The emergence of MaaS in Belgium

In terms of MaaS schemes in the region, a lower level MaaS platform defined by Kamargianni et al. (2016) is available in the Brussels region. However, that integrated mobility system is only

advantageous by allowing integrated ticketing among different city transport modes. MaaS also has been implemented for businesses through the platform of Olympus that aims to integrate company cars for employees with alternative modes of transport (Olympus Mobility, 2016). Currently, as of the end of 2017, services include PT, fixed station car and bike sharing, without taxi services.

In terms of a MaaS system eventually taking foot in the region, a MaaS pilot was deployed in Ghent (Derycke, 2016). The study was concluded, as described in general in a local transportation magazine (De Paepe, 2017). It was reported from the article that the pilot was conducted by 100 participants that were distributed among three groups with fixed 'mobility budgets' of 150, 250, and 350 Euro per month to use various transport modes organised from a smartphone app. The general result, according to a spokesperson in a press event, that MaaS app allowed participants to complement their private car with car-shares, bikeshares, and PT, use but not replace private car use all together. One source from the local media gave reference to a 1/3 reduction in private car travel (Torfs, 2017)

Further, the Whim app service by MaaS Global is expected to be launched to the public from the beginning of 2018 and this gathered the attention of regional policy makers (Vlaams Parlement, 2017). Many questions were raised when about the role of MaaS in the region in the future, though the regional minister for mobility emphasised that MaaS is best developed in the "[free] market" with "end-users" being the deciding factor of their success and that "[the government] should not [develop]" such applications but to stimulate a conducive regulatory environment[8].

### 3.1.2 City transport and mobility patterns

Modal share patterns were overviewed for the region, however noteworthy from the summary report on Flemish travel patterns is that the reliance of the car depends greatly on location in or outside the city (MOW, 2017). For example, the two largest city areas in the region (Antwerp and Ghent) collectively, the number of car trips taken in proportion decreases to 32.4 percent and walking increases to 25.5%. In Leuven, it is expected that more people would be less dependent on car travel when compared to the average individual's mobility behaviour of the region, as observed in Antwerp and Ghent.

The city is served by an intercity train station from the national passenger railway company NMBS with direct lines to all other major Belgian cities and services as the bus network for De Lijn, which is a hub for the eastern part of Flemish Brabant. Further, there is station-based bike sharing system at the train station, a long-term bike rental service, and station-based carsharing from the company known as Cambio with just over 30 stations distributed across the city. Lastly, a taxi hub operates from the train station.

In terms of the use of transport modes by Leuven residents, according to the latest addition of the *Stadsmonitor,* an analysis of 13 of the largest cities in Flanders, carsharing and cargo bike use (bakfiets) rates in the city stand at 5%, and a public transport subscription is 56%. These proportions for the 13 largest cities in Flanders. Also based from the *Stadsmonitor* sample, in 2017, households in

[8] "De markt is het best geplaatst om dergelijke innovatieve applicaties te ontwikkelen. Wij moeten dat niet doen. We moeten dat enkel stimuleren. De markt kan het best kort op de bal spelen en zeer dicht bij de eindgebruiker." - Minister Ben Weyts.

Leuven with at least one car was 82%, which is average proportion for all of the 13 cities (Bral, Jacques, Laenen, & Vanderhasselt, 2018).

Even though private car ownership may be high among households, diverse travel patterns would likely to be evident among them. According to latest available statistics (2009), the modal-split, which is the proportion of trips based on mode of transport, for cars, soft-modes (cycling and walking), and PT, for trips within the city was 44, 42, and 14 percent, respectively; these proportions are compared to the modal-spit of all journeys, including those entering and exciting the city area, for cars, soft-modes, and PT at 57, 20, and 23 percent, respectively (Van Reeth, 2014). Mobility policy that aims for the modal share for a third (1/3) each in proportion for bikes, cars, and public transport is promoted (Vandevyvere et al., 2013).

### 3.1.3 Defining a hypothetical survey population

The starting aim is to define the survey population as all adults who reside within the municipal borders of Leuven. The first constraint of sampling in the target city is considering who can be represented in local statistics as adult residents. There are almost 43,000 post-secondary education students in the city's namesake university (KU Leuven, 2017). There are other but smaller post-secondary institutions in the city. Many of these students live '*op kot'* in student accommodation and many of these persons are not domiciled, but instead still consider their parents' house as their primary address. However, international students at KU Leuven who number at 7,700, would be domiciled and therefore part of official statistics of the city.

While the limitations of an internet survey are known, most notably a lack of internet use by significant proportions of the population and the difficulty of being able to directly communicate with people so they can be recruited to participate. Statistics on internet usage and information technology literacy justify the limiting of the survey population based on national and regional averages. In 2017, 86% of Belgian households had at least an internet connection and a computer; proportions of individuals (persons 16 to 74 yrs. of age in Belgium) use the internet in varying frequency: 72% daily, 11% at least once weekly, and 2% less per week; 68% of individuals access the internet using a smartphone; and 72% individual social media use (Eurostat, 2017).

According to sampled data for Leuven, 94% of households in Leuven have an internet connection (Bral et al., 2014) though statistics of internet use were not found. Even though the internet survey approach will exclude a significant proportion of people (~30%) without the means to become inducted and participate in the survey. Thus, it is postulated the MaaS concept may most probably only be relevant to persons who are information technology literate, and these persons as result are users of the internet.

Possibly a stronger justification for limiting the survey population is based on Flemish statistics. According to an OECD (2016) survey, at least 31% of potentially economically active adults (defined as 16-75 yrs.) in Flanders do not have the skill to use computer devices "*to solve problems involving few steps, [requiring] simple reasoning and little or no navigation across applications*", while 29.8% could use "*widely available and familiar technology applications with minimal navigation required to access the information or commands required to solve the problem*", and 34.5%, the top tier, can use "*both generic and more specific technology applications*".

The above skill levels also align to internet use, though may not be overlapping, but indicate the upper limit of persons within the survey population. The number of persons who have the minimal skills

for technology use is aligned to persons who the proportion of persons using a smart phone (64.4% in total for Flanders, and 68% for Belgium, respectively). These proportions also mirror internet users between 16-74 years who carry out online banking (74.5%) and shopping (65.1%) (FOD Economie, 2017).

In terms of the population of Leuven fitting to the regional averages for information and technology literacy, average income (2013) and rates of employment (2015) are seen to be within 1-2 percentage points of the Flemish average (Statistics Flanders, 2017) and therefore may imply the same proportions in Leuven given the high correlation between the OECD skill indicators and financial wellbeing (OECD, 2012). Since the survey is about the digital platform of MaaS, persons who are active users of internet and could sufficiently understand the survey centred on very new technological and service concepts, can be assumed to fill in the survey.

Since the survey is conducted online and requires a minimal level of computer and information literacy, and cognitive ability to participate, **the survey population of the study is defined as all adults who reside on a legal basis within the municipal borders of Leuven who are active information technology users.** This follows the approach followed in the London MaaS attitudinal study (Kamargianni et al., 2018). The definition of adults may be flexible to allow younger people to participate, since the OECD define adults from 16 years old (OECD, 2016). When data is collected from the survey then consideration can be made to filter the dataset. This aligns to available local statistics for any possible weighing and dataset comparison. However, the adult population figure used to calculate the survey population will be persons of at least 18 years old because of available statistics which amount to 82,075 persons or 83% of the total population in 2016 (Statistics Flanders, 2017).

**A limitation** of this proportion, as an average for Belgium, is that it **excludes persons older than 75 years though persons above this age would more likely be infrequent uses of the internet**, thus be outliers in the survey population. However, this will not be used as an exclusion criterion in defining the target population. Available statistics for the elderly in Leuven indicate that the group 75 years and older would be only a small proportion in the survey population, with persons between 65-79 years and older than 80 years making up 10.3% and 5.8% of the overall population in 2016, respectively (Statistics Flanders, 2017), which are significant proportions.

Because of the nature of the data collection medium, through the internet, the proxy to capture the target group is those can access and conduct the survey. In other words, people who declare themselves as legal inhabitants of the city and since there is no available or known statistics on internet use frequency for Leuven. The Eurostat daily internet user percentage of 72% will be used to determine the sampling design which is within the technology literacy indicator. Using this proportion, **the survey population is postulated to be 59,094 (82,075 × .72) individuals**. Because these are adults, it is assumed that this number is distributed across the total number of households of 49,666 (Statistics Flanders, 2017).

## 3.2 Survey instrument design and testing

### 3.2.1 Considerations taken for the online survey's design

Self-administered website surveys tend to have a lower survey response rate and **issues of survey dropout rates** – when recruited respondents start the survey but quit because of an information overload or aesthetic issues (Fan & Yan, 2010). This is especially the case when there is no form of financial compensation or chance to win a lottery after participation. Therefore, the following

considerations are taken after a review of the work by Nulty (2008), Fan & Yan (2010) and Akbulut (2015) on maximising web survey response, consistency, and completion rates.

Firstly, presenting statements and questions that are clear and accessible to a large audience, thus avoiding technical mobility terms. As a result, written descriptions of new mobility concepts will be made into a simple and intuitive graphics (as demonstrated in the appendix). Because many people use their smartphone to use the internet, and less so laptops and computers the survey must be designed to cater for smaller format displays. Further, persons may come across the survey but may not have the time to complete it, therefore, in the survey website can have a section to allow them to subscribe their email so they can receive a reminder to complete the survey.

Respondents should be convinced that data processed anonymously and that personal socioeconomic questions are limited to what is needed for the analysis. This can be achieved by providing a sense of authenticity (high quality designs and correct Dutch), authority (associated with a master programme from a local university), and societal benefit from the survey (learning more about new mobility for a more sustainable future). Further from unscrupulous submissions, it should be cognisant that alter their self-presentation by avoiding polarising language and to apply this in the context of mobility, the survey design should avoid the environmental and sustainability rhetoric that may alienate owners or users of cars, as revealed by a study on bus marketing (Beale & Bonsall, 2007).

### 3.2.2 Survey pilot design and testing

A pilot survey was designed and circulated that allowed testers to write-in detail feedback at various steps of the survey. Further, for all sections a general assessment acceptability was provided. The testing survey recorded 23 completed and 2 incomplete entries. Recruitment for the survey was done conveniently. The average year of birth of the respondents is 1987, and the male-female sex ratio was 13:10. Even though the goal was not for a fully representative sample, the variation among participants in the pilot survey was diverse in terms of educational background and age – which are deemed important when considering survey comprehension and duration.

Testers were explained that it was important the survey should have assessed for it being accessible and non-technical enough to be understood easily by a broad population. They therefore acted as a crowdsourced assessment of the survey which highly beneficial since the original survey was developed in the Dutch language and the testers first language is also Dutch. An obvious limitation is the small sample of testers; however, their feedback nevertheless provides valuable feedback since it was made clear of their role to assess, be critical and provide constructive specific and general comments both pertaining to content and writing style. The most pertinent results and feedback are described together with a description of each section of the survey.

Testers were asked to assess the survey's duration. Two-third (66.7%) of respondents found the survey to be *at least* "average" in terms of duration, with one-third indicating it being 'somewhat slow' (23.8%), and to a lesser extent, slow (9.52%), this will point to towards a problem of a survey-dropouts in a public survey. Overall the survey duration records showed completion rates between 5 and 15 mins, with most being done within 10 mins when not providing written in comments. Those who provided written in comments tended to have surveys lasting more between 20 to 30 minutes.

One major limitation of the pilot survey was its not fully assessing the propensity or willingness of individuals to longer term mobility change. Even though the primary goal of the thesis is to identify

which transport services 'matter the most' to people, it is important to also assess personal evaluation of MaaS being a platform to negate the need for transport mode ownership through usership, particularly for cars, though the idea of it applying for bikes is interesting and not represented in literature. With this taken into consideration, and with motivation found in the London attitudinal study by Kamargianni et al. (2018).

### 3.2.3 Final survey structure and contents

The final survey was then translated into English (though it was expected that most respondents first language was Dutch). The is divided into 5 main sections that collects data on:

S1: Sociodemographic and economic variables
S2: Mobility and transport behaviour
S3: Evaluations towards the Golden Questions
S4: The overall MaaS concept
S5: Transport service concepts

The main sections begin and end with introductory and closing pages respectively. The final survey uses an underlying coding system per section (e.g. section one is S1) and per question (e.g. Q01) which is combined for a five-character code (e.g. S1Q01). Non-question sections of the survey are coded as descriptions (e.g. S1D1) used to explain concepts though image diagrams. This coding is used throughout the rest of this report so that the reader can reference to the actual wording of the question in Dutch and English in subsection 7.6 of the appendix. The following subheadings outlay the structure of each section.

#### Section 1: Baseline sociodemographic variables

The most important feedback (from three individuals) for the first section of the pilot survey was how to describe one's household composition. The categories were described by one person to be confusing since he lived with his parents. After reviewing the enumeration approach taken in Belgian household census a more consistent system of subcategories was used.

For the final survey core questions (S1Q01-9) included their residency in Leuven in terms of if they live there as a registered inhabitant, which part of the municipality they live in, year of birth, sex, nationality, household structure, age groups of persons living with them. These questions and their subcategories were motivated by how demographic statistics are provided by local authorities. Questions for this section aimed to align chiefly with household categories. If the respondent indicates that they do not live alone, this will active questions on the characteristics of their household based on listed individuals in their household based on age. Eleven persons who tested the survey lives in Leuven, though that was not a criterion for testing the survey. Additional questions for S1 included (Q10-14) highest level of education, employment status, asking why they may not be working, location of their work or school, and lastly their monthly net household income.

#### Section 2: Mobility behaviour and technology use

The development of questions relating to mobility behaviour derives from long established travel behaviour research from the OVG and *Stadsmonitor*. The most important feedback from this section was the lack of an objective self-reporting of transport mode use frequency. The survey used descriptive labels rather than frequencies within a fixed period, for example "at least once a week" as opposed to "frequency" as seen in the approach taken in the *Stadsmonitor*, as opposed to the Flemish travel behaviour (OVG) method's more quantitative self-assessment. More objective frequencies of a period

were used throughout the survey. Two questions that were not included in the pilot study were firstly the self-reported **most important mode of transport per type of activity**. This was suggested by a respondent and though this was originally included in earlier drafts in the survey.

**The final survey laid out questions in the following order (S2Q01-10):** drivers licence's possession, frequency of various means of travel (following the OVG survey), namely walking, driving a car, being a car passenger, with the train, bus, tram, or metro, bike, electric bike, motorcycle, and scooter; presence of household car, personal car ownership, company car possession, means of travel for work/school, shopping/running errands, visiting family or friends, and reaching a train station; possession of a bike, types of bikes in household possession, smartphone possession, and finally frequency of use of apps for roadway navigation, PT use.

### Section 3: SEGMENT 'Golden Questions' for mobility clustering

Clustering the sample population into mobility clusters is one objective of this study, as explained in the literature review, in subsection 2.4.4. Mobility clusters are assigned based from individual responses to Golden Questions from the SEGMENT study. This section is comprised of questions derived from that study. During the pilot study **this section received the most negative appraisal compared to other sections.**

The Golden Questions were kept as they were worded from the SEGMENT study (S3Q01-18) were except for three deviations. Firstly, since survey testers found the negative formulation of some of the Golden Questions to be too confusing and cumbersome to quickly read and understand, questions 4, 7, and 15 of those set of questions were rephrased, but this change meant that before the results are inputted into the segment allocation algorithm (explained in a following subsection) Likert response scale were inversed. Secondly, the wording for questions relating to active modes (walking and cycling) was specified for situations in the city as to not confuse them with recreational activities since testers questioned the context of cycling and walking. Thirdly, in the Golden Questions bus is used to referrer as PT. An extra question (S3QX) accessing the statement for using the train was also added. This would be for observational purposes and therefore not be considered in segment allocation.

### Section 4: MaaS paradigm introduction and attitudinal assessment

This section (S4) and the proceeding section (S5) deal with the mobility concept of MaaS and various types of transport services, and for this report be collectively termed 'mobility concepts' (of this study). This section provides descriptions and diagrams to explain explain the features of MaaS, as defined from the literature review.

In the pilot survey this section was most favoured among participants, unlike the more neutral evaluations for the other sections. More precisely, the section evaluation had an overall positive response according to the pilot study participants, with 9.5% being very satisfied, 66.7% being satisfied, 19.1% being neutral, and 4.8% (one respondent) being unsatisfied. Remarks about the section however firstly mentioned the questioning read too negatively, and the rest of the comments related to language issues that were resolved.

In the final survey S4 is structured as follows: a question is posed to respondents for them to access the statement of them being aware of MaaS and/or combined or integrated mobility (S4Q1). At this stage the MaaS concept is introduced (S4D02) by firstly describing the situation of having no access to a private car, but a possibility is use of various transport modes, which was visualised in the survey as shown in Figure 9 on the next page. The respondent is then questioned if the use of various means

of transport to replace the (private) car is problematic for them (S4Q02). The MaaS concept, as an integrative platform smartphone-based app that connects people to mobility services with ambiguity given to the exact services (to get a ride or access a vehicle) available is described (S4D03) and illustrated as shown in Figure 9 below.

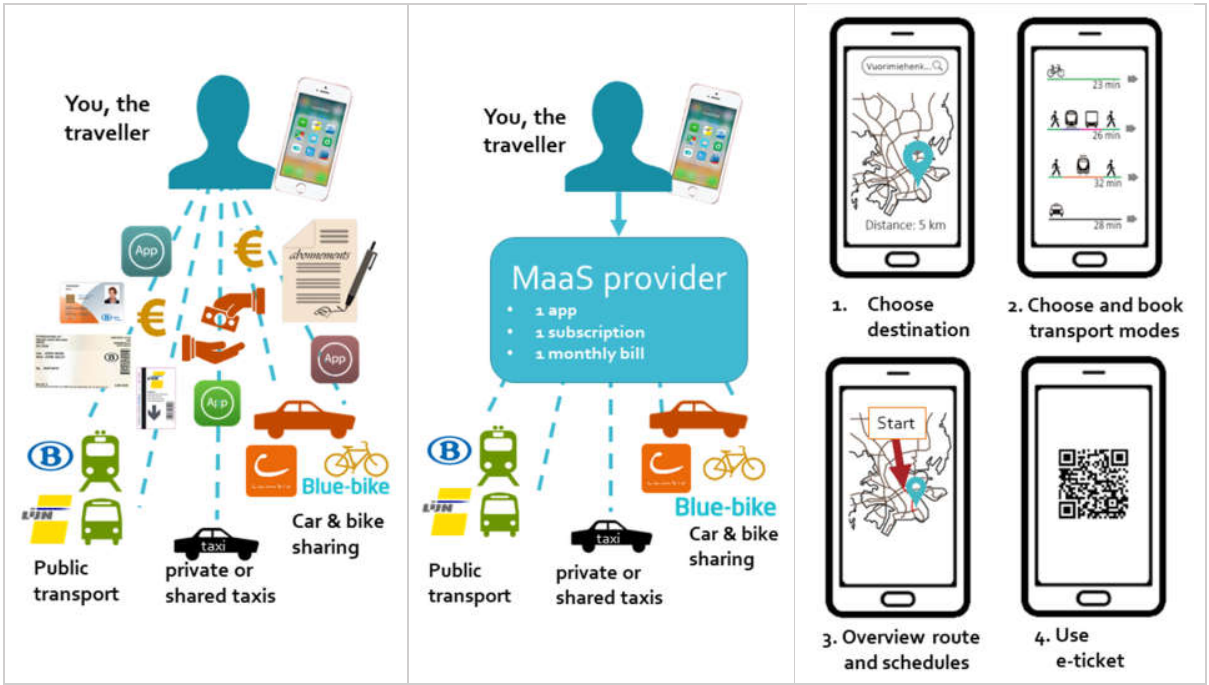



Figure 9 - Diagram of travel without (left) and with (middle) MaaS and use of the MaaS app (right)

The respondent is then asked to evaluate the statement of them surely using the app (S4Q03). The following question then asks the respondent to rank the 4 MaaS feature most important to them. Lastly, the respondent then evaluates the statement that the MaaS app would be advantageous for them (S4Q05).

### Section 5: Transport services and attitudinal assessment

The outline of transport services, as developed in subsection 2.2 provides the basis for this section. Possible transport services within the MaaS framework was introduced to respondents as providing an individual with a ride (from PT, taxis, DRT vehicles) or a vehicle (i.e. a car or bike provided). Focus is placed on more unfamiliar concepts of free floating and ride hailing transport services. During the pilot survey 65% answering that they were satisfied, though 35% were indifferent. An important comment for improvement was better clarifying the difference between a demand responsive mini-bus and a shared taxi.

For the final survey, respondents were firstly asked to assess the importance of ride providing services, starting with PT, then concepts that may be more unfamiliar: e-hailed taxis, shared taxis, and demand responsive mini-buses or micro-transit (S501-4). The idea of gaining access to a vehicle, either a hybrid/electric or gas/diesel powered car or van or (e)bike or cargo bike was introduced (S5D02). An evaluation if a certain type of vehicle will be important to access via a MaaS app was assessed based on the Likert scale of 'not interested, possibly interesting, interesting'. The various transport mode that were listed were randomly showed for each respondent.

The concept of vehicle sharing systems based on it either being station based or free-floating was introduced (S5D03). Then the respondents' knowledge and possible membership of the already existing of Cambio® and Blue-bike® car and bike sharing services, respectively, was tested (S4Q06-7). Like the previous more general question one which vehicle would be interesting for the respondent to access, the question was posed again but this time between station based or free-floating car or bike sharing systems, in addition to access to scooters. Further the concept of longer term possession of a (e-)bike, cargo bike, or scooter was introduced and assessed for the respondent's interest where choices are listed randomly (S5Q09).

The last questions of the survey, that dealt more with the MaaS concept, were placed at the end since their evaluation by the respondent would be put into context juxtaposed to vehicle and mobility service access via MaaS. Firstly, the concept of a MaaS subscription at that point was introduced and the respondent's acceptance towards the concept was assessed (S5Q10). The last two questions assess the respondent's acceptance of MaaS being a means for them to allow bike and car ownership to become redundant for them (S5Q11-12).

## 3.3 Data collection strategy

This study is done within the context of a master thesis and the **resources available to collect data are limited**. More precisely, there are no sources of external funding that can allow for a more efficient sampling strategy. A more ideal sampling strategy would employ various survey recruitment and dissemination mediums, such as door-to-door and face-to-face interviewing, telephoned recruitment, and mailed in-surveys and invitations. This means that a survey will conducted on the internet. Furthermore, because it is a survey conducted through a website browser, it will be an inherently self-administered survey.

**Recruiting participants will be done through online social networks** though a more direct recruitment approach is described. Further, survey participants will have to volunteer themselves to carry out the survey, since no form of compensation (i.e. a small but attractive amount of money or gift-card) for completed surveys could be provided. The internet as a medium to recruit and conduct surveys is a recent development and has **minimal costs** when compared to other more traditional survey methods (Petersen & Farrell, 2016). Surveys administered through the internet have notable advantages, as outlined by Smyth, Dillman, Christian, & O'Neill (2010). Internet surveys can have preprogramed skip patterns and consistency checks thus allowing for a greater level of flexibility and ease of use. Moreover, **high quality images can be incorporated into the survey to better explain** concepts thus increasingly survey comprehension.

It is even possible that the **internet may be overall a more favoured medium** because of its wide availability and high usage. However, according to a review by Nulty (2008) that gave the option to be either filled in on paper or online, the response rate internet surveys were "much lower" (on average 23% lower). In the same line, a local example where respondents were given the choice to either fill in an online or mail-in, only about 1 out of 4 people overall opted to fill the survey online (Bral et al., 2014) and therefore this alludes to a possible challenge to recruit survey participants.

In an ideal data collection approach, randomly sampling would in theory provide an accurate composition of the target population. However, obtaining a representative sample will be difficult to achieve. Uncertainties of being able to equally target all individuals who compose the target population may persist. This is because it is an internet survey and the recruitment will be conducted through that

medium. Respondents who influence themselves to complete the survey can **contribute to self-selection bias**. This could result in an over representation of a certain sub-group individuals (e.g. persons interested in innovation, sustainability, and mobility concepts) to participate in a survey (Pinjari, Pendyala, Bhat, & Waddell, 2011).

A participation lottery was implemented to motivate persons who may be indifferent to the survey's topic of investigation (countering self-selection bias) and maximise the overall participation rate. The lottery was based on the chance to win one of 12 cinema gift voucher tickets. Even though respondents living in Leuven were targeted for recruitment for survey participation, persons also not residing in Leuven were able to participate, though there were excluded from the lottery.

**Establishing an accessible online presence to encouraging participation was an important consideration.** Since the survey is online, it should be easy to access so therefore a custom website domain name is created so potential participants can easily access the website of www.maasonderzoek.be (Dutch for MaaS research). The goal was to minimise hinderances that a potential participant may face, especially if they are recruited via printed means such as from a flyer. Further various social media groups on Facebook for Leuven was used to promote the survey. These groups have high levels of activity and membership levels at least above 5,000.

## 3.4 Assigning and verifying mobility profiles

### 3.4.1 The SEGMENT allocation algorithm compared to a direct cluster analysis

One core aspect of this thesis is to classify each respondent to a mobility profile based on the SEGMENT project. The respondent evaluates attitudinal statements on car use, cycling, bus travel, climate change, and keeping healthy through active modes. This follows a consumer market segmentation technique (as explained in the literature review, page 24).

Car drivers and non-car drivers are first separated, and the Likert scale responses per question is recoded from a categorical variable into an integer between 1 to 5 for which the value is multiplied by the weighting coefficient per question per segment. The values are then summed up and is subtracted from a value termed the constant per segment. The highest resulting value to corresponding profile is then the segment that is assigned. The results are shown in the appendix since they do not form part of the main discussion.

### 3.4.2 Assessing the validity of segment and variable relationships

The SEGMENT study compared their statistical clustering approach to results from the allocation algorithm (Anable & Wright, 2011). The accuracy that was reported was between 70% and 85% depending on the segment. Further when comparing the results from individual case study cities the difference accuracy can range from 40 to 97%.

Further, from the project's literature no reference was found of results of respondents evaluating the segment that was assigned to them. Even though literature is sparse about respondents self-assessing their segments, a follow up survey was done to ask respondents who inputted their email (81% of all valid responses) with the possibility for follow up questions. A personalised link was sent to their email that allowed them to read their assigned segment title and description and assess it by selecting a choice on the Likert scale of agreement. Respondents also had the option to leave a comment. The purpose of this self-assessment is also for descriptive purposes but may yield interesting results for discussion, a view that was shared with the principle investigator of the SEGMENT.

### 3.4.3 Analysing the statistical association between variables

An aim of segmenting individuals is to understand possible relationships between a segment and the preference for MaaS and underlying service concepts. A common statistical test would be to analyse segments in relation to concepts in relation to non-segmented baseline (sub)categories in relation to evaluations towards the mobility concepts of this study. More concretely, firstly mobility concept evaluations (from section 4 and 5 of the survey) was compared with segment categories (derived from S3) and baseline socioeconomic (S1) and mobility behaviour (S2) variables. Secondly, segment classes are compared to baseline socioeconomic (S1) and mobility behaviour (S2) variables for which results can describe the discriminant capability of segment classes reveal heterogeneity (based on cognitive psychosocial variables from the TPB) among respondents when compared to baseline non-attitudinal variables (i.e. socioeconomic and mobility behaviour variables).

A series of Chi-square to test for association between the segments and the other characteristics reveal the likelihood that there is any observed difference between segments and other variables, and this aims to take into consideration that variation in the data is not an outcome by chance (e.g. Crespo Casado, Rundle-Thiele, & Dietrich, 2017). However, Chi-square is not appropriate because of values in a contingency table may be too sparse for a survey with too little respondents the Chi-square will not produce valid results, therefore, an Exact Test is done based on a Monte Carlo simulation of the dataset which has already been applied to validate segmentation results in terms of determining the optimal number of clusters (Nylund, Asparouhov, & Muthén, 2007).

Statistical tests are done to explore patterns in the expansive 100-plus column dataset and not to achieve inferential judgements about the parameters of a population since achieving a random sample for this study is not possible. Limitation of this approach and the validity of accepting or rejecting the null hypothesis from the battery of Exact Tests are namely: consideration of the issue of multiplicity, or the multiple comparisons problem which increases the chance that results are statistically significant when there is no underlying effect, and subjectivity of choosing the significant level adjustment (the alpha value) that determines the cut-off to reject the null hypothesis (e.g. 0.05 or 0.01) of probability of a statistical relationship (Chen, Feng, & Yi, 2017). However, the value of the statistical tests forms a basis to develop a more statistical rigours approach in future research on the topic.

# 4 Results

The following subsections provide the results from the analysis of data collected by the survey. These three results subsections form the basis of the discussion developed in chapter 5. Firstly, as shown on subsection 4.1, baseline characteristics of the target sampling area is outlined and compared to reference statistics available for Leuven. Secondly, in subsection 4.2, results on the preference for MaaS and transport services are overviewed, and results are described in relation to baseline characteristics for significant and noteworthy relationships.

Results from the mobility segment allocation methodology are then outlined: subsection 4.3 introduces mobility segments firstly in terms of the distribution among respondent's data, and then compares this to distributions among segments from other studies. Fourthly in subsection 4.4, each segment is described based on results from the crosstabulations. Lastly in 4.5, results from a validation of segments by original survey respondents are overviewed together with remarks of the statistical validity from the survey dataset.

## 4.1 Baseline socioeconomic & mobility characteristics

During the period from March until May 2018 the online survey platform recorded a total 111 completed inputs out of a total of 134 initial and unique attempts to carry out the survey. This represents a dropout rate of 17.1% (22 records) and most persons who dropped out did so early in the survey. Sixty percent of survey dropouts did so in the first half of the survey. It is contended that the survey achieved a good level of completion when respondents become motivated to begin the survey in the first place. The time needed to complete the survey was on average 14 minutes, after excluding 9 outliers[9].

In terms of the overall response rate of the survey, that proportion is difficult to ascertain since recruitment was done opportunistically and unsystematically by targeting Facebook Groups (and there is no indication of the number of times a post has been viewed) that facilitate community-based forums for the people of Leuven but also through acquaintances living in the city.

Out of the 111 completed entries, 104 surveys (94%) were from people stating that they lived in Leuven. The seven respondents not living in Leuven all lived in surrounding municipalities (namely, Herent, Holsbeek, Kampenhout, Korbeek-Lo, Lubbeek). The survey also questioned if residents were legally domiciled; 95 (91%) answered yes and 9 (9%) no. Even though legally domiciled residents would most likely be represented in local statistics, undomiciled residents (avg. age 27 years; 6 respondents studying and 5 working) are included in the analysis because of the already limited sample analysis that focused on segmentation and mobility concept appraisal rather than statistical representativity of the Leuven population.

### 4.1.1 Demographic and socioeconomic patterns

The results for this subsection derives from the first section (S1) of the survey. Table 5 overviews these demographic and sociodemographic attributes in relation to available statistics for Leuven. Even

[9] The duration would have timed from when users would have begun the survey, and then closed it, to then later resume it, granted that they did this within 24 hours and browser data was not reset

though a representative sample is not possible given the unsystematic survey recruitment approach, the comparison nevertheless allows one to contextualise further presented analysis.

The table begins with the population distribution among the various districts of Leuven. Making such distinction allows interesting comparisons to made since two (Wilsele and Wijgmaal) of the 5 districts are more suburban or rural compared to more centralised and urbanised areas. However, given the low response rate (3-8 responses), conclusions of the influence of urban form and accessibility to transport hubs may be difficult to substantiate. In terms of the accessibility to transport hubs, the Leuven station lies between Leuven and Kessel-lo and provides highspeed and direct connections to all other major cities in the country. Adjacent to the train station is also the regional bus network hub for that region of Flanders (known as the *Vervoergebied Leuven*).

The demographics of the survey sample, the gender distribution from this study over represents males though marginally, and thus should provide enough insight into the influence of gender on further results. A slight difference (less than 2%) is shown in nationality. The survey also recorded the language it was taken in, and 6.25% of all survey respondents choose the English version as opposed to the Dutch version. The distribution between age groups make it apparent that the 25-34 and 35-44 age group is overly represented with percent differences of around 15%, and this difference is contracted with persons over the age of 55. The pattern becomes clear after the age group of 65, and the survey recorded no one older 75.

The household structure distribution recorded by the survey was more representative to official statistics though given the age structure distribution, household structure would not take well into account older persons. In terms of households with children less than 18 years old, the distribution seems to account for household with more children, compared to those with one child. Educational and economic attributes were not able to be fully compared to local statistics. However, the distributions for education and income appear to be heterogenous except for employment status, at least when comparing to the employment and job seeking statistics (Statistics Flanders, 2018b).

Employed persons are therefore overrepresented but this may be no surprise given the persons who may be most economically active – persons between 25 and 60 years responded to the survey. Never the less, except for employment status and older age groups, heterogeneity between subgroups within the sample are advantageous in supporting further analysis, particularly when respondents are segmented into mobility profiles.

### 4.1.2 Mobility and transport use behaviour

The results from in subsection summarises the response from the second part of the survey (S2). Table 5 summaries mobility and transport use patterns from the sample population to, when they are available, local statistics. Firstly, in terms of driver's licence possession, the proportion matches regional average within a 5% margin. When location is compared either outside or inside the city it has a similar proportion to official, albeit dated, statistics. Working location may influence mobility behaviour since transport options would vary greatly. People working in larger cities may see public transport more feasible than driving car.

Table 5 – Sociodemographic distributions from results compared with official statistics

| Result from this study | | | | Official statistics for Leuven | | |
|---|---|---|---|---|---|---|
| | | n | % | N | % | Sources |
| Population per district | Leuven (centre) | 47 | 44.7 | 27,235 | 32.8 | Stad Leuven (2017) |
| | Heverlee | 20 | 19.1 | 21,504 | 25.9 | |
| | Kessel-Lo | 27 | 25.7 | 23,628 | 28.4 | |
| | Wilsele | 8 | 7.6 | 7,836 | 9.4 | |
| | Wijgmaal | 3 | 2.8 | 2,885 | 3.5 | |
| | *Total* | 105 | | 83,088 | | |
| Sex dist. (Leuven) | Female | 54 | 47.8 | | 51.0 | Statistics Flanders (2018a) |
| | Male | 59 | 52.2 | | 49.0 | |
| Age dist. | 17-24 | 10 | 9.5 | | 11.0 | |
| | 25-34 | 33 | 31.4 | | 13.8 | |
| | 35-44 | 29 | 27.6 | | 15.4 | |
| | 45-54 | 22 | 21.0 | | 18.3 | |
| | 55-64 | 8 | 7.6 | | 16.9 | |
| | 65-74 | 3 | 2.7 | | 12.8 | |
| | 75+ | 0 | 0 | | 11.9 | |
| Nationality | Belgian | 97 | 92.4 | | 93.6 | |
| | Non-Belgian | 8 | 7.62 | | 6.4 | |
| Household structure | Couple /no children | 29 | 27.6 | | 29.2 | Statistics Flanders (2018) |
| | Couple w. children | 35 | 33.3 | | 26.9 | |
| | 1 parent w. children | 4 | 3.8 | | 4.4 | |
| | Living alone | 24 | 22.9 | | 31.2 | |
| | Collective living[10] | 3 | 2.9 | | 2.5 | |
| | Other[11] | 10 | 9.5 | | 5.8 | |
| Households with children (<18yrs) | 1 child | 14 | 22.2 | 5,592 | 42.0 | |
| | 2 children | 26 | 41.3 | 4,986 | 37.5 | |
| | 3 children | 18 | 28.6 | 2,046 | 15.4 | |
| | 4 or more children | 5 | 7.9 | 684 | 5.1 | |
| | *Total* | 63 | | 13,308 | | |
| Highest level educational diploma | Secondary school | 25 | 23.8 | | | |
| | Post-secondary inst. | 18 | 17.1 | | | |
| | University | 62 | 59.1 | | | |
| Employment status | Employed | 88 | 83.8 | | 68.7 | 2014 figures (Statistics Flanders, 2018) |
| | Job seeker | 1 | 1.0 | | 7.2 | |
| | Retired | 3 | 2.9 | | | |
| | Student | 13 | 12.4 | | | |
| Monthly household income (net) in Euro | 1001-2500 | 31 | 35.2 | | | |
| | 2501-4000 | 25 | 28.4 | | | |
| | 4001-5500 | 19 | 21.6 | | | |
| | 5500+ | 7 | 8.0 | | | |

[10] For example, in a retirement home or a student dorm
[11] Living with housemates, adults living with parents, family, etc.

Most respondents working outside Leuven travel to Brussels (n=14), and most travel with the train (n=9); in comparison to persons working within the province (n=5) of which 70% use the car to get to work. The province that Leuven is situated in is more rural and is more likely to be served less frequently by local trains and bus services when compared to Leuven itself or other larger cities.

Table 6 then shows the mode of transport taken to reach work or school is also shown and compared to data available specifically for Leuven from 2017. Notably people who drive to work (n=100), and to a lesser extent, use public transport are underrepresented when comparing to the overrepresentation of walking and cycling. This indicates that the sample that participated in the survey have an overall travel behaviour favouring active and publicly shared modes, as opposed to private car use.

Transport mode use behaviour is more evident when comparing the frequency of transport mode use to that at the level of the Flemish Region (from the OVG study) shown on Figure 10 (page 46). Even though regional patterns will over represent car use, differences are noticeable with 13.5% of respondents using the car daily, compared to 42.29 percent for Flanders as a whole. Being a car passenger is another variable that is also under represented from this survey. Even when comparing OVG data available for urban areas of Antwerp and Ghent, their level of daily car trips only decrease to 32.4% (MOW, 2017) and this compares to 13.5% for this study; therefore it can be assumed that the survey overrepresented infrequent car drivers.

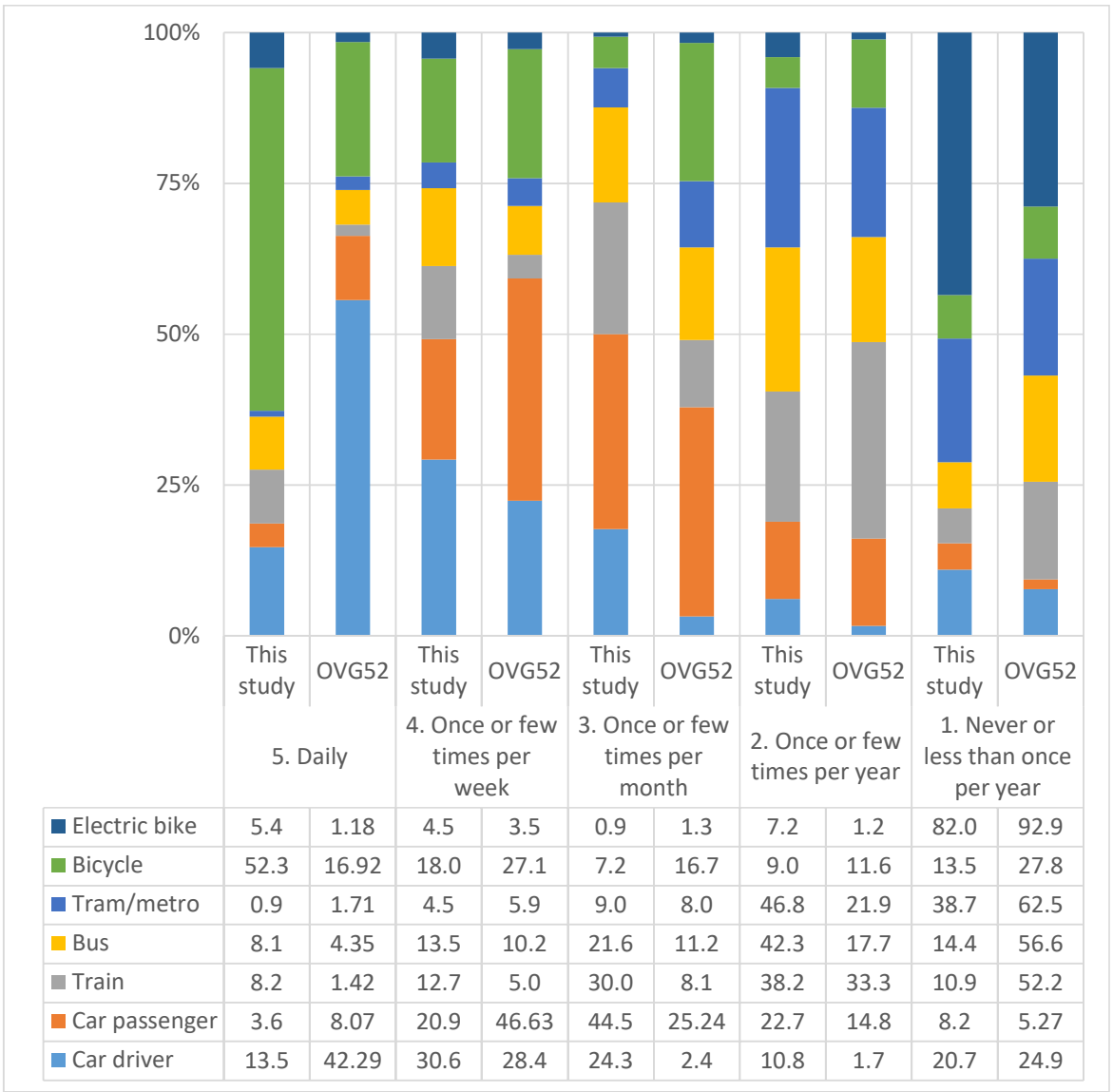
Figure 10 also shows transport use at more infrequent scales (numbered items 4 to 1 on the figure). Apparent is that car driving is done more frequently on a weekly or monthly basis, and this contrasts to cycling and PT (namely with the train and bus), which is skewed to a more daily use. Not all types of PT transport show an overrepresentation in terms of more frequent use though. Tram and metro use is less frequent, but this could be due to the lack of any such PT system present in Leuven.

One's household access to a mode of transport may provide an interesting relationship when compared their actual means for work. Firstly, there is an apparent similarity to the distribution from the local statistic, from bike access, and car access (to a lesser extent) is less comparable when compared to the household availability electric and cargo bike. In terms of the question of car access, one limitation of the survey identified after data collection ended was that the question asking the number of household cars was only activated when a respondent stated they have a driver's licence. Possession of a company car is more representative though this can be the result of respondents being employed.

The last part of Table 6 mostly lacks statistics to compare to local patterns however provide interesting insight to the survey population. Smartphone ownership and use is high with people using apps for PT and road navigation, at 21.1 and 32.7%, respectively. This can be related the preference towards MaaS which is provided via apps. Most people are aware of sharing systems, though a minority are members of those services.

Table 6 – Mobility behaviour distributions from results compared with official statistics

| Results from this study | | | | Official statistics for Leuven or Flanders | | |
|---|---|---|---|---|---|---|
| *For persons living in Leuven* | | n | % | N | % | Source |
| Driver's licence | In possession | 94 | 83.2 | | 80.2 | OVG52: Declercq, Reumers, Janssens, & Wets (2017) |
| | Not in possession | 19 | 16.8 | | 18.8 | |
| Commuting for work | Leuven | 65 | 73.9 | 17,920 | 47.0 | 2014 data from Steunpunt Werk (n.d.) |
| | Outside Leuven | 23 | 26.1 | 20,211 | 53.0 | |
| Transport means: work *or* school | (Electric) bicycle | 44 | 44 | | 32 | *Stadsmonitor* 2017: (Bral et al., 2018) |
| | Bus or train | 21 | 21 | | 26 | |
| | Walking | 16 | 16 | | 7 | |
| | Driving | 19 | 19 | | 35 | |
| Household access to vehicle | House hold car | 73 | 72.3 | | 79 | |
| | Bicycle | 90 | 84.9 | | 82 | |
| | Electric bike | 11 | 10.4 | | 15 | |
| | Cargo bike (bakfiets) | 5 | 4.7 | | 5 | |
| Car ownership | Personally own | 47 | 72.3 | | - | |
| | Company car | 8 | 17.7 | | 12.1 | OVG52 |
| Smartphone ownership and use | Has smartphone | | 93.0 | | | |
| | Apps for PT >2/ week | | 21.1 | | | |
| | Navigation >2/ week | | 32.7 | | | |
| Bike sharing | No knowledge | 4 | 3.8 | | | |
| | General knowledge | 11 | 10.5 | | | |
| | Knowledge Blue-bike | 77 | 73.3 | | | |
| | Blue-bike member | 13 | 12.4 | | | |
| Car sharing | No knowledge | 3 | 2.9 | | | |
| | General knowledge | 4 | 3.8 | | | |
| | Knowledge Cambio | 86 | 81.9 | | | |
| | Cambio member | 12 | 11.4 | | 5 | *Stadsmonitor* 2017 |




| | 5. Daily | | 4. Once or few times per week | | 3. Once or few times per month | | 2. Once or few times per year | | 1. Never or less than once per year | |
|---|---|---|---|---|---|---|---|---|---|---|
| | This study | OVG52 | This study | OVG52 | This study | OVG52 | This study | OVG52 | This study | OVG52 |
| Electric bike | 5.4 | 1.18 | 4.5 | 3.5 | 0.9 | 1.3 | 7.2 | 1.2 | 82.0 | 92.9 |
| Bicycle | 52.3 | 16.92 | 18.0 | 27.1 | 7.2 | 16.7 | 9.0 | 11.6 | 13.5 | 27.8 |
| Tram/metro | 0.9 | 1.71 | 4.5 | 5.9 | 9.0 | 8.0 | 46.8 | 21.9 | 38.7 | 62.5 |
| Bus | 8.1 | 4.35 | 13.5 | 10.2 | 21.6 | 11.2 | 42.3 | 17.7 | 14.4 | 56.6 |
| Train | 8.2 | 1.42 | 12.7 | 5.0 | 30.0 | 8.1 | 38.2 | 33.3 | 10.9 | 52.2 |
| Car passenger | 3.6 | 8.07 | 20.9 | 46.63 | 44.5 | 25.24 | 22.7 | 14.8 | 8.2 | 5.27 |
| Car driver | 13.5 | 42.29 | 30.6 | 28.4 | 24.3 | 2.4 | 10.8 | 1.7 | 20.7 | 24.9 |

Figure 10 – Comparison between transport mode use frequency (percent) with Flemish average (OVG52)

## 4.2 Evaluation of mobility concepts

The core to this study is the evaluation of the MaaS concept in terms of the preference of mobility services and vehicle availability within an integrated mobility service. The third section (S3) of the survey deals with questions to resolve the research questions. Those questions seek to investigate the preferences for MaaS generally and in terms of its features, and of the different types of 'ride' or 'vehicle' providing services.

These results show the proportions of levels of acceptance for which the positive or negative (agree or disagree) ends of the Likert scale were aggregated. That was also the case to statements that questions the interest of certain types of vehicle access via MaaS: possibly interesting and interested were combined. Further, certain statements that may be shown paraphrased on the figure, therefore the question or description code can be used to reference the actual survey in the appendix.

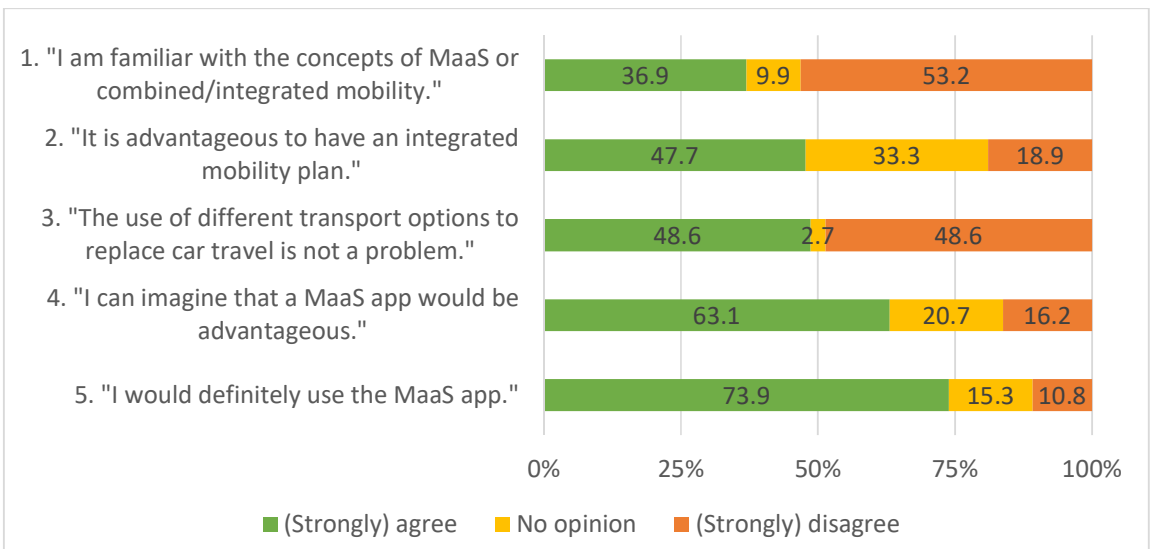
### 4.2.1 Appraisal to MaaS concepts and features

More general evaluations for MaaS were done by responds, as shown on Figure 11 below. The other of results follows below.

Before MaaS was explained to the respondent, a question (S4Q1) accessed their knowledge of MaaS but also of integrated mobility for which 63.1% individuals did not have a positive appraisal of the statement. The survey then described a possible situation that someone may face when traveling without personal access to car and accessing various forms of mobility services (S4D02). Next, the survey questioned respondents if such a situation is problematic for them and the response was split: 48.6 % either (strongly) agreed or disagreed to the statement. The survey then proceeded to explain the integrated mobility concept of MaaS (S4D03), and the respondent was then questioned if they will *surely* use a MaaS app. The response was clearly positive, with 73.9% (strongly) agreeing to the statement.

The survey then questioned respondents for a second general appraisal of the MaaS (S4Q05) by presenting the statement of "MaaS being advantageous" to them. After the mental task of ranking features of MaaS and their understanding being probably clearer, 63.1% respondents (strongly) agreed to the statement. The more negative response may be explained by the apparently more targeted wording of the statement of the usefulness of the service to their current travelling needs rather than making general use of it.

The advantageousness of having an integrated mobility plan was assessed based on a statement[12] after concepts of mobility services were explained (next subsection). A slight minority (47.7%) agreed in some way with the statement, though the second largest group, 1/3 of respondents had an indifferent appraisal. This indicates that a MaaS service may need to cater to customers with varying preferences to the idea of a bundled service offer.




[12] S5Q10: "I think it is advantageous for me to use an integrated mobility plan from a MaaS provider, which is more advantageous than paying the costs individually"

Figure 11 – Average distributions for the evaluation of statements relating to MaaS

The survey then allowed the respondent to rank the features (as defined from the literature review) of MaaS that was most important to them. As shown in Figure 12 the respondents split on the first choice at 43.9%: travel information or subscription-less access to individual services. The second choices were more equally split between the four choices, though as with the first choice, travel information and access to services were equally top choices both at 27.6%. Second to those two was the electronic ticket feature.

Respondents then choose their 3rd and 4th choices, the highest rating features were electronic tickets (35.7%) and single account billing (48%), respectively. The result from this ranking task may be more related to how the respondent understood how MaaS which was explained before the question was present, in a possible sequence of use than a prioritisation of features.

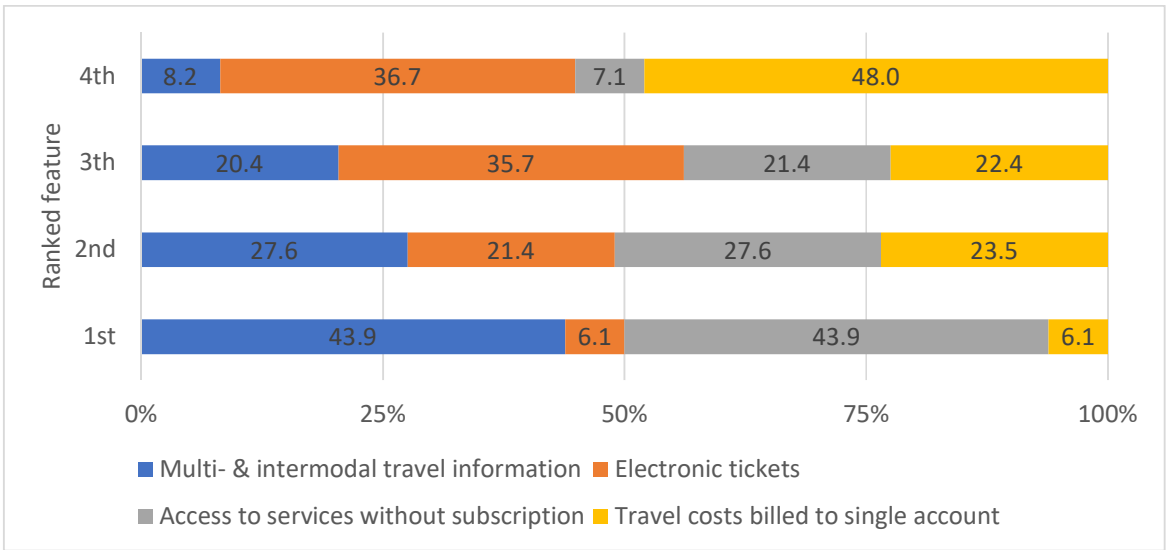



Figure 12 – Distribution of the ranked importance for four MaaS features

### 4.2.2 Mobility and vehicle service accessibility and ownership

#### Ride providing services

The survey then continued to the last section of the survey (S5), introducing mobility services that could be integrated MaaS. The first set of questions dealt in this section dealt 'ride' providing services (S5Q1-4), namely private taxis, shared taxis, micro transit minibuses, and public transport, as shown on Figure 13. An apparent tread emerged: people agreed more the statement when it involved a more public and larger scale form of transport.

Public transport (examples were given of the bus, tram, metro, and train services in Belgium) had a 91.9% favourability in their inclusion in a MaaS app. This contrasted to private and more traditional taxi services that had a favourability of 54.1% though had the largest proportion of indifferent and negative responses. Taxis would be known to respondents in their operation compared to shared taxis and micro-transit and the more contemporary and innovative services are favoured more.

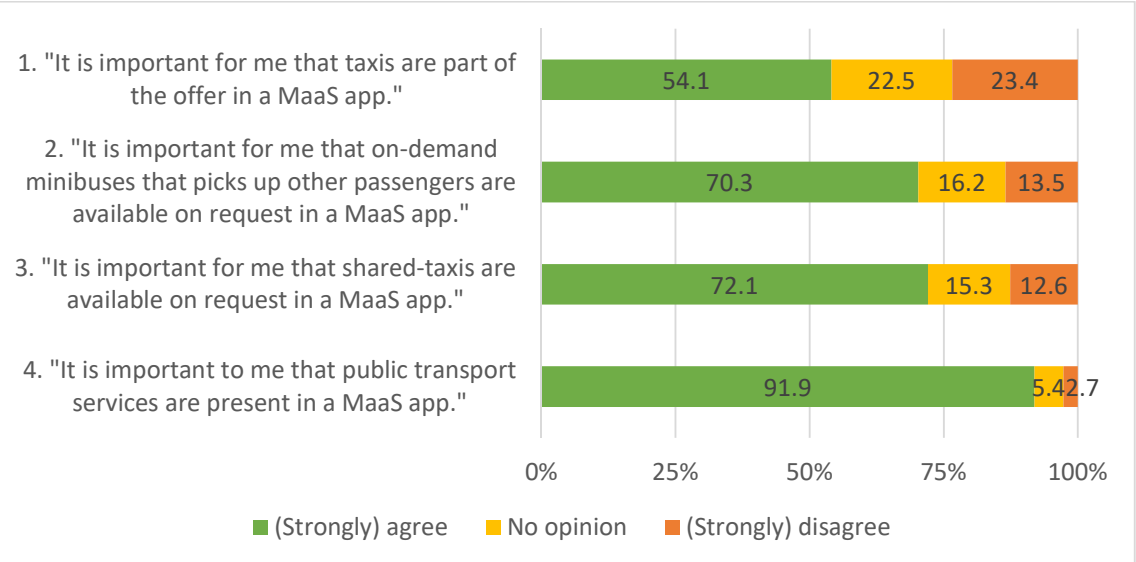



Figure 13 – The evaluation of statements relating to various ride providing services

Vehicle access

The next set of questions dealt with the possibility of gaining access to vehicles, a term that is broadly applied to both cars, bikes, and scooters. A general appraisal on various types of vehicles (S5Q05) was clear based on a measure of interest, as shown in Figure 13. The vehicles are listed, top to bottom, based on the proportion of respondents providing a negative evaluation of 'not interesting', and the scooter fared the worst (which is also the case for longer term rental in Figure 14), contrasted to the most positive proportion to a normal bicycle. When comparing vehicles of the same categories, electric bikes fared worst to normal bikes, while electric or hybrid cars fared better than conventional cars. This may indicate an apparent discord with a higher favourability with more technologically advanced vehicles: greater preference for an ordinary bike as opposed a lesser preference to conventual cars.

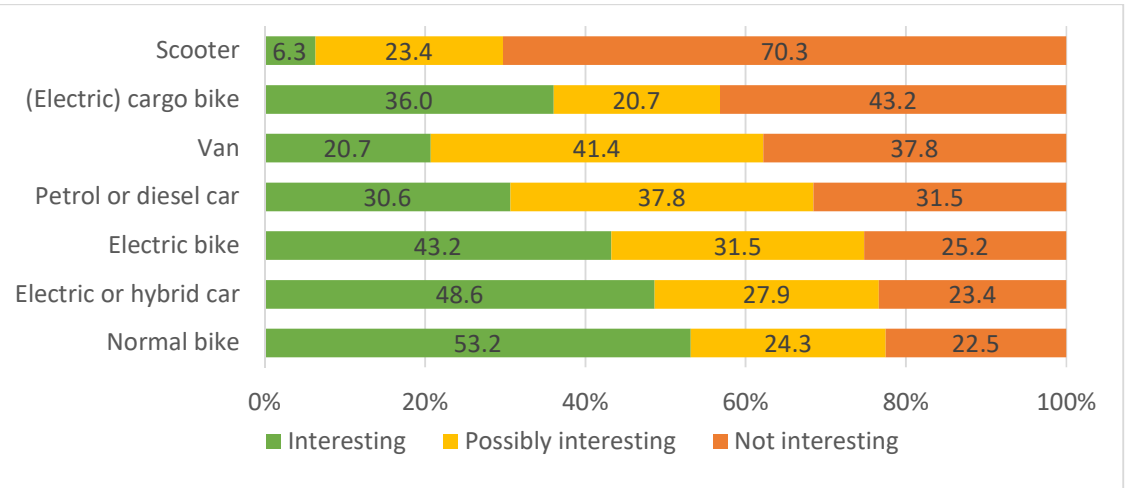



Figure 14 – Distributions on the evaluation of interest for vehicles accessible through MaaS

The largest proportions of 'possibly interesting' was from vans, petrol/ diesel car, and then the electric bike. Those vehicles may more often be favoured in more exceptional circumstances. For example, a van when needing to move large objects from one place to another, an electric bike for a

longer than usual bike ride, and a fuel-based car as a response to electric vehicle's range anxiety resulting from the uncertainty to recharge the vehicle for longer journeys. Cargo bikes, electric or otherwise, also may be used for exceptional circumstances but had a slightly lower favourability.

The general concept of access to vehicles was made more concrete to the idea of accessing a vehicle for longer term usage (S5Q09), as overviewed in Figure 15, below. Again, the favourability to scooters fared similarly to a general assessment though favourability between an electric and conventional bike gained similar proportions. Electric bikes may therefore be more favoured for longer term use, and the same holds though for a lesser extent for cargo bikes.

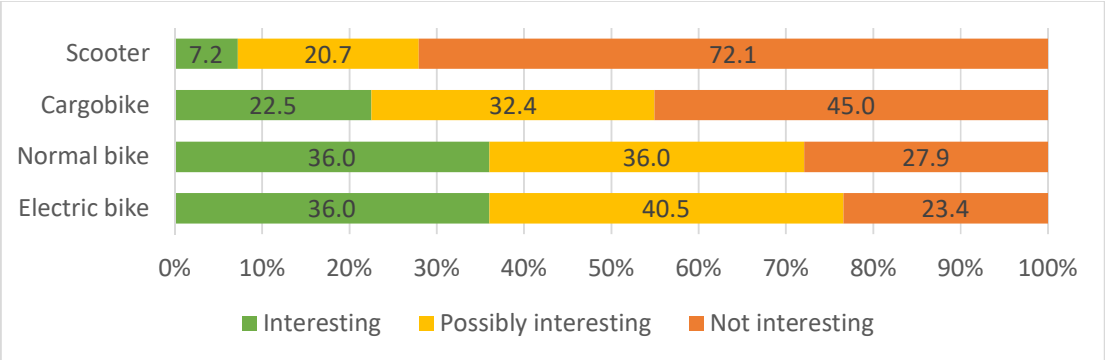



**Figure 15 – Distributions on the evaluation of interest for longer term vehicle rental**

Another more specific concept was the dichotomy between free-floating and fixed station sharing systems for cars and bikes (S5Q08) as shown in Figure 16 below. Fixed station sharing systems had generally more of a positive response, while free-floating systems received a greater share of a 'possibly interesting' proportion. Free-floating systems are only now emerging in the country, and there are no known services for Leuven. Therefore, it may be postulated that respondents may be less certain of how the concept may work compared to well station-based systems that have existed for many years.

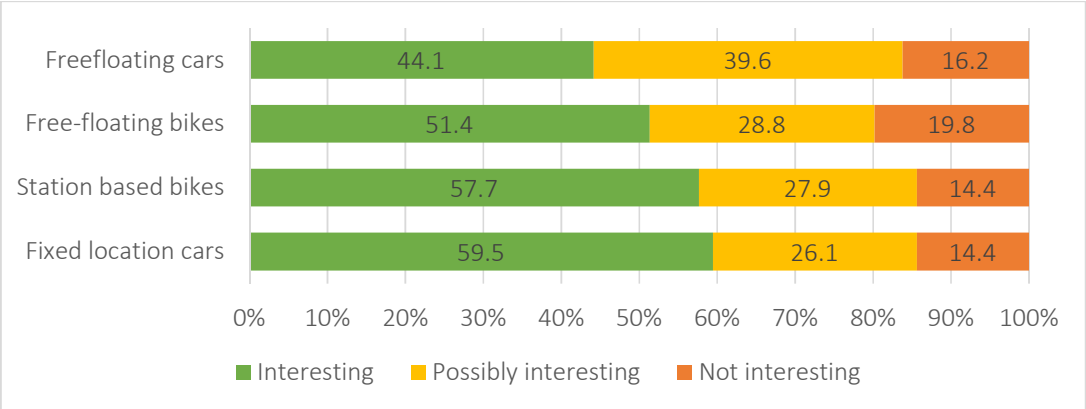



**Figure 16 – Distributions on the evaluation of interest for fixed and freeloading sharing systems**

Questions for the survey ended with an evaluation to the statement of MaaS leading to bike and car ownership being redundant (S5Q11-12) as shown in Figure 17 on the next age. The question was poised as untargeted with 'imagining'. Instead of ownership, vehicles could be accessed both for short (akin to sharing systems) and longer term (akin to leases) possession. In terms of bike ownership, 60.4% disagreed with the statement, while 33.3% disagreed when it concerned cars. The idea of replacing car ownership with temporary use seems more feasible, rather than for bikes. Though it should be noted

that the explanation for a 'longer term' access was not explained in detailed because of the already lengthy survey that went into detail explaining the MaaS concept. The results from Figure 17 are disaggregated at the level of the access to a household car and age on Figure 18 below.

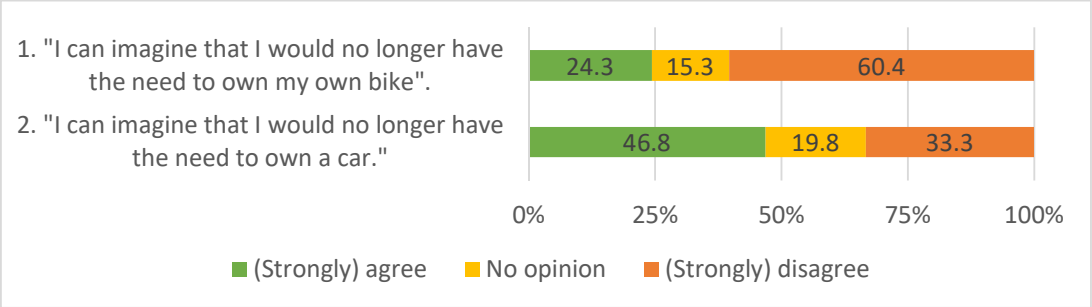



Figure 17 – Average distributions for the evaluation of statements for MaaS on car and bike ownership

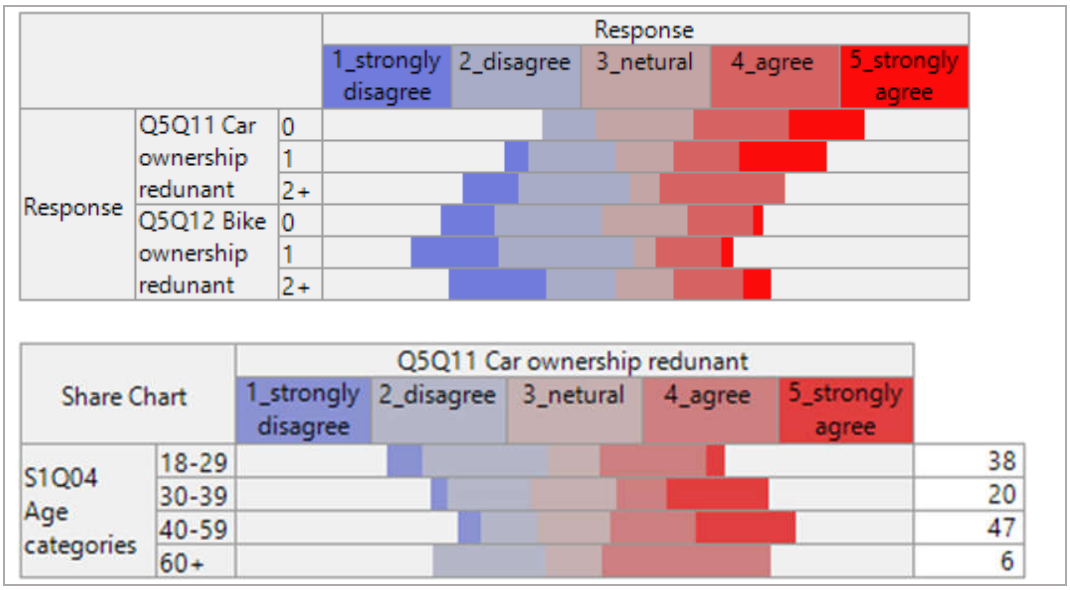



Figure 18 - Household cars access and age compared to appraisal about (bike) and car ownership

### 4.2.3 Comparing the evaluation of mobility concepts with baseline attributes

In previous subsections, survey data variables were shown without any comparison with other variables. From this part of the chapter, results are disaggregated by presenting crosstabulations between one set of variables with another. The crosstabulations for mobility concept evaluation with baseline attributes are presented on Tables 14 and 15 of the appendix (from page 83). Positive points on Likert scale were combined for each evaluations of a mobility concept are shown in percentage per (sub)category. The statistical relations are strongest when mobility concept evaluations are compared to mobility behaviour (last subsection of results chapter).

## 4.3 Mobility segments

In the previous two subsections baseline attributes of the sample population and their preferences and favourability towards MaaS and services within were presented. Those findings were generalisations across all participants. Even though the results could be analysed for statistical relationships between individual variables and groups of variables, the primary approach that was taken was to divide respondents into mobility segments. This study followed the approach developed by the SEGMENT project as overviewed in subsection 3.5 of the methodology. Figure 19 presents the overall distribution of the eight predefined segments with proportions between 32% and 3%.

As shown on Figure 20 (next page), the distribution of segments are compared to findings from a study from Leuven (Semanjski et al., 2016), Flanders (Semanjski & Gautama, 2016), and from six other European cities that originally developed and/or tested and validated the SEGMENT methodology (Anable, 2013).

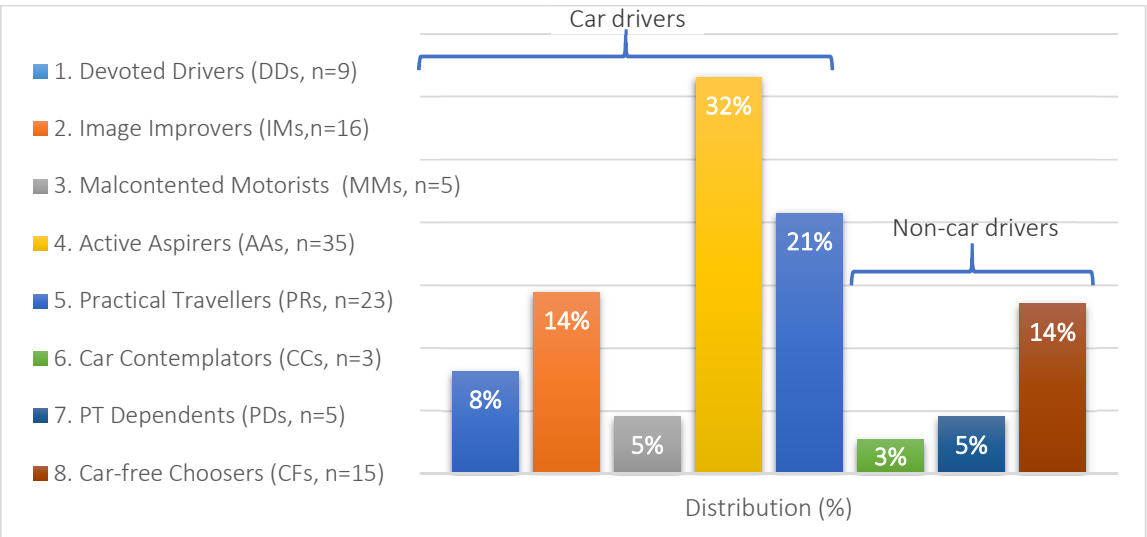
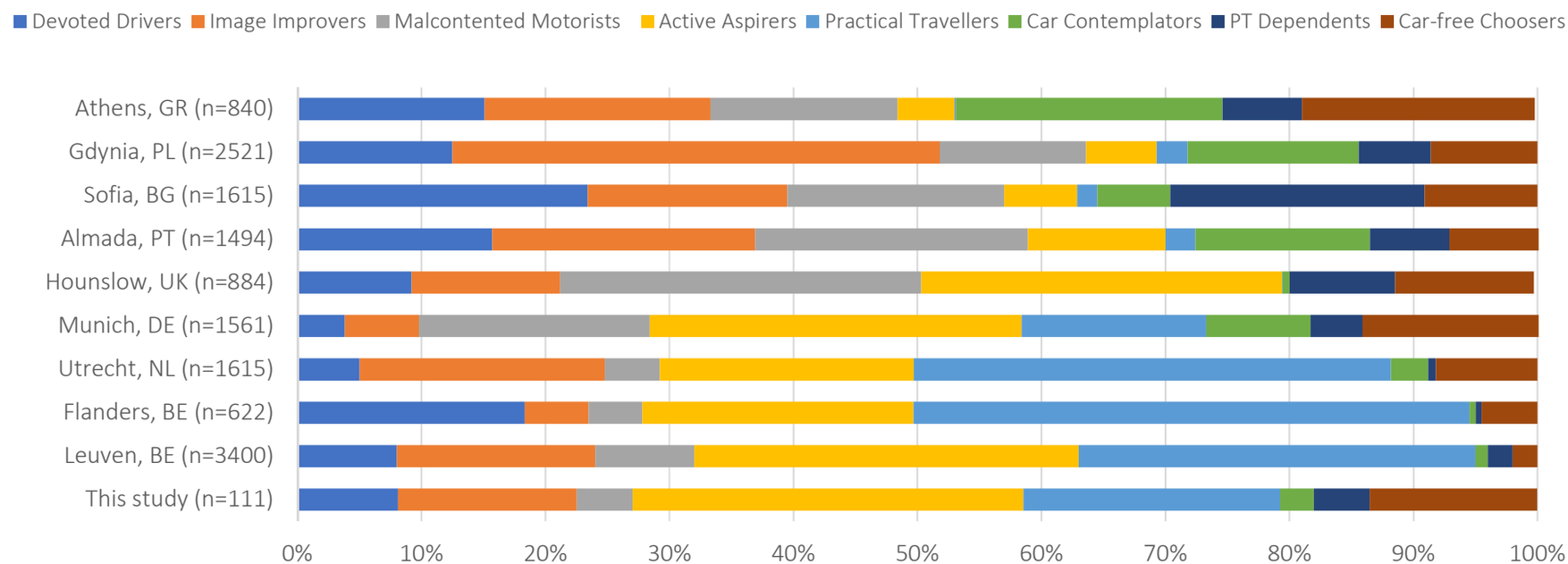



**Figure 19 – Segments among survey respondents divided into car drivers (CD) and non-car drivers (ND)**

### 4.3.1 Disaggregation of survey results per segment

Following the results from the Exact Tests analysing the relationships between different variables from the survey, segments provided a marked level of heterogeneity, as overviewed in the last subsection of this results chapter. Respondents were assigned a segment, and this allows general results to be presented in four crosstabulations as follows the figure comparing results to other studies.

- **Golden questions response:** the segments were assigned based solely on results from the Golden Question which are shown per segment based on their average scores, shown on Table 7.
- **Demographic and socioeconomic attributes:** six main categories together with subcategories for demographic and socioeconomic attributes are disaggregated per segment as shown on Table 8.
- **Mobility and travel behaviour:** travel and transport use behaviours were outlined into six categories per segment as shown on Table 9.
- **Appraisal of mobility concepts:** evaluation of MaaS and transport service concepts were overviewed on Table 10. The responses were aggregated to show the acceptability of statements.




| | This study (n=111) | Leuven, BE (n=3400) | Flanders, BE (n=622) | Utrecht, NL (n=1615) | Munich, DE (n=1561) | Hounslow, UK (n=884) | Almada, PT (n=1494) | Sofia, BG (n=1615) | Gdynia, PL (n=2521) | Athens, GR (n=840) |
|---|---|---|---|---|---|---|---|---|---|---|
| Devoted Drivers | 8% | 8% | 18% | 5% | 4% | 9% | 16% | 23% | 13% | 15% |
| Image Improvers | 14% | 16% | 5% | 20% | 6% | 12% | 21% | 16% | 39% | 18% |
| Malcontented Motorists | 5% | 8% | 4% | 4% | 19% | 29% | 22% | 18% | 12% | 15% |
| Active Aspirers | 32% | 31% | 22% | 21% | 30% | 29% | 11% | 6% | 6% | 5% |
| Practical Travellers | 21% | 32% | 45% | 39% | 15% | 0% | 2% | 2% | 3% | 0% |
| Car Contemplators | 3% | 1% | 0% | 3% | 8% | 1% | 14% | 6% | 14% | 22% |
| PT Dependents | 5% | 2% | 0% | 1% | 4% | 9% | 6% | 21% | 6% | 6% |
| Car-free Choosers | 14% | 2% | 5% | 8% | 14% | 11% | 7% | 9% | 9% | 19% |

**Figure 20 – distribution of segments compared from this study compared to that from other samples**

Table 7 - Mobility profiles compared to average evaluations to "Golden Questions" from the SEGMENT study

| **Explanation for averages:** questions 1 to 5 and 7 to 18 were evaluated on a Likert 5-point scale of agreement: (strongly) agree, neutral or indifferent, (strongly) disagree, which were coded with the values 5 (red) 3, (yellow) and 1 (green) respectively. Question 5 also uses a 5-point scale, but for likelihood. | | Devoted Drivers | Image Improvers | Malcontented Motorists | Active Aspirers | Practical Travellers | Car Contemplators | PT Dependents | Car-free Choosers |
|---|---|---|---|---|---|---|---|---|---|
| | | DD | IM | MM | AA | PR | CC | PD | CF |
| Distribution among respondents (n) | | 9 | 16 | 5 | 35 | 23 | 3 | 5 | 15 |
| Distribution among respondents (%) | | 8 | 14 | 6 | 32 | 21 | 3 | 6 | 14 |
| Golden Questions: statements and questions | Q1: Has driven a car in the last 12 months? | Cell averages per question per segment | Yes | | | | | No | | |
| | Q2: Preference for the car over other transport modes | | 4.22 | 3.75 | 2.60 | 1.56 | 1.96 | N/A | | |
| | Q3: I like to drive just for the fun of it | | 4.11 | 3.94 | 2.80 | 2.15 | 2.04 | | | |
| | Q4: I am not interested in reducing my car use | | 3.44 | 2.38 | 2.80 | 1.71 | 2.65 | | | |
| | Q5: Driving gives me a way to express myself | | 2.78 | 2.25 | 1.80 | 1.47 | 1.39 | | | |
| | Q6: How likely are you to drive in the next 12 months? | | N/A | | | | | 3.33 | 1.60 | 1.93 |
| | Q7: I am not the kind of person who rides a bicycle | | 3.89 | 1.81 | 4.00 | 1.14 | 1.22 | 2.67 | 4.20 | 1.13 |
| | Q8: I feel I should cycle more to keep fit | | 2.00 | 4.44 | 2.60 | 4.60 | 2.57 | 3.67 | 1.60 | 3.33 |
| | Q9: I find cycling stressful | | 3.11 | 1.94 | 3.00 | 1.66 | 1.30 | 3.00 | 3.40 | 1.27 |
| | Q10: Cycling can be the quickest way to travel around | | 2.67 | 4.38 | 3.20 | 4.74 | 4.87 | 3.67 | 3.40 | 4.87 |
| | Q11: I like travelling by bicycle | | 1.89 | 4.00 | 2.20 | 4.71 | 4.61 | 2.67 | 1.60 | 4.80 |
| | Q12: I am the kind of person who likes to walk | | 3.89 | 4.50 | 4.40 | 4.49 | 4.13 | 4.00 | 4.60 | 4.20 |
| | Q13: I feel I should walk more to keep fit | | 3.22 | 4.00 | 4.20 | 4.29 | 3.26 | 3.67 | 4.60 | 4.60 |
| | Q14: I like travelling by walking | | 3.33 | 4.38 | 4.40 | 4.37 | 3.83 | 3.33 | 4.80 | 4.47 |
| | Q15: I am not the kind of person to use the bus | | 3.78 | 3.31 | 2.40 | 3.40 | 4.00 | 3.33 | 3.20 | 2.73 |
| | Extra question not in analysis: "I don't like to use the train" | | 2.11 | 3.19 | 3.60 | 3.89 | 3.43 | 3.67 | 4.20 | 4.07 |
| | Q16: In general, I would rather cycle than use the bus | | 2.56 | 4.25 | 1.80 | 4.80 | 4.91 | 2.33 | 1.60 | 4.60 |
| | Q17: A moral obligation to reduce greenhouse gases | | 2.11 | 3.19 | 3.60 | 3.89 | 3.43 | 3.67 | 4.20 | 4.07 |
| | Q18: People should use their cars as much as they like | | 3.11 | 4.13 | 2.40 | 4.26 | 3.96 | 3.67 | 3.80 | 4.13 |

Table 8 - Segments compared to baseline characteristics

| | | | Devoted Drivers | Image Improvers | Malcontented Motorists | Active Aspirers | Practical Travellers | Car Contemplators | PT Dependents | Car-free Choosers |
|---|---|---|---|---|---|---|---|---|---|---|
| Segment | | | DD | IM | MM | AA | PR | CC | PD | CF |
| **Socioeconomic indicators and subcategories** | | % | 8 | 14 | 6 | 32 | 21 | 3 | 6 | 14 |
| Sex | Female | Column percentages per indicator group per segment | 11 | 44 | 60 | 49 | 39 | 100 | 60 | 60 |
| | Male | | 89 | 56 | 40 | 51 | 61 | 0 | 40 | 40 |
| Average age (in 2017 to compare to available statistics) | | | 42.5 | 40.3 | 34.1 | 41.4 | 42.6 | 37.5 | 36.3 | 33.8 |
| Age groups | 18-29 | | 22.22 | 62.50 | 40.00 | 20.00 | 34.78 | 33.33 | 40.00 | 40.00 |
| | 30-39 | | 22.22 | 0.00 | 0.00 | 20.00 | 17.39 | 33.33 | 40.00 | 26.67 |
| | 40-59 | | 44.44 | 37.50 | 60.00 | 51.43 | 47.83 | 33.33 | 20.00 | 20.00 |
| | 60+ | | 11.11 | 0.00 | 0.00 | 8.57 | 0.00 | 0.00 | 0.00 | 13.33 |
| Household: Living… | Collectively: e.g. dorm or retiree home | | 11.11 | 6.25 | 0.00 | 0.00 | 4.35 | 0.00 | 20.00 | 0.00 |
| | Alone | | 11.11 | 6.25 | 60.00 | 25.71 | 21.74 | 0.00 | 40.00 | 13.33 |
| | Alone with children | | 0.00 | 12.50 | 0.00 | 5.71 | 8.70 | 0.00 | 0.00 | 6.67 |
| | Partner with children | | 55.56 | 25.00 | 20.00 | 25.71 | 34.78 | 33.33 | 20.00 | 40.00 |
| | Partner without children | | 22.22 | 25.00 | 0.00 | 37.14 | 26.09 | 66.67 | 20.00 | 26.67 |
| | Other: with housemates | | 0.00 | 25.00 | 20.00 | 5.71 | 4.35 | 0.00 | 0.00 | 13.33 |
| Employment | Employed | | 66.67 | 75.00 | 100.00 | 91.43 | 91.30 | 100.00 | 40.00 | 80.00 |
| | Job seeker | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 20.00 | 0.00 |
| | Retired | | 11.11 | 0.00 | 0.00 | 2.86 | 0.00 | 0.00 | 0.00 | 6.67 |
| | Student | | 22.22 | 25.00 | 0.00 | 5.71 | 8.70 | 0.00 | 40.00 | 13.33 |
| Family income (€) | 0-2500 | | 0.00 | 36.36 | 100.00 | 31.25 | 42.86 | 33.33 | 100.00 | 54.54 |
| | 2591-4000 | | 20.00 | 27.27 | 0.00 | 25.00 | 33.33 | 66.67 | 0.00 | 36.36 |
| | 4001+ | | 80.00 | 36.36 | 0.00 | 43.76 | 23.81 | 0.00 | 0.00 | 9.09 |
| Place of work or education | Leuven | | 75.00 | 56.25 | 80.00 | 73.53 | 69.57 | 100.00 | 100.00 | 84.61 |
| | Outside Leuven | | 25.00 | 43.75 | 20.00 | 26.47 | 30.43 | 0.00 | 0.00 | 15.38 |

Table 9 – Mobility segments (all respondents) compared to mobility and transport use behaviour

| | | | Values are percentages of each (sub) category per column or | Devoted Drivers | Image Improvers | Malcontented Motorists | Active Aspirers | Practical Travellers | Car Contemplators | PT Dependents | Car-free Choosers |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Mobility Segment** | | DD | IM | MM | AA | PR | CC | PD | CF |
| | | Distribution among respondents (%) | | 8 | 14 | 6 | 32 | 21 | 3 | 6 | 14 |
| Proportion of driver's licence holders | | | | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 0.00 | 20.00 | 26.67 |
| Transport mode use frequency | Car driver | Never or less than once per year | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 | 100.00 | 100.00 |
| | | Once or few times per year | | 0.00 | 6.25 | 40.00 | 14.29 | 17.39 | 0.00 | 0.00 | 0.00 |
| | | Once or few times per month | | 11.11 | 25.00 | 20.00 | 37.14 | 34.78 | 0.00 | 0.00 | 0.00 |
| | | Once or few times per week | | 33.33 | 31.25 | 20.00 | 45.71 | 39.13 | 0.00 | 0.00 | 0.00% |
| | | Daily | | 55.56 | 37.50 | 20.00 | 2.86 | 8.70 | 0.00 | 0.00 | 0.00% |
| | Bus/train | Never or less than once per year | | 33.33 | 12.50 | 0.00 | 2.86 | 8.70 | 0.00 | 0.00 | 0.00% |
| | | Once or few times per year | | 22.22 | 25.00 | 0.00 | 34.29 | 39.13 | 0.00 | 20.00 | 20.00 |
| | | Once or few times per month | | 22.22 | 0.00 | 60.00 | 31.43 | 30.43 | 0.00 | 40.00 | 46.67 |
| | | Once or few times per week | | 22.22 | 25.00 | 20.00 | 17.14 | 13.04 | 0.00 | 40.00 | 33.33 |
| | | Daily | | 0.00 | 37.50 | 20.00 | 14.29 | 8.70 | 100.00 | 0.00 | 0.00 |
| | (e-)Bike | Never or less than once per year | | 44.44 | 0.00 | 40.00 | 0.00 | 0.00 | 33.33 | 60.00 | 0.00 |
| | | Once or few times per year | | 44.44 | 18.75 | 40.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.67 |
| | | Once or few times per month | | 11.11 | 18.75 | 20.00 | 5.71 | 0.00 | 0.00 | 20.00 | 6.67 |
| | | Once or few times per week | | 0.00 | 31.25 | 0.00 | 14.29 | 21.74 | 66.67 | 20.00 | 6.67 |
| | | Daily | | 0.00 | 31.25 | 0.00 | 80.00 | 78.26 | 0.00 | 0.00 | 80.00 |
| No. household cars | | 0 | | 0.00 | 18.75 | 60.00 | 28.57 | 17.39 | 33.33 | 50.00 | 53.85 |
| | | 1 | | 33.33 | 37.50 | 40.00 | 60.00 | 60.87 | 66.67 | 50.00 | 38.46 |
| | | 2+ | | 66.67 | 43.75 | 0.00 | 11.43 | 21.74 | 0.00 | 0.00 | 7.69 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Most important means of travel to get to work or school | | (e-)bike | | 0.00 | 31.25 | 0.00 | 52.94 | 60.87 | 0.00 | 0.00 | 76.92 |
| | | Bus | | 12.50 | 18.75 | 40.00 | 0.00 | 0.00 | 66.67 | 0.00 | 0.00 |
| | | Walking | | 0.00 | 6.25 | 40.00 | 20.59 | 4.35 | 0.00 | 100.00 | 15.38 |
| | | Train | | 0.00 | 18.75 | 0.00 | 14.71 | 21.74 | 0.00 | 0.00 | 7.69 |
| | | With the car | | 87.50 | 25.00 | 20.00 | 11.76 | 13.04 | 33.33 | 0.00 | 0.00 |
| Most important means of travel to run errands/shop | | (e-)Bike | | 0.00 | 31.25 | 0.00 | 54.29 | 56.52 | 33.33 | 0.00 | 73.33 |
| | | Walking | | 22.22 | 18.75 | 80.00 | 20.00 | 17.39 | 33.33 | 100.00 | 26.67 |
| | | With the car | | 77.78 | 50.00 | 20.00 | 25.71 | 26.09 | 33.33 | 0.00 | 0.00 |
| Knowledge and membership of sharing systems | Car sharing | Cambio member | | 0.00 | 6.25 | 20.00 | 17.14 | 8.70 | 33.33 | 0.00 | 6.67 |
| | | General knowledge | | 22.22 | 0.00 | 0.00 | 2.86 | 0.00 | 0.00 | 20.00 | 6.67 |
| | | Knowledge of Cambio | | 77.78 | 81.25 | 80.00 | 80.00 | 91.30 | 66.67 | 60.00 | 86.67 |
| | | No knowledge | | 0.00 | 12.50 | 0.00 | 0.00 | 0.00 | 0.00 | 20.00 | 0.00 |
| | Bike sharing | Blue-bike member | | 0.00 | 0.00 | 0.00 | 17.14 | 21.74 | 0.00 | 0.00 | 13.33 |
| | | General knowledge | | 22.22 | 12.50 | 20.00 | 2.86 | 13.04 | 66.67 | 20.00 | 0.00 |
| | | Knowledge of Blue-bike | | 66.67 | 87.50 | 60.00 | 77.14 | 65.22 | 0.00 | 80.00 | 80.00 |
| | | No knowledge | | 11.11 | 0.00 | 20.00 | 2.86 | 0.00 | 33.33 | 0.00 | 6.67 |

Table 10 – Mobility profiles compared to evaluations to MaaS and transport services

| | | | Devoted Drivers | Image Improvers | Malcontented Motorists | Active Aspirers | Practical Travellers | Car Contemplators | PT Dependents | Car-free Choosers |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Mobility Segment | DD | IM | MM | AA | PR | CC | PD | CF |
| | | Distribution among respondents (%) | 8 | 14 | 6 | 32 | 21 | 3 | 6 | 14 |
| General statements about MaaS | S4Q01: Familiarity of MaaS or integrated mobility | (Strongly)agree | 44.44 | 31.25 | 40.00 | 31.43 | 52.17 | 0.00 | 20.00 | 40.00 |
| | S4Q02: Car-free travel is not a problem | | 11.11 | 18.75 | 40.00 | 62.86 | 43.48 | 33.33 | 60.00 | 80.00 |
| | S4Q05: A MaaS app would be advantageous | | 44.44 | 87.50 | 20.00 | 65.71 | 60.87 | 33.33 | 40.00 | 73.33 |
| | S5Q10: MaaS subscriptions advantageous | | 11.11 | 50.00 | 60.00 | 57.14 | 34.78 | 0.00 | 60.00 | 66.67 |
| | S4Q03: "I would definitely use the MaaS app." | | 55.56 | 87.50 | 60.00 | 82.86 | 69.57 | 66.67 | 40.00 | 73.33 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Vehicle ownership | S5Q12 "... no longer have the need to own a bike." | | | 33.33 | 43.75 | 80.00 | 20.00 | 8.70 | 0.00 | 20.00 | 20.00 |
| | S5Q11 "... no longer have the need to own a car." | | | 11.11 | 43.75 | 40.00 | 77.14 | 30.43 | 33.33 | 60.00 | 26.67 |
| Ride services | Private taxis | | | 44.44 | 75.00 | 60.00 | 51.43 | 52.17 | 66.67 | 40.00 | 46.67 |
| | Shared minibuses | | | 66.67 | 93.75 | 60.00 | 71.43 | 65.22 | 66.67 | 60.00 | 73.33 |
| | Shared taxis | | | 44.44 | 87.50 | 80.00 | 85.71 | 60.87 | 66.67 | 0.00 | 66.67 |
| | Traditional PT | | | 88.89 | 93.75 | 100.00 | 97.14 | 91.30 | 100.00 | 60.00 | 86.67 |
| Vehicle (general access) | Scooter | | (Possible) interest | 22.22 | 50.00 | 20.00 | 25.71 | 30.43 | 33.33 | 40.00 | 20.00 |
| | (Electric) cargo bike | | | 22.22 | 81.25 | 40.00 | 60.00 | 43.48 | 33.33 | 40.00 | 80.00 |
| | Van | | | 55.56 | 81.25 | 40.00 | 65.71 | 65.22 | 66.67 | 20.00 | 53.33 |
| | Petrol or diesel car | | | 88.89 | 87.50 | 100.00 | 68.57 | 82.61 | 33.33 | 20.00 | 26.67 |
| | Electric bike | | | 33.33 | 87.50 | 80.00 | 74.29 | 86.96 | 33.33 | 20.00 | 93.33 |
| | Electric or hybrid car | | | 77.78 | 87.50 | 80.00 | 85.71 | 86.96 | 33.33 | 40.00 | 46.67 |
| | Normal bike | | | 33.33 | 87.50 | 80.00 | 82.86 | 82.61 | 66.67 | 60.00 | 80.00 |
| Vehicle sharing | Free-floating | Cars | | 87.50 | 100.00 | 88.57 | 91.30 | 33.33 | 60.00 | 66.67 | 60.0 |
| | | Bikes | | 93.75 | 80.00 | 91.43 | 86.96 | 33.33 | 20.00 | 80.00 | 80.0 |
| | Station-based | Bikes | | 87.50 | 100.00 | 94.29 | 95.65 | 66.67 | 40.00 | 86.67 | 86.7 |
| | | Cars | | 87.50 | 100.00 | 97.14 | 91.30 | 66.67 | 40.00 | 73.33 | 66.7 |
| Long term vehicle | Scooter | | | 44.44 | 56.25 | 20.00 | 25.71 | 26.09 | 33.33 | 20.00 | 33.33 |
| | Cargo bike | | | 33.33 | 75.00 | 40.00 | 51.43 | 56.52 | 33.33 | 20.00 | 73.33 |
| | Normal bike | | | 44.44 | 87.50 | 80.00 | 77.14 | 65.22 | 66.67 | 40.00 | 80.00 |
| | Electric bike | | | 55.56 | 87.50 | 80.00 | 88.57 | 73.91 | 33.33 | 20.00 | 80.00 |

## 4.4 Description and interpretation per segment

### 4.4.1 Car driving segments

There are 5 car driving segments and consequently all have driver's licences but also have driven at least once in the past year, which the later was the condition to answer 4 additional questions unavailable to non-car-drivers.

#### Devoted Drivers (DD)

As the title suggests DDs are not keen to change their mobility behaviour based exclusively on car use. Eight or 8% (9 in total) of all respondents were classed in this profile. However, on average they score lower compared to IMs to the statement of not wanting to reduce car use. A preference for car only travel and driving for the pleasure of it scored the highest compared to other car drivers. Across all segments they have the lowest score for cycling and walking as a means of travel. Even though they have also the lowest score towards a concern of climate change, their evaluation about people being able to drive ranks only the second lowest to MMs.

In terms of demographic and socioeconomic indicators, this profile (across all segments) has the highest proportion of males, highest living with a partner with children, higher family income and working outside Leuven, and the lowest proportion of persons under 30 years old. In terms of mobility behaviour, they are by far the most frequent daily uses of the car (also always to getting to work/school) and one of the more infrequent users of PT and cycling. Since they are on the road more often they are the most frequent uses of road navigation apps. They are already knowledgeable of car and (less so for) bike sharing services that operate in the city.

When evaluating mobility concepts there were less keen about them when compared to other segments. They have the lowest evaluation to the idea of carless travel and giving up car ownership. However, their response was not as negative for other evaluations, with similarities apparent to MMs and CCs. They are the least have access to use shared minibuses, but that preference did not hold for PT. Interest to accessing vehicles was low, most especially so scooters and all kinds of bikes. However, the idea of free-floating cars seemed more interesting than station-based systems. Longer term vehicle possession was less favoured for cargo bikes when compared to scooters and other bikes, however for all subcategories the proportion espousing a positive response was not more than a half.

#### Image Improvers (IM)

Accounting for the third largest proportion of respondents (16%), this group has the second highest agreement to the statement of their preference over the car compared to other modes, second to DDs. Unlike DDs, according to its predefined description, they see the car use as a symbolic extension their success. However, their symbolic attachment to the car (Q5), as an objective of expression, was second to DDs. Compared to DDs and MMs they are more open to cycling and using active modes to keep fit. They are largely indifferent to moderately concerned about the environment.

Demographically, they are likely to be male (56%), be younger than 30 (63%), and compared to other segments, living in mixed households (i.e. living with parents or unrelated housemates). In terms of their driving patterns a minority drive daily (37%) though on at least a weekly basis this proportion is much higher (67%) and is the highest after DDs. However, use the car to get to work, but only marginally 25%). Most use PT and/or bikes daily or weekly, which differs from DDs. A small proportion (19%) do not have access to a household car. Unlike DDs, a few are members of car sharing services (6.25%).

Evaluations to mobility concepts show observable patterns when compared to other segments. Most noticeably they are considerably most positive to the MaaS concept being advantageous to them (86%). They were also confident they would use the app (88%) and they have the third highest evaluation (at 44%) of the concept making car ownership redundant. They had the most positive evaluations towards ride providing (most particular towards shared minibuses – 94%) and vehicle proving (based on different concepts) services, though less so far taxis. Comparing to other car driving segments, they had consistently high interest for access for different types of cars (above 80%) and had the highest evaluation for scooters (56%), which in general are not favourable. They were most keen towards electric and ordinary bike long term possession (both 8.57%) when compared to all other segments.

### Malcontented Motorists (MM)

Along respondents this profile accounted for only account for 5% of respondents. According to the predefined description are more open to reducing car use, however MMs from this sample they are less inclined to reduce car use when compared to DDs (low sample) but less than IMs, AAs, and PR (Q4). They don't have a symbolic attachment to the car (Q5) compared to DDs and IMs therefore may consider other transport modes, according its predefined profile. However, they have low evaluations to cycling. Pertaining to bus use their average favouring bus use is the highest among car drivers. Their concerns about environmental are more neutral but they have the highest average disapproval towards the statement that people should use their cars as much as they want (Q18), across all segments.

The group is marginally likely to be female, though one should be mindful of the small sample of 5 individuals representing the segment. Three fourths live alone and are all employed, which has the highest proportion among all segments. In terms of their mobility behaviour, they are less frequent drivers of cars compared to the first two segments but more so than AAs and PRs. They are more likely to use PT on a weekly basis compared to other car driving segments. In terms of cycling they have the lowest proportions based on frequency of use compared to all segments.

Compared to all other car driving segments they are less likely to have a household car available to them. When they do have a car, they use it to drive to work, though a majority either walks or use PT. They have the highest proportions of people using apps to assist their use of PT. Car sharing is all known to them, and 20% are (or were) members. They have one of the highest proportions of among segments that are unware of bike sharing.

Their evaluation of mobility concepts provided interesting patterns when compared to all other segments. Firstly, there was a low appeal towards MaaS being advantageous, this was even the lowest proportion (20%) compared to all other segments but 60% are positive about using the app (60%). Comparing to other car driving segments they are the least interested with the idea of a MaaS app. When questioned however about the possibility of MaaS facilitating car or bike usership opposed to ownership, this group was most open to such concept for bikes, but not for cars. For the remainder of the evaluations that dealt with different concepts of car and bike access, proportions for their favourability showed similar patterns across IMs, AAs, PRs. One major difference was their total lack of interest for scooters.

### Active Aspirers (AA)

This profile, accounting for 32% of all respondents and is the largest group, and is unique among car-drivers, as according to its redefined profile and to the results of this study they are the most likely to

have positive views about their role in environmental protection (avg. score of 4.26) and (and are highly motivated to use active modes. Those characteristics were also seen from this sample: with the second lowest score about the symbolic use of the car (Q5).

This segment has a high moral obligation to the environment and a motivation to use active transport modes, predominantly cycling as they strive for being fit and convenience, as evident by consistently high averages in this sample when viewing the result from questions 10 to 14. Despite being keen to reduce their carbon footprint they are the most positive about individual freedom to drive cars. They are not public transport users and see lots of problems with using it, as shown with a slightly negative evaluation, though they view the train more positively.

AAs are the most balanced in terms of gender and more than 60% is older than 40. They are more likely to live with a partner without children, though only marginally (37%). Overwhelmingly most are employed, and household income appears to be balanced across subcategories. A majority (65%) work outside Leuven, and overall their means of transport to reach there is mostly the bike, then walking and PT, and at 5% with the car. Their general frequency of car use is much lower compared to the three previously discussed car groups, at 5% daily use, using it more on a weekly or monthly basis.

PT use is less frequent compared to the other car-driving groups, the majority (65%) used PT at least once a month or less. Daily cycling is a major trend 80% which is the highest proportion that is shared with PRs. Access to household cars however is more prevalent (1 or more: 70%). Further, 92.3% with household cars stated that it is personally their own, which is the highest proportion, except for MMs (100%, though has a low sample). In terms of vehicle sharing systems, this group has the third largest proportions of Cambio (compared to car-drivers) and Blue-bike members both at 17%.

Their evaluation to the mobility concepts of this study revealed discernible patterns when comparing to other segments. Firstly, AAs (when comparing to car-drivers) have the lowest familiarity to the concept of integrated mobility, but on the other hand they were most accepting to the statement about car-free travel. When evaluating the statement of them 'surely using the app' they agreed 83%, second to IMs. In terms of the MaaS concept relinquishing vehicle ownership, they 80% disagreed to that prospect for bikes, but 77% agreed towards it for cars.

Appraisals to ride providing services via MaaS showed similar patterns, though they are more likely to accept shared minibuses and taxis than PRs. In terms of their general access to vehicles, they were interested in cargo bikes and vans compared to PRs and MMs. Noteworthy they are one of most interested groups for electric bikes. Evaluations to (non-)free-floating sharing concepts showed little apparent variation.

### Practical Travellers (PR)

This is the second largest group representing 21% of respondents, and as the profile name suggests, they value practicality or the convenience of a transport mode than the mode itself. Comparing to other driving segments, they have the second lowest preference for the car and intention to reduce the using the car after AAs. They are the least likely to agree that the car has a symbolic value to them reinforcing their predefined characteristic for the instrumental or practical use of cars. As they value the most efficient mobility options, and they agree the most (sharing that place with CFs) that cycling is the best option for the city. Among car drivers they agree the most that cycling isn't stressful, and across all segments have a general positive attitude towards it. They also value walking though is more indifferent about its benefit to them keeping fit.

PRs disfavour the bus the most after DDs but gave a positive evaluation to using the train. Their distaste for the bus mean they will rather cycle, with this preference having the highest preference across all segments and highest score of agreement (4 out of 5) across all questions. In terms of their concern for the environment and against individual car-usage choice, their response was more neutral albeit slightly agreeing.

The PR profile is more likely to be male at 61%. Proportions of age groups were skewed towards persons between 40-50 years. Most of the household was composed couples with children (34%), which is the highest proportion compared to all other segments except for DDs. Most works or go to school in Leuven (60%) and most ride the bike to reach there which is the second highest proportion among segments after CFs.

Their use of cars to get to work has the second lowest proportion (12%) among driving segments and there is almost the same than AAs. PT use much more infrequent than MMs and AAs. Even though they drive less than other segments, they have the highest proportion among car drivers to have at least one household car (78%) after DDs (who all have a household car). They ride bicycles daily the most compared to all segments. Regarding car and bike sharing they are less likely to be a Cambio member when compared to all other car-driving groups except for DDs and IMs. Like AAs they are most likely to have a Blue-bike membership at 22%.

Practical Travellers gave one of the most positive appraisals towards the mobility concepts of this study, like AAs and IMs. Though they were most likely to be familiar about integrated mobility at 52%, compared to all other segments. Their view of MaaS allowing them to forgo ownership was less positive when compared to IMs and AAs, and compared to all car-driving groups, and all segments except for CCs (though with a sample size of only 3) they scored the lowest to the evaluation towards the idea of not owning a bike (8%). For shared taxis and minibuses, they also gave lower proportions of a positive interest when compared to AAs. For vehicle access via MaaS they gave the highest indication of interest towards vans and fuelled powered cars. They are also more negative towards free floating sharing (33% positive evaluation) systems compared to station-based systems (67% positive evaluation). This difference was the greatest compared to all other segments.

### 4.4.2 Non-driving segments

There are 3 non-driving segments sharing the characteristic that they haven't driven in the last year. Questions 2 to 5 were not applicable to them.

#### Car Contemplators (CC)

This group had the smallest membership from respondents, making up only 3% or a total of 3 persons who completed the survey. They are more indifferent to the intention of driving within one year, though they all do not have a driver's licences. Comparing to other non-driving groups they had the highest average score towards the intention of driving within the upcoming year, however the score is more aligned to an indifferent evaluation. They prefer on average to work than cycle but have more neutral responses to many of the questions. All are female, employed and living in Leuven, belonging to each of the age groups under 60, and are not in possession of a driver's license. They are all partnered, and 2 out of 3 live in households without children.

All are daily users of PT, especially the bus and rarely or never the train. Two of the three individuals are car passengers at least weekly and have access to a household car. One individual goes to work with the car but as a passenger. One doesn't have a smartphone, but others have one and use

apps regularly for PT. Two cycle at least once a year or never, while one cycles at least once a week. This group is the least knowledgeable about either bike-sharing and Blue-bikes. This group has the lowest positive evaluations towards the mobility concepts were explained to them, for cars and bike access but ride providing services excluding PT.

### PT Dependents (PD)

This group is made of 4% of the survey's sample. They have the lowest intention to use a car within the upcoming year. They are not keen about cycling and it being a way to kept fit, having the highest negative score about it (Q7), and are more neutral towards the idea that cycling is the best way to get around the city. However, when having to choose between the bus and the bike to get around they had the most positive preference to the bike (Q16). They much prefer walking, giving statements relating about it the highest scores among all segments. Their evaluation towards the statement about bus use was more neutral but when asked about travelling with the train their evaluation was the most positive across all segments. They also had the strongest pro-environment view compared to all other segments.

PDs were on average the youngest group, more likely to be female, and more likely to be a student. All either work or go to school in Leuven. Only 20% have their driver's licence and are not daily users of PT and the bike. They are aware of car and bike sharing systems but are members for neither Cambio or Blue-Bike.

In terms of their evaluations towards mobility concepts they had the lowest acceptance to the statement that they will use the app (40%) across all segments. They also had the lowest evaluations towards all ride services, across all categories so much so, no one expressed interest towards shared minibuses. Their interest in vehicle access was also low, and was the lowest for bikes, vans across all segments, and all longer-term access to vehicles.

### Car-free Choosers (CF)

Representing 14 percent of all respondents, CFs attitudinal evaluations towards cycling scored positively, with the around highest averages for all cycling related statements. They are more indifferent towards the statement linking their motivation to cycle in reaching fitness goals compared to a positive evaluation towards walking. They are however neutral in their response about bus use, but more positive towards trains. They have the highest preference for cycling when compared when compared to all other non-driving segments. They also accept the statement about free use of cars but also their environmental concern.

CFs are balanced in term of gender, with slightly more females. They are presented across all age groups but have the highest proportion younger than 30. They mostly live in households with their partner, split between with or without children. Most are employed, work in Leuven, and most use the bike to get there. Most (93.3%) rarely drive the car though only 27% has a driver's license. Daily use of other modes is most obvious for the bike, but this does not apply for PT with most using it at least once or a few times a month.

In terms of their evaluations to mobility concept statements, these were more positive compared other non-driving groups. Comparing non-drivers, they agreed the most that combined mobility is a familiar concept. Out of all segments they had the highest proportion (80%) in agreement that car-free is not problematic, though only 67% thought the app will be advantageous for them and they will use it. As daily uses of the bike only 20% agreed that MaaS will allow them to forgo bike ownership. Despite that they are most interested in bike access (and much less so far cars), either generally or though

sharing systems, when compared to other non-driving segments. However, it is not surprising since they will not be interested in different type of cars access services or concepts since most do not have a driver's license.

## 4.5 Segment and survey data reliability

### 4.5.1 Response from mobility profile self-evaluation

A follow up survey was done to ask people who provided their emails during the survey (90 people but one email bounced) to what extent they agree with their profile description. The response rate was 60%. Table 11 summaries the results from which respondents were question to what extent they agreed with their profile (descriptions are shown in 7.5 of the appendix) and is compared to the reported segment accuracy from the segment study (Anable & Aditjandra, 2011). Respondents who evaluated their segment (strongly) agreed 57.6% of the time, while 37.9% disagreed, and 4.6%.

Table 11 – Evaluation of assigned segment by respondents in follow up survey

| | Predicted accuracy | All surveys | | Provided email | Response rate | Evaluation of statement (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Strongly Agree | Agree | Neutral | Disagree | Strongly disagree |
| Segment | % | N | % | % | % | | | | | |
| Devoted Drivers (DD) | 82.6 | 9 | 8.2 | 77.8 | 33.3 | 0.00 | 66.67 | 0.00 | 0.00 | 33.33 |
| Image Improvers (IM) | 89.8 | 16 | 14.5 | 81.3 | 56.3 | 0.00 | 22.22 | 11.11 | 22.22 | 44.44 |
| Mal. Motorists (MM) | 79.2 | 5 | 4.5 | 100. | 80.0 | 0.00 | 0.00 | 25.00 | 75.00 | 0.00 |
| Active Aspires (AA) | 78.8 | 34 | 30.9 | 88.2 | 67.7 | 26.09 | 21.74 | 4.35 | 39.13 | 8.70 |
| Practical Travellers (PR) | 70.9 | 23 | 20.9 | 65.2 | 56.5 | 76.92 | 15.38 | 0.00 | 7.69 | 0.00 |
| Car Contemplators (CC) | 82.6 | 3 | 2.7 | 100. | 66.7 | 50.00 | 0.00 | 0.00 | 50.00 | 0.00 |
| PT Dependents (PD) | 90.4 | 5 | 4.5 | 60.0 | 40.0 | 0.00 | 0.00 | 0.00 | 100.00 | 0.00 |
| Car-free Choosers (CF) | 85.9 | 15 | 13.6 | 93.3 | 66.7 | 50.00 | 50.00 | 0.00 | 0.00 | 0.00 |
| | | | Totals | 60.0 | 60.0 | 33.33 | 24.24 | 4.55 | 27.27 | 10.61 |

### 4.5.2 Results from statistical analysis of segments' differentiating characteristics

As introduced in the methodology, analysing the statistical significance between variables is done to explore possible patterns from the data. It was also used to justify limiting the number of summary tables in the results chapter so to better presents observations that may be more meaningful towards the discussion. As shown in Table 12 and 13 (next two pages) a series of tests were done between various contingency tables. The null hypothesis (H0) is that there is no association between rows and columns of a contingency table, and the alternative hypothesis (H1) is the opposite. The null hypothesis is rejected when the test statistic or p-value is less than or equal to the critical value, alpha (α) which was designated at 0.05. As shown in the table, cells are heighted in green when the H0 is rejected and the H1 is accepted which provides an exploratory guide that there is a possible relationship between variables in question. From the results it can be assumed that segments may enable a stronger analysis.

Table 12 – Results from the Monte Carlo simulation for the Exact Test that tests the significance of association between contingency tables

| | | | Ques. ID | SEGMENTS | Sex | Age | Household composition | Work/ school location | Family income | Car driving freq. | Train & bus use freq. | (e-)bike use freq. | Travel mode: work/school | Travel mode: friends/ family visit | Travel mode: errands/shopping | PT app use freq. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| General statements about MaaS | Knows MaaS | | S4Q01 | 0.8836 | 0.0363 | 0.1416 | 0.7284 | 0.5797 | 0.5636 | 0.4044 | 0.0474 | 0.9092 | 0.6238 | 0.3678 | 0.5680 | 0.0400 |
| | Car-free Trav. | | S4Q02 | 0.0090 | 0.5969 | 0.2152 | 0.5751 | 0.2996 | 0.2347 | 0.0050 | 0.1257 | 0.1490 | 0.0001 | 0.0004 | 0.0001 | 0.3475 |
| | MaaS Adv. | | S4Q05 | 0.2234 | 0.9777 | 0.0905 | **0.0519** | 0.3191 | 0.2367 | 0.9088 | 0.5607 | 0.2256 | 0.1693 | 0.0551 | 0.0984 | 0.0613 |
| | MaaS subscr. | | S5Q10 | 0.0486 | 0.5002 | 0.1110 | 0.6604 | 0.1410 | 0.6145 | 0.2263 | 0.4459 | 0.9072 | 0.0699 | 0.1353 | 0.4226 | 0.8217 |
| | Will use MaaS | | S4Q03 | 0.0935 | 0.0767 | 0.9054 | 0.3441 | 0.0926 | 0.4687 | 0.6214 | 0.0209 | 0.0580 | 0.0940 | 0.0149 | 0.1366 | 0.0208 |
| Vehicle ownership | Bike | | S5Q12 | 0.1101 | 0.1170 | 0.9966 | 0.5692 | 0.0782 | 0.6867 | 0.6585 | 0.4153 | 0.0065 | 0.5284 | 0.2325 | 0.4306 | 0.0016 |
| | Car | | S5Q11 | 0.0032 | 0.4523 | 0.1742 | 0.3446 | 0.9649 | 0.2634 | 0.1898 | 0.3448 | 0.4563 | 0.1956 | 0.3577 | 0.4727 | 0.8862 |
| Ride services | Private taxis | | S5Q02 | 0.7064 | 0.3769 | 0.6675 | 0.7179 | 0.6890 | 0.5132 | 0.0889 | 0.2758 | 0.6671 | 0.3935 | 0.1103 | 0.0086 | 0.2736 |
| | Micro-transit | | S5Q04 | **0.0698** | 0.1653 | 0.2056 | 0.7989 | 0.1287 | 0.4407 | 0.4930 | 0.6226 | 0.4761 | 0.7575 | 0.4733 | 0.3799 | 0.8523 |
| | Shared taxis | | S5Q03 | 0.8774 | 0.2194 | 0.0940 | 0.3974 | 0.9222 | 0.4421 | 0.5846 | 0.1877 | 0.6644 | 0.3833 | 0.1265 | 0.7201 | 0.5259 |
| | Traditional PT | | S5Q01 | 0.8814 | 0.1447 | 0.2159 | 0.2718 | 0.5434 | 0.1900 | 0.0837 | 0.1231 | 0.6553 | 0.8252 | 0.3993 | 0.1526 | 0.6728 |
| Vehicle (general access) | Scooter | | S5Q05_7 | 0.0249 | 0.0393 | 0.7176 | 0.2988 | 0.1624 | 0.7182 | 0.9135 | 0.0397 | 0.7384 | 0.5943 | 0.5935 | 0.8007 | 0.0001 |
| | (e-) cargo bike | | S5Q05_6 | 0.0249 | 0.9695 | 0.1342 | 0.0077 | 0.9598 | 0.8221 | 0.0732 | 0.2833 | 0.3383 | 0.5069 | 0.0079 | 0.0028 | 0.4065 |
| | Van | | S5Q05_3 | 0.4547 | 0.4693 | 0.2031 | 0.7549 | 0.4427 | 0.8842 | 0.2536 | 0.5365 | 0.3212 | 0.0420 | 0.4886 | 0.5101 | 0.2684 |
| | Petrol/diesel car | | S5Q05_1 | 0.0002 | 0.1625 | 0.3375 | 0.1200 | 0.2311 | 0.5725 | 0.0137 | 0.7134 | 0.5192 | 0.6046 | 0.0315 | 0.0282 | 0.6270 |
| | Electric bike | | S5Q05_5 | 0.0008 | 0.0949 | 0.0504 | 0.3158 | 0.7512 | 0.1829 | 0.8958 | 0.5940 | 0.0001 | 0.1322 | 0.0579 | 0.0043 | 0.4205 |
| | Electric/ hybrid car | | S5Q05_2 | 0.0035 | 0.2533 | 0.2732 | 0.2962 | 0.2126 | 0.2014 | 0.0036 | 0.3586 | 0.4422 | 0.4129 | 0.0005 | 0.0649 | 0.3842 |
| | Normal bike | | S5Q05_4 | 0.0468 | 0.4977 | 0.8586 | 0.5955 | 0.9183 | 0.0265 | 0.5663 | 0.6844 | 0.0001 | 0.0499 | 0.3155 | 0.1255 | 0.2794 |
| Vehicle sharing | Free-floating | Cars | S5Q08_2 | **0.0505** | 0.1742 | 0.1928 | 0.6064 | 0.0374 | 0.7931 | 0.2604 | 0.4548 | 0.9230 | 0.5220 | 0.0156 | 0.5335 | 0.3203 |
| | | Bikes | S5Q08_4 | 0.0019 | 0.1742 | 0.7580 | 0.7177 | 0.2386 | 0.0485 | 0.3194 | 0.8336 | 0.0345 | 0.5994 | 0.0058 | 0.4317 | 0.9688 |
| | Station-based | Bikes | S5Q08_3 | 0.0045 | 0.9644 | **0.0588** | 0.3308 | 0.4755 | 0.1745 | 0.7763 | 0.7367 | 0.0139 | 0.5309 | 0.0189 | 0.2737 | 0.0220 |
| | | Cars | S5Q08_1 | 0.0489 | 0.4689 | 0.2106 | 0.7608 | 0.3015 | 0.2830 | 0.0326 | 0.3590 | 0.3706 | 0.3811 | 0.0872 | 0.2427 | 0.0374 |
| Long term vehicle | Scooter | | S5Q09_2 | 0.3711 | 0.0044 | 0.7547 | 0.3458 | 0.2032 | 0.9868 | 0.9977 | 0.0782 | 0.5214 | 0.7909 | 0.8549 | 0.7322 | **0.0697** |
| | Cargo bike | | S5Q09_4 | 0.2267 | 0.4025 | 0.1572 | 0.2315 | 0.5602 | 0.4329 | 0.3884 | 0.8899 | 0.5069 | 0.4993 | 0.1805 | 0.0065 | 0.5297 |
| | Normal bike | | S5Q09_1 | 0.2212 | 0.5661 | 0.8954 | 0.1507 | 0.6074 | 0.0543 | 0.2622 | 0.8977 | 0.0152 | 0.5415 | 0.7837 | 0.6010 | 0.3662 |
| | Electric bike | | S5Q09_3 | 0.0007 | 0.1591 | 0.1759 | 0.0743 | 0.7358 | 0.3705 | 0.4965 | 0.6968 | 0.0052 | 0.5609 | 0.1237 | 0.0101 | 0.8100 |
| Per Column rejection null hypothesises (%) | | | | *50.0* | *11.5* | *0.0* | *3.8* | *3.8* | *7.7* | *15.4* | *11.5* | *26.9* | *11.5* | *30.8* | *26.9* | *23.1* |

When comparing segments with socioeconomic and mobility behaviour variables one may observe the trend that mobility behaviour variables may have a stronger relationship compared to demographic and economic variables. More concretely, when comparing variables for the frequencies of transport mode use for car driving, bikes, and primary mode of travel for work or school, running errands or shopping and visiting family or friends, one may deduce a relationship already described in the description of segments laid out in previous subsections.

Table 13 - Exact Test comparing mobility behaviour and demographic variables with segments

| Variable category | SEGMENTS |
|---|---|
| Sex (male or female) | 0.1611 |
| Age categories | 0.3780 |
| Household composition | 0.5357 |
| Work/school location | 0.5922 |
| Family income (Euros) | 0.0496 |
| Car driving frequency | 0.0001 |
| Train & bus frequency | 0.0028 |
| (E-)bike frequency | 0.0001 |
| Travel mode to work/school | 0.0001 |
| Travel mode errands/shopping | 0.0001 |
| Travel mode family/friends visits | 0.0001 |
| Apps PT | 0.0443 |
| Apps roadway navigation | 0.1297 |
| Online banking | 0.2561 |
| Car ownership (38% missing data) | 0.7209 |
| **Rejection of null hypothesises (%)** | **53.3** |

# 5 Discussion and conclusions

## 5.1 Attitudinal segments deciphering MaaS preferences for usership?

The aim of this study was to investigate MaaS within a wider context of transport services that achieves usership instead of ownership. A possible outcome of MaaS, as a handheld digital assistant, allows the access to transport options dynamically in relation to temporal and spatial circumstances. The literature review clarified the different services that a MaaS end-user may value. The preferences of potential MaaS users are categorised based on their attitudinal mobility segment. The results presented in the previous chapter aim to assess on one hand preferences for the mobility concepts of this study but on the other hand help understand the potential of attitudinal segments in supporting future research.

### Results compared to other studies

Other studies utilised the SEGMENT approach, even though the study of this thesis had a distinctly lower sample size (n=111), the heterogeneity of segment classes can be interpreted positively, despite some segments accounting for only 3 to 8 persons. Segments were compared to the segment distribution from Leuven (that did not detail sampling strategy), Flanders (where segments were modelled from mobility behaviour patterns), and cities geographically closer and arguably culturally similar (Utrecht and Munich). In conclusion, the comparison of the same segments that had smaller proportions (closely) matched across the different variables, namely Devoted Drivers, Malcontented Motorist, and PT Dependents.

This study had a larger proportion of Car-free Choosers when compared to geographically similar cities and this indicates a bias/over representation (possibly due to the means of recruitment) of the sample especially when comparing to the OVG reference data in Figure 10. When looking at daily transport mode use car drivers represented 13.5% from this sample whereas the Flemish average is 42.3%, which is contrasted to cycling, which is 52.3% from this study's sample and for Flanders it is 16.92%.

### Attitudinal segments correlate closely with actual behaviour

According to Anable (2013) the strongest predictors for cluster assignment based on the SEGMENT allocation algorithm are: current and intended car driving (Q1 & 6), attachment to car driving (Q2-5), inclination for cycling (Q7, 10) and walking (Q12, 14), bus use (Q15, 16), desire to be fit (Q8, 13), environmental concern (Q17), and sympathy to car drivers (Q18). The extra evaluation for train travel was added, and on average the score was one point higher than for bus travel.

When segments were cross tabulated to mobility behaviour, results patterns were easy to identify from the summary tables (pages 54-58). This is further supported by the results from the Exact Test analysis (pg. 65) that explored possible relationships between the different datasets. As shown in Table 12 transport mode frequency and the primary travel mode per type of activity indicated high level of relationship. The relationship between SEGMENT clusters and behaviour was confirmed by Semanjski & Gautama (2016) when they mapped segments using support vector machines based on "n dimensional space" crowdsourced data, achieving a 97% validation rate.

### Favourability of the MaaS concept

Evaluations towards MaaS concepts were investigated at the level of assigned segments where conclusions from can be made while being cognisant of the overall low sample of the study. Firstly, the

numerically smallest segments (less than 10 respondents per segment) in proportion to all other segments were Devoted Drivers (DD), Malcontented Motorists (MM), Car Contemplators (CC), and PT Dependents (PD). Nevertheless, the evaluations are not contradictory when relating to their segment profile. For example, the least favourable evaluations towards statements imagining the definite and advantageous use of a MaaS app were from CCs, DDs, MMs, and (the lowest) from PDs. Even though PDs are non-car drivers and more frequent users of PT (though Active Aspires use PT more frequently on a daily basis) the idea of MaaS does not seem to captivate them which was also observed from the Sydney study (Ho et al., 2017).

Segments that agreed more positively to evaluations about MaaS (S4Q3&5) were Image Improvers (IM), Aspiring Achievers (AA), and Car-free choosers (CF). However, those positive evaluations were not shown when questioned about MaaS subscriptions. When questioned about MaaS leading towards not owning a bike or car, the results were more discerning for cars. The idea that bike ownership may be made redundant received low evaluations except along MMs. However, when the idea of usership is focused on cars two segments standout in terms of their positive evaluation: AAs and PDs, though the latter segment is disregarded for further discussion because of their low sample and inconsistencies of their responses.

Active Aspirers (AA) are described as highly motivated to curtail car-use in favour of active modes, primarily cycling, but not through PT since they highly disfavour it and these aspirations are motivated by their high environment concern and their view that cycling provides more freedom and is beneficial to their health. AAs made up the highest proportion of respondents and provided interesting patterns: 70% have access to a household car, were not one the most aware of the MaaS or integrated mobility concept, but had enthusiastic evaluations towards vehicle access concepts, especially for e-bikes.

The results from the previous Leuven study on the acceptance of sustainable mobility travel suggestions provided actual behavioural responses to app-based travel information (one feature of MaaS) and AAs, together with Practical Travelers (PR) were the only segments that tried new multimodal routes (Semanjski et al., 2016). AAs also executed suggestions for the largest share of trip purposes whereas other segments used suggestions for mostly commuting (Semanjski et al., 2016).

Practical Travels (PR), like Active Aspirers, are also more positive evaluations towards general statements about MaaS but were less keen to the idea that the concept can relieve them from car ownership. As their profile description states, PRs seek to maximise convenience and that includes cars. It can be suggested that they prefer a more stable access to bikes and cars (82% has household car access and 63% owns that car) and therefore may be more conservative in accepting new mobility concepts. Semanjski et al. (2016) observed that PRs had the most diverse use of transport modes but also accepted multimodal travel information suggestions, but it is unclear if it was for travel with transport modes they already use.

### Ride providing services: the need for better response variables

The second research question focused on preferences between 'ride providing' and 'vehicle providing' services. In terms of the overall evaluation towards ride providing services, traditional PT had the most positive evaluation (92%), while shared taxis and minibuses received 72% and 70% positive evaluations respectively, and private taxis received the most negative response: a 54% positive evaluation. The preference for taxis was shown to be more neutral in the Sydney MaaS study when the offer for discounts did not motivate the choice of (shared) taxis in a MaaS plan (Ho et al., 2017). This

was also the case from the London MaaS attitudinal study as they observed that "users seem to not prefer the traditional taxi services" (Kamargianni et al., 2018). The option of PT in MaaS plans in the London study was chosen all the time, thus indicates the high value of PT compared to smaller scale and on-demand services.

The variation between segments for ride providing services was less marked, though less so for micro-transit or shared minibuses. This is contrasted to the possibility that more discernible patterns were observed across various segments for vehicle access. This lack of variation for ride providing services may also be supported by the Exact Test relational (Table 11, pg. 65) since all tests statistics were not rejected and thus suggesting no relation between variables. It is however noteworthy that micro-transit had a much closer p-value to the threshold of accepting the null hypothesis. Image Improvers (IM) and Active Aspires (AA) were most positive towards the micro-transit concept though based on the segment description for IM one may propose that they will be less inclined for shared vehicles, but the group did the highest evaluation for private taxis.

Vehicle access concepts: revealing an untapped demand?

Evaluations to vehicle access concepts showed variation between certain types of vehicles and access or rental period both generally across all respondents and per segment. In this part of the discussion, it was not possible to fully compare this study with existing literature since the focus on vehicle access in other studies is very limited. The results form Exact Test statistics supports this pattern of a association since vehicle access (described generally) all except one (vans) gave a result that postulated a relationship between variables. Generally, access to bikes, electric/hybrid cars, and electric bikes gained (in that order) the highest evaluations, though all other types of vehicles had an evaluation of at least 50% except for scooters (negative evaluation at 70%) which was also the case for longer term access.

Segment wise, evaluation for vehicle access was the highest for all car driving segments exact for Devoted Drivers (DD). Cargo bikes were highly favoured by Image Improvers (IM) which probably relates to their tolerance of cycling as a means of travel but more importantly inclination to self-expression and promotion which may be achieved by the more elaborate concept of a cargo bikes. IMs had one of the highest proportions (together with Active Aspirers - AA) of a positive evaluation towards long term electric bike access and hybrid/electric car, which may also reinforce the description of IMs of needing to express themselves through innovative forms of transport that is often provided by new mobility services.

Evaluations towards car and bike-sharing based on the dichotomy of free-floating and station-based systems provided variations across segments. From the Exact Test however free-floating cars marginally passed the null hypothesis and station-based cars marginally failed the test statistic. This may indicate that evaluations towards bikesharing based on its type of system has more heterogeneous preferences.

When comparing all segments however free-floating bikes were less preferred compared to station based bikes. That difference was the greatest for Practical Travel (PR) as they approved station-based bikesharing at 67% compared to free-floating at 33.3%. The postulation that PRs value stable access and may want to avoid any potential inconvenience may be further strengthened by this difference between the more fluid concept of free-floating bikes. This is contrasted to IMs, AAs, and

PRs since they favoured free-floating bikes by at least 80%, with AAs having the highest evaluation. These segments may be more willing to patronise new mobility services.

Appraisals towards **longer term vehicle** access was limited to **bikes and scooters**. Results from the Exact Test suggest that the evaluations towards this concept did not result in any meaningful relationship, exact for the electric bike. When comparing the results per segment electric bikes and normal bikes were given more positive evaluations. IMs, AAs, CFs provided the highest evaluations towards bikes. PRs gave higher evaluations towards longer term bike access compared to the sharing system, and therefore indicates a preference for household access of bikes.

The evaluations for all vehicle access concepts were the lowest for Devoted Drivers (DD), Car Contemplators (CC) and PT Dependents (PR), however these segments had a much longer share of respondents, but nevertheless their profiles suggest a lack of willingness to consider new modes, except for CCs who desire a car driving lifestyle. Though interestingly, while CCs may want to drive more, they were positive about not owning a car and towards free-floating cars, though low evaluations to other concepts. It could be the case that CCs may positively evaluate longer term car access given that variable was not included in the survey.

## 5.2 Study limitations

The results and discussion provided insightful findings, especially in consideration of the segments. However, there were significant limitations, foremost the limited number of completed surveys. A postulated survey population was described be 59,000 individuals, however because the survey did not follow a systematically random sampling approach, any possibility of a representative sample would not have been achieved. A lack of representation of older, retired, job seeking individuals and students mean that the results of this study would only be relevant to persons who are more likely to be economically active in terms of their participation in the labour market. Further, the lower number of surveys meant that statistical analysis was constrained and the ability to draw inferences to form conclusions with certainly not possible.

Further, the survey produced many variables, and together with sparseness between certain crosstabulations, conducting an analysis to statistically infer relationships was limited. Though an alternative approach made use of the Monte Carlo simulations of Exact Test caution must be taken when drawing conclusions. One example is the lack of relation between age and the evaluation towards MaaS being a means to forgo car ownership (Table 12, pg. 65). However, when one interprets Figure 18 (pg. 51) the apparent trend positive being older and the agreement to the statement.

In terms of the validity of the segments, though it is not feasible to draw solid conclusions from the follow up survey, it is a positive result that a majority agreed with their profile. Further, because the attitudes are determined on foundational cognitive theory and validated by many thousand surveys, a self-assessment one's profile may be a subjective.

One conclusion regarding segmentation is the importance of feedback of profiles, especially when it guides public policy. Certain segments may be perceived as biased and even provocative to certain segments, especially car drivers. This was the sentiment shared by persons who commented on their profile. Further, some individuals that were segmented within car-driving profiles also commented that they do not drive or have not in a very long time. This probably resulted in the sharp distinction between non-drivers and drivers that then lead to two different allocation algorithms.

## 5.3 A proposal for future research

Future research should better deal with issues of the segmentation methodology, the data source to derive segments, and approach taken to investigate the preference for mobility concepts. The approach developed by SEGEMENT provides a foundation to develop more geographically and culturally contextual surveys based on profiles that are meaningful to guide policy. For the SEGMENT approach to be finetuned a wide sample across a region should be done systematically so that a respondent can have a statistically equal chance to be part of the survey. Having a regional idea survey on an (updated) version of the Golden Questions can allow a reference data base to be developed, like the OVG travel behaviour dataset.

Using Flanders as an example, the respondents from OVG travel survey can also fill in attitudinal survey. Following the approach by Semanjski & Gautama (2016), the mobility behaviour that is captured spatially and categorised per activity by the OVG travel survey can be used to model segmentation results at various scales, both in urban and more rural contexts. The extrapolated Segment data can then be used as a reference to conduct research that is more focused when investigating MaaS.

One disadvantage of this study was possibly the wide scope of potential MaaS services that may be difficult to draw strong conclusions. An alternative approach is more focused studies investigating various aspects of MaaS and underlying services, e.g. on bike sharing and access services. This can also be coupled with choice models that can provide data consumer demand and the willingness to pay for certain services. A more grounded economic model can then be integrated an attitudinal segmentation based on well-established psychosocial cogitative models (e.g. TPB).

## 5.4 Conclusion

Various emerging transport solutions aim to transform the urban mobility system as we know it. MaaS is such is a new mobility and can be defined from several angles. From the angle of end-usership: MaaS is a digital platform that gives end-users access to mobility (in form of services) promoting the abandonment of vehicle ownership towards vehicle usership. Traditional services of public transportation are complemented with shared mobility services that allow for flexible intermodal travel and integrated in digitalized platform to allow for handheld travel and integrated payment.

Different MaaS schemes (defined by their depth of integration and available services) are being tested in real life through academic set-ups. However present literature does take sufficiently into account the different individual transport services, some of which are very new concepts that are only recently emerging in cities. The focus was to therefore design a research approach that resolves gaps and unexplored avenues in literature. The research design involved the use of a segmentation approach in relation to a self-administered survey that evaluates attitude the attitudes of MaaS, mobility services, and the willingness change behaviour through transport mode usership and using an integrating service platform.

The findings of the study had issues of a lack of representation and limited responses to defend conclusions about the target population. However, the segmentation approach taken made it possible to discover patterns in terms of the preference for MaaS and underlying services. The segments of Active Aspirers Image Improves, and Car-free Choosers gave evaluations towards MaaS and services. Practical Travellers had a more cautious evaluation. These findings can be related to previous studies about the attributes of these segments.

Some segments had less than 10 respondents and therefore drawing any conclusion will be difficult from these groups. However, from previous studies segments also had low proportions. In future attitudinal surveys for mobility questions and profiles could be more culturally attuned to local circumstances. These surveys could also be done at regular intervals to investigate changing behaviour and attitudes, and how the two may influence each other. Future research on integrated mobility services should aim to incorporate attitudinal segmentation so that decisions guiding MaaS business models, public policy, and regulation, and most importantly, the needs and expectations of the public can be based on underlying psychosocial and cognitive factors that influences the demand and preferences for MaaS and underlying mobility services and features.

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# 7 Appendix

## 7.1 Survey and analysis datasets

Links for the datasets used for the analysis and statistical summary tables are accessible from the following URL link: goo.gl/g88ph2

## 7.2 Comparing segmentation results

The following table cross-tabulates overlap between segments assigned by the allocation algorithm from the SEGMENT project compared to a standard k-means cluster analysis done direct from Golden Question results. The figure below the table provides a visual representation of clustered numbered 1-5 (car drivers) or 1-3 (non-car drivers)

Table 14 - Comparing raw data clustering with SEGMENT's weighting approach for car-driving segments

| | | | Car driving segments | | | | | Non-car driving segments | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *SEGMENT* | | DD | IM | MM | AA | PR | CC | PD | CF |
| Clusters from raw Golden Question results | 1 | N | 0 | 1 | 0 | 5 | 13 | 2 | 1 | 14 |
| | | Row % | 0% | 53% | 0% | 26% | 68% | 12% | 6% | 82% |
| | | Col % | **0%** | **6%** | **0%** | **15%** | **57%** | **67%** | **20%** | **100%** |
| | 2 | N | 0 | 10 | 1 | 29 | 9 | 1 | 0 | 0 |
| | | Row % | 0% | 29% | 2% | 59% | 18% | 100% | 0% | 0% |
| | | Col % | **0%** | **63%** | **20%** | **85%** | **39%** | **33%** | **0%** | **0%** |
| | 3 | N | 8 | 5 | 3 | 0 | 1 | 0 | 0 | 0 |
| | | Row % | 47% | 29% | 18% | 0% | 6% | 0% | 100% | 0% |
| | | Col % | **89%** | **31%** | **60%** | **0%** | **4%** | **0%** | **80%** | **0%** |
| | 4 | N | 1 | 0 | 0 | 0 | 0 | | | |
| | | Row % | 100% | 0% | 0% | 0% | 0% | | | |
| | | Col % | **11%** | **0%** | **0%** | **0%** | **0%** | | | |
| | 5 | N | 0 | 0 | 1 | 0 | 0 | | | |
| | | Row % | 0% | 0% | 100% | 0% | 0% | | | |
| | | Col % | **0%** | **0%** | **20%** | **0%** | **0%** | | | |

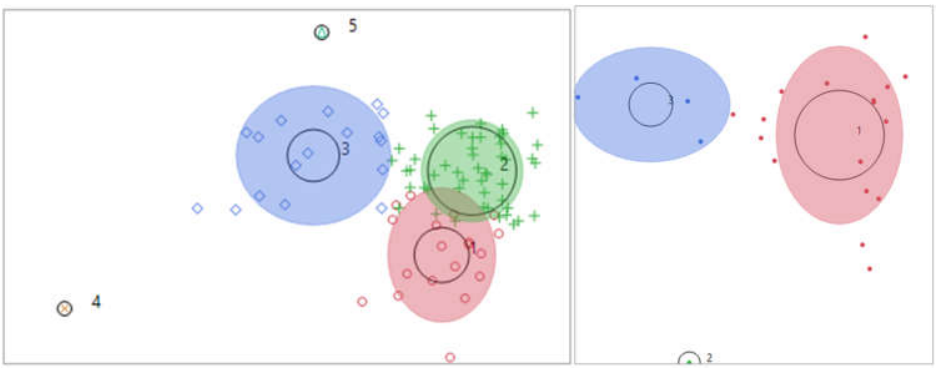



Figure 21 - Cluster demarcation areas (left: car-driver & right non-car drivers) compared to data points

## 7.3 Crosstabulations: mobility concept evaluation and baseline attributes

The following two tables cross tabulates the positive evaluation towards mobility concepts in relation to a selection of baseline attributes.

Table 15 – Cross tabulation between evaluations to mobility concepts and sociodemographic variables

| Mobility Segment | | | | Age Categories | | | Household composition | | | Empl. | Student | Work location | | Family income (Euros) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distribution among respondents (%) | | | | 18-29 | 30-39 | 40-59 | Alone | Partner no child. | Partner w. child | | | Leuven | Beyond | <2500 | <4000 | >4000 |
| General statements about MaaS | S4Q01 Knows MaaS | | (strongly) agreed with statement | 28.95 | 40.00 | 44.68 | 43.48 | 40.00 | 37.50 | 38.71 | 35.71 | 38.96 | 35.71 | 32.35 | 40.00 | 46.43 |
| | S4Q02 Car-free Trav. | | | 39.47 | 55.00 | 51.06 | 52.17 | 45.71 | 50.00 | 49.46 | 42.86 | 53.25 | 32.14 | 52.94 | 60.00 | 42.86 |
| | S4Q05 MaaS Adv. | | | 73.68 | 55.00 | 57.45 | 47.83 | 48.57 | 84.38 | 61.29 | 64.29 | 66.23 | 53.57 | 61.76 | 72.00 | 57.14 |
| | S5Q10 MaaS subscr. | | | 60.53 | 40.00 | 42.55 | 43.48 | 42.86 | 53.13 | 45.16 | 64.29 | 51.95 | 35.71 | 50.00 | 48.00 | 39.29 |
| | S4Q03 Will use MaaS | | | 81.58 | 65.00 | 72.34 | 69.57 | 68.57 | 84.38 | 73.12 | 71.43 | 72.73 | 75.00 | 67.65 | 84.00 | 75.00 |
| Vehicle ownership | S5Q12 Bike | | | 23.68 | 30.00 | 23.40 | 30.43 | 28.57 | 12.50 | 21.51 | 42.86 | 20.78 | 35.71 | 17.65 | 20.00 | 25.00 |
| | S5Q11 Car | | | **36.84** | **45.00** | **55.32** | 47.83 | 42.86 | 50.00 | 46.24 | 50.00 | 49.35 | 42.86 | 44.12 | 40.00 | 60.71 |
| Ride services | Private taxis | | | 44.74 | 65.00 | 57.45 | 60.87 | 54.29 | 50.00 | 55.91 | 42.86 | 54.55 | 57.14 | 58.82 | 44.00 | 67.86 |
| | Shared taxis | | | 73.68 | 75.00 | 72.34 | 69.57 | 74.29 | 75.00 | 73.12 | 64.29 | 72.73 | 75.00 | 67.65 | 80.00 | 78.57 |
| | Micro-transit | | | 78.95 | 60.00 | 74.47 | 69.57 | 68.57 | 68.75 | 73.12 | 64.29 | 71.43 | 78.57 | 70.59 | 80.00 | 75.00 |
| | Traditional PT | | | 89.47 | 95.00 | 93.62 | 95.65 | 97.14 | 81.25 | 94.62 | 71.43 | 93.51 | 92.86 | 94.12 | 96.00 | 96.43 |
| Vehicle (general access) | Scooter | | (Possible) interest | 34.21 | 35.00 | 27.66 | 21.74 | 31.43 | 21.88 | 29.03 | 42.86 | 29.87 | 32.14 | 26.47 | 40.00 | 21.43 |
| | (Electric) cargo bike | | | 63.16 | 60.00 | 57.45 | 43.48 | 57.14 | 43.75 | 59.14 | 57.14 | 59.74 | 57.14 | 64.71 | 56.00 | 57.14 |
| | Van | | | 57.89 | 60.00 | 72.34 | 52.17 | 74.29 | 53.13 | 63.44 | 71.43 | 63.64 | 71.43 | 55.88 | 68.00 | 71.43 |
| | Petrol or diesel car | | | 71.05 | 65.00 | 70.21 | 69.57 | 77.14 | 62.50 | 68.82 | 71.43 | 72.73 | 64.29 | 61.76 | 76.00 | 75.00 |
| | Electric bike | | | 78.95 | 65.00 | 80.85 | 65.22 | 77.14 | 68.75 | 78.49 | 64.29 | 76.62 | 82.14 | 79.41 | 80.00 | 78.57 |
| | Electric or hybrid car | | | 73.68 | 70.00 | 85.11 | 60.87 | 82.86 | 75.00 | 77.42 | 78.57 | 76.62 | 82.14 | 67.65 | 84.00 | 89.29 |
| | Normal bike | | | 78.95 | 75.00 | 78.72 | 73.91 | 71.43 | 78.13 | 78.49 | 78.57 | 77.92 | 82.14 | 88.24 | 88.00 | 64.29 |
| Vehicle sharing | Free-floating | Cars | | 84.21 | 85.00 | 87.23 | 82.61 | 85.71 | 78.13 | 84.95 | 78.57 | 84.42 | 85.71 | 82.35 | 84.00 | 92.86% |
| | | Bikes | | 81.58 | 70.00 | 85.11 | 82.61 | 77.14 | 78.13 | 83.87 | 57.14 | 77.92 | 92.86 | 88.24 | 84.00 | 85.71% |
| | Station-based | Bikes | | 86.84 | 75.00 | 93.62 | 91.30 | 82.86 | 84.38 | 88.17 | 71.43 | 88.31 | 85.71 | 94.12 | 92.00 | 82.14% |
| | | Cars | | 81.58 | 80.00 | 93.62 | 86.96 | 85.71 | 84.38 | 88.17 | 71.43 | 89.61 | 82.14 | 85.29 | 92.00 | 92.86% |
| Long term vehicle | Scooter | | | 28.95 | 40.00 | 36.17 | 26.09 | 40.00 | 18.75 | 33.33 | 35.71 | 35.06 | 32.14 | 35.29 | 40.00 | 25.00 |
| | Cargo bike | | | 65.79 | 55.00 | 53.19 | 39.13 | 57.14 | 46.88 | 58.06 | 50.00 | 55.84 | 64.29 | 64.71 | 56.00 | 53.57 |
| | Normal bike | | | 76.32 | 65.00 | 72.34 | 73.91 | 62.86 | 68.75 | 73.12 | 71.43 | 76.62 | 67.86 | 82.35 | 76.00 | 60.71 |
| | Electric bike | | | 73.68 | 65.00 | 87.23 | 78.26 | 82.86 | 59.38 | 78.49 | 71.43 | 77.92 | 82.14 | 82.35 | 76.00 | 78.57 |

Table 16 – Cross tabulation between evaluations to mobility concepts and mobility behaviour variables

| | | | | Daily use of travel means | | | Transport mode to go to work | | | | | Running errands | | | Household cars | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Car dri. | Tr.&bu. | Cycling | Cycling | Bus | Walk | Train | Car | Cycling | Walk | Car | 0 | 1 | 2+ |
| General statements about MaaS | S4Q01 Knows MaaS | | (strongly) agreed with statement | 40.00 | 17.65 | 41.27 | 44.68 | 12.50 | 37.50 | 28.57 | 40.00 | 42.86 | 30.00 | 34.38 | 30.00 | 45.45 | 26.09 |
| | S4Q02 Car-free Trav. | | | 6.67 | 35.29 | 58.73 | 63.83 | 25.00 | 68.75 | 35.71 | 10.00 | 71.43 | 50.00 | 12.50 | 83.33 | 40.00 | 21.74 |
| | S4Q05 MaaS Adv. | | | 40.00 | 58.82 | 71.43 | 78.72 | 62.50 | 37.50 | 71.43 | 40.00 | 79.59 | 46.67 | 53.13 | 76.67 | 60.00 | 56.52 |
| | S5Q10 MaaS subscr. | | | 33.33 | 35.29 | 49.21 | 57.45 | 50.00 | 50.00 | 42.86 | 25.00 | 48.98 | 56.67 | 37.50 | 53.33 | 49.09 | 39.13 |
| | S4Q03 Will use MaaS | | | 66.67 | 76.47 | 79.37 | 85.11 | 62.50 | 43.75 | 71.43 | 75.00 | 83.67 | 53.33 | 78.13 | 70.00 | 81.82 | 65.22 |
| Vehicle ownership | S5Q12 Bike | | | 26.67 | 29.41 | 15.87 | 14.89 | 37.50 | 31.25 | 42.86 | 25.00 | 26.53 | 30.00 | 15.63 | 23.33 | 23.64 | 30.43 |
| | S5Q11 Car | | | 33.33 | 52.94 | 52.38 | 51.06 | 62.50 | 56.25 | 57.14 | 20.00 | 53.06 | 43.33 | 40.63 | 53.33 | 47.27 | 39.13 |
| Ride services | Private taxis | | | 80.00 | 58.82 | 47.62 | 51.06 | 75.00 | 50.00 | 42.86 | 70.00 | 46.94 | 56.67 | 62.50 | 30.00 | 60.00 | 65.22 |
| | Shared taxis | | | 73.33 | 82.35 | 69.84 | 74.47 | 87.50 | 50.00 | 85.71 | 75.00 | 71.43 | 70.00 | 75.00 | 63.33 | 74.55 | 73.91 |
| | Micro-transit | | | 73.33 | 82.35 | 71.43 | 72.34 | 87.50 | 62.50 | 85.71 | 70.00 | 73.47 | 66.67 | 68.75 | 70.00 | 76.36 | 60.87 |
| | Traditional PT | | | 86.67 | 100.0 | 92.06 | 91.49 | 100.0 | 93.75 | 92.86 | 95.00 | 93.88 | 93.33 | 87.50 | 93.33 | 90.91 | 91.30 |
| Vehicle (general access) | Scooter | | (Possible) interest (%) | 26.67 | 41.18 | 28.57 | 27.66 | 37.50 | 31.25 | 42.86 | 25.00 | 26.53 | 30.00 | 34.38 | 23.33 | 29.09 | 43.48 |
| | (Electric) cargo bike | | | 40.00 | 58.82 | 65.08 | 65.96 | 62.50 | 56.25 | 71.43 | 35.00 | 71.43 | 53.33 | 37.50 | 73.33 | 45.45 | 65.22 |
| | Van | | | 53.33 | 76.47 | 61.90 | 63.83 | 50.00 | 68.75 | 85.71 | 60.00 | 65.31 | 50.00 | 68.75 | 50.00 | 69.09 | 69.57 |
| | Petrol or diesel car | | | 73.33 | 82.35 | 66.67 | 68.09 | 75.00 | 68.75 | 71.43 | 75.00 | 61.22 | 60.00 | 87.50 | 56.67 | 72.73 | 82.61 |
| | Electric bike | | | 73.33 | 70.59 | 84.13 | 87.23 | 62.50 | 75.00 | 85.71 | 60.00 | 85.71 | 63.33 | 68.75 | 80.00 | 74.55 | 69.57 |
| | Electric or hybrid car | | | 86.67 | 70.59 | 79.37 | 78.72 | 50.00 | 75.00 | 92.86 | 80.00 | 77.55 | 60.00 | 90.63 | 63.33 | 85.45 | 82.61 |
| | Normal bike | | | 73.33 | 82.35 | 79.37 | 78.72 | 75.00 | 93.75 | 85.71 | 65.00 | 81.63 | 80.00 | 68.75 | 83.33 | 72.73 | 78.26 |
| Vehicle sharing | Free-floating | Cars | | 80.00 | 88.24 | 85.71 | 82.98 | 75.00 | 81.25 | 100.0 | 85.00 | 83.67 | 76.67 | 90.63 | 76.67 | 87.27 | 91.30 |
| | | Bikes | | 80.00 | 82.35 | 87.30 | 87.23 | 62.50 | 81.25 | 85.71 | 75.00 | 87.76 | 70.00 | 78.13 | 83.33 | 81.82 | 73.91 |
| | Station-based | Bikes | | 80.00 | 82.35 | 92.06 | 95.74 | 87.50 | 81.25 | 78.57 | 80.00 | 93.88 | 80.00 | 78.13 | 90.00 | 87.27 | 78.26 |
| | | Cars | | 73.33 | 88.24 | 92.06 | 93.62 | 87.50 | 81.25 | 92.86 | 75.00 | 93.88 | 76.67 | 81.25 | 90.00 | 87.27 | 82.61 |
| Long term vehicle | Scooter | | | 33.33 | 29.41 | 30.16 | 29.79 | 37.50 | 43.75 | 35.71 | 35.00 | 26.53 | 26.67 | 46.88 | 30.00 | 30.91 | 39.13 |
| | Cargo bike | | | 53.33 | 52.94 | 63.49 | 68.09 | 62.50 | 43.75 | 57.14 | 45.00 | 71.43 | 40.00 | 43.75 | 63.33 | 45.45 | 69.57 |
| | Normal bike | | | 73.33 | 64.71 | 73.02 | 76.60 | 75.00 | 93.75 | 57.14 | 65.00 | 75.51 | 70.00 | 68.75 | 73.33 | 67.27 | 78.26 |
| | Electric bike | | | 73.33 | 64.71 | 85.71 | 87.23 | 62.50 | 81.25 | 78.57 | 65.00 | 87.76 | 56.67 | 78.13 | 70.00 | 80.00 | 78.26 |

## 7.4 Segment allocation coefficients and constant

The following table details the weighting coefficients and constant per Golden Question. The approach in how to use the table is explained in the methodology.

| Coefficient Constants | Devoted Drivers | Image Improvers | Malcontented Motorists | Active Aspirers | Practical Travellers | Car Contemplators | PT Dependents | Car-Free Choosers |
|---|---|---|---|---|---|---|---|---|
| | DD | IM | MM | AA | PR | CC | PD | CF |
| Q2 | 2.925 | 2.73 | 1.9 | 1.406 | 1.995 | | | |
| Q3 | 2.797 | 2.745 | 2.028 | 1.815 | 1.854 | | | |
| Q4 | 3.336 | 2.799 | 2.454 | 1.99 | 2.578 | | | |
| Q5 | 1.402 | 1.322 | 0.933 | 0.793 | 0.533 | | | |
| Q6 | | | | | | 2.344 | 1.079 | 1.322 |
| Q7 | 4.972 | 3.465 | 4.589 | 3.01 | 2.893 | 3.83 | 4.977 | 3.223 |
| Q8 | 1.438 | 2.141 | 1.987 | 2.181 | 1.103 | 1.074 | 0.727 | 1.187 |
| Q9 | 3.087 | 2.78 | 3.121 | 2.629 | 2.373 | 2.9 | 3.318 | 2.568 |
| Q10 | 1.993 | 2.445 | 2.387 | 3.147 | 3.049 | 1.831 | 1.796 | 2.631 |
| Q11 | 3.065 | 4.292 | 3.6 | 4.549 | 4.252 | 4.113 | 2.94 | 4.437 |
| Q12 | 4.101 | 3.555 | 3.389 | 3.174 | 3.458 | 3.141 | 2.707 | 2.787 |
| Q13 | 2.625 | 2.969 | 2.774 | 3.074 | 1.841 | 1.995 | 2.603 | 2.424 |
| Q14 | 4.579 | 5.385 | 5.067 | 5.499 | 5.367 | 3.843 | 4.341 | 4.39 |
| Q15 | 1.449 | 1.192 | 0.858 | 0.622 | 0.846 | 1.777 | 1.613 | 1.71 |
| Q16 | 2.761 | 3.772 | 2.621 | 4.045 | 4.151 | 1.91 | 1.555 | 2.637 |
| Q17 | 4.598 | 4.868 | 4.676 | 5.479 | 4.806 | 4.45 | 4.637 | 4.834 |
| Q18 | 3.428 | 3.157 | 2.752 | 2.279 | 2.688 | 3.123 | 3.026 | 2.549 |
| CONSTANT | 82.797 | 85.85 | 70.934 | 77.747 | 70.288 | 57.12 | 56.903 | 61.695 |

## 7.5 Detailed mobility Segments profile descriptions (English & Dutch)

The following text are directly sourced from the final report of the SEGMENT study that described first person descriptions (Anable, 2013). The Dutch descriptions were directly sourced from Goedopweg (n.d.) from reisstijltest.nl/segments.

### 7.5.1 Car drivers

**Devoted Drivers (DD)**

You prefer to use a car than any other mode of transport and you are not interested in reducing your car use. You do not believe there are realistic alternatives to most of the journeys you make and you do not see yourself as a bus user or a cyclist anyway. Other modes are too slow and often stressful with few, if any, advantages over the car. It has probably been a while since you have been on a bus or a bike and you use a car most days. You tend to think successful people use cars and driving is a way to express yourself. You are not particularly motivated by using your travel time to get fit by using the bike or walking, and you are also not particularly motivated by reducing your emissions of greenhouse gases. You believe that people should be able to use their cars as much as they like with little restriction on this and you would like to see more roads built to reduce congestion.

**De fanatieke autogebruiker**

Jij verkiest altijd de auto boven elke andere vorm van vervoer en je bent niet van plan om de auto minder vaak te pakken. De bus of de fiets is voor jou zeker geen alternatief. Die zijn te langzaam, te stressvol en bieden geen voordeel ten opzichte van de auto. Het is al lang geleden dat je de bus of fiets nam. Succesvolle mensen reizen per auto, vind je. Autorijden is een manier om jezelf te uiten. Je vindt jouw reistijd niet geschikt om te lopen of te fietsen en daarmee iets aan je conditie te doen. Dat je daarmee een bijdrage zou leveren om de klimaatverandering tegen te gaan, spreekt je niet aan. Je wilt onbeperkt de auto gebruiken en bent voorstander van de aanleg van meer wegen om files te voorkomen.

**Image Improvers (IM)**

You like to drive and consequently you do not want your ability to drive to be restricted, but you also recognize that it would be good for the planet if we all reduced our car use a little. The main reason you do not want to reduce your car use is largely practical, but you also feel that car driving is part of who you are and your identity. You do not relate to bus users, but you are likely to see cycling as a form of self-expression and have been interested and committed to keeping slim and fit. You are also likely to think you should walk more and leave the car at home but everything takes so much longer when you walk. You are not entirely convinced about the scientific evidence on global warming and your motivation to act is not high, but at the same time you want to do the right thing.

**De imago reiziger**

Jij rijdt graag auto en je wilt daarin niet beperkt worden. Reizen per auto is voor jou de meest praktische wijze van vervoer en ook een onderstreping van jouw persoonlijkheid en imago. Je ziet jezelf niet als busreiziger en fietsen doe je om fit te blijven. Je wilt wel vaker lopen maar de tijd die dat vergt, houdt je tegen. Je beseft wel dat minder autorijden beter voor de aardbol is maar wetenschappers hebben jou (nog) niet overtuigd dat vermindering van het autogebruik opwarming van de aarde tegengaat. Je gaat dan ook niet minder autorijden. Toch doe je graag goede dingen.

**Malcontented Motorists (MM)**

You drive a lot but find it increasingly stressful. You want to cut down your car use but find that there are a lot of practical problems and issues with using alternative modes. For instance, you are likely to feel that bus provision in your area is inadequate or would

**De ontevreden reiziger**

Jij rijdt regelmatig auto maar vindt het in toenemende mate stressvol. Alternatieven heb je niet. In jouw omgeving rijden te weinig bussen, waardoor openbaar vervoer je teveel tijd kost. Tijd die je niet hebt. Hoewel je erkent dat fietsen beter

take too long to do all you need to do. Although you can see that it might be beneficial to your health, cycling is not something you feel comfortable doing. You walk sometimes, but only when it is more convenient than driving and for practical rather than fitness reasons. You might make more effort to walk more in the future though. Environmental issues are something you are aware of and know a little bit about, but you do not feel it is practical to make decisions about your travel based on these issues.

is voor je gezondheid, fiets je niet graag. Je loopt wel eens vanwege puur praktische redenen omdat het dan makkelijker is, níet omdat het gezonder is. Je bent wel van plan vaker te lopen. Hoewel je weet dat autorijden nadelige gevolgen heeft voor het milieu, laat je je daardoor niet weerhouden bij het kiezen voor de auto.

### Active Aspirers (AA)

You feel that you drive more than you should and you would like to cut down. You feel particularly guilty when you use your car on short journeys. But you do not see the bus as a solution – even though it can sometimes be quicker – because it is not always practical for carrying things or travelling with children. Your most preferred alternatives are walking and cycling. You walk a lot already because it is healthy and you enjoy it and are likely to try and fit it into your daily routine as much as possible. Cycling is also something you already do or consider to offer freedom, speed and fitness. You are likely to be motivated by environmental issues and this gives you some extra impetus to leave the car at home when you can.

### De gemotiveerde reiziger

Hoewel je vindt dat je –ook voor korte ritjes- te vaak de auto pakt, is de bus uit praktische overwegingen meestal geen oplossing. Zelfs als het minder tijd kost, vind je de bus niet geschikt omdat je spullen moet vervoeren of omdat je de kinderen meeneemt. Je wilt eigenlijk wel vaker lopen en fietsen. Het is gezonder, het maakt je fit, het biedt meer vrijheid en je geniet ervan. Je staat open voor informatie over klimaatverandering en het motiveert je om de auto vaker te laten staan.

### Practical Travellers (PR)

You regard the car merely as a practical means of getting from A-B and largely use it only when necessary. But you also see other modes as equally or more practical in certain circumstances. You walk and/or cycle a lot as you believe these modes can often be superior to the car in terms of speed, cost and general convenience. The bus, however, is something you feel is often inferior because of the time penalty it involves. You do not tend to walk or cycle specifically because it helps you to be fitter, but fitness is important to you and you are likely to be fit already. You would not change much about how you currently travel as you feel you are already making optimum choices given your commitments and what you have available to you.

### De praktische reiziger

Afhankelijk van de omstandigheden kies je voor de auto, loop je of neem je de fiets. Lopen en fietsen heeft vaak jouw voorkeur omdat je het net zo praktisch vindt en omdat het qua snelheid, kosten en gemak wint van de auto. Dat je er fitter van wordt, is mooi meegenomen maar voor jou geen doel op zich. Je voelt je al fit genoeg. Je ziet geen redenen om dit te veranderen. De keuzes die jij maakt, passen bij jouw verplichtingen en binnen jouw mogelijkheden.

### 7.5.2 Non-car drivers

**Car contemplators (CC)**

You do not have a car at the moment but would like one at some point in the not so distant future. You are likely to not be able to afford a car at the moment or acknowledge that it would be a hassle or an unnecessary drain on your resources in your current circumstances. However, you aspire to own a car as you believe it is a sign of being successful and will provide much desired independence and freedom. Cycling is not something you want to do more of and you believe it is a rather impractical and stressful mode. You see walking as practical sometimes, good for fitness and something you intend to do more of, but generally limited as a mode of transport. You see even more problems with using the bus and whilst you might use it a lot at the moment, you would like to use the car more.

**De autoverlanger**

Je hebt nu geen auto maar zodra jij je er een kan permitteren, staat 'ie voor de deur. Nu is dat nog een onverantwoorde investering. De auto is voor jou een statussymbool, hij straalt succes uit, geeft vrijheid en maakt je onafhankelijk van anderen. Fietsen doe je liever niet, dat vind je stressvol en niet praktisch. Je wilt wel vaker lopen omdat het gezond is maar je ziet het niet als vervangend vervoermiddel. De bus vind je nog ongeschikter. Dat weet je omdat je er nu noodgedwongen op aangewezen bent. Het wachten is op de auto.

**Public Transport Dependents (PD)**

Although you are not against cars in any way and think people should be allowed to use them freely, you don't like driving very much. You are frustrated, though, that you do not get to travel by car a bit more often as you are fed up with the bus being slow so much of time, particularly when it gets caught up in congestion. You do not see yourself as a cyclist, but you don't mind walking and would like to do more of it, particularly for fitness. You have very little interest in environmental issues and do not think they concern you very much, although local pollution and congestion is a concern.

**De OV-gebruiker**

Je hebt absoluut niets tegen de auto. Diegene die dat wil, moet de auto kunnen gebruiken wanneer en zo vaak als 'ie wil. Zelf ben je geen echte autorijder. Toch zou je vaker de auto willen nemen omdat je je ergert dat de bus zo langzaam is als 'ie weer eens vaststaat tussen het verkeer. Je bent ook geen fietser. Lopen zie je wel zitten en wil je vanwege de gezondheid vaker doen. Milieukwesties interesseren jou niet, dit raakt jou niet. Luchtverontreiniging en files bij jou in de straat en de buurt doen dat wel.

**Car-free Choosers (CF)**

You are not keen on driving and believe that cars and their impacts are something that need to be urgently addressed. You are committed to using other more healthy modes of transport instead. You can see benefits of travelling by walking, cycling, and using the bus. If you take the bus you find it enjoyable and relaxing. If you walk you see it as healthy and would like do more of it. If you cycle, you like the sense of freedom it gives you and feel it says something about who you are and how you feel about protecting the environment.

**De bewuste autoloze**

Je vindt reizen met de bus en de tram wel relaxed, maar je loopt en fietst liever. Dat is gezond, het houdt je fit, het geeft je een gevoel van vrijheid en het is ook beter voor het milieu. Eigenlijk heb jij het niet zo op auto's. Wat jou betreft neemt het autoverkeer eerder af dan toe.

## 7.6 Survey

This survey was developed on the online platform of Qualtrics accessible using the website of www.maasonderzoek.be. The survey was available in English (overviewed from the next page) and then in Dutch. The survey had questions that was only shown when the respondent answered a previous question in a certain way. The following is a list of question viewing logic:

- S1Q02: when S1Q01 is not Leuven question is shown.
- S1Q03: when S1Q01 is lives in Leuven question is shown.
- S1Q06: when S1Q01 is not Leuven question is shown.
- S1Q08: when S1Q07 is lives not alone question is shown.
- S1Q09: when S1Q07 is lives not alone question is shown.
- S1Q12: when S1Q11 is no question is shown.
- S1Q13: when S1Q12 is yes or S1Q12 is student question is shown.
- S1Q14: when S1Q11 is yes question is shown.
- S2Q02: when S2Q01 is no option 3 (as car driver) is not shown.
- S2Q04: when S2Q1 is yes and S2Q03 is not none, question is shown.
- S2Q05: when S2Q04 is yes question is shown.
- S2Q06: option for work is shown when S1Q11 is yes or when S1Q12 is student.
- S2Q08: when S2Q07 is yes question is shown.
- S2Q10: when S2Q09 is has smartphone, question is shown.
- S3Q1-4: when S2Q01 is yes question is shown.
- S3Q05: when S3Q01 is no question is shown.
- S6.2 is shown when S1Q01 is Leuven.
- S6.3 is shown when S1Q01 is not Leuven.
- S6.5 is shown when S5.4 is not empty.

English (UK) ▾

**0. Survey introduction**

*S0S00.*

***Optie om van taal naar het Nederlands te gaan***

## Mobility as a Service (MaaS) survey for residents of Leuven

*S0S01.*
Dear resident of Leuven,

I am a Transportation Science master student who happen to live in Leuven. As a fellow resident, I would greatly appreciate your participation in my study on Mobility as a Service (MaaS) for my master thesis.

MaaS offers various transport services as a service and provides possible a future without private car or even bicycle ownership. With this survey I am investigating whether there is a demand for the introduction of MaaS in Leuven and then which services would be most interesting in a MaaS platform.

**For this survey I am looking for adults (18+) who live in Leuven (and it's sub-municipalities).**

All results are processed anonymously. The survey only takes 10 minutes of your valuable time, but your participation helps me tremendously!

**As a token of my gratitude to participants, you would have the chance to win one out of 12 cinema tickets raffled among participants of this survey. Registration for the raffel is at the end of the survey.**

Even if you do not live in Leuven, you can participate in case you want to learn about MaaS and new mobility services!

→ **If you're ready to begin the survey, scroll down below!**

Thanks for your help and with the best regards,
Damian Robinson

*S0D02.*
Master student Transportation Sciences at the University of Hasselt, Flanders, Belgium. Thesis reserach titled: "Achieving transport usership through Mobility as a Service: which services will matter most?". Reseach objectives are avaliable from this link. Promoter: Prof. D. Janssens and supervisor: Prof. A. Neven. Contact: damian.robinson@student.uhasselt.be

imob
TRANSPORTATION RESEARCH INSTITUTE
UHASSELT

*S01V.*
Just to check that you're not a robot...
Click on the square to verify.

Type the text | Privacy & Terms

*S0D3.*

**Click on [>>] to begin survey**

*S0.meta.* Metagegevens browser

*This question will not be displayed to the recipient.*

Browser: **Chrome**

Version: **66.0.3359.181**

Operating System: **Windows NT 10.0**

Screen Resolution: **1366x768**

Flash Version: **-1**

Java Support: **0**

User Agent: **Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/66.0.3359.181 Safari/537.36**

**1. Core sociodemographic variables**

*S1D01.*

## Section 1: demography

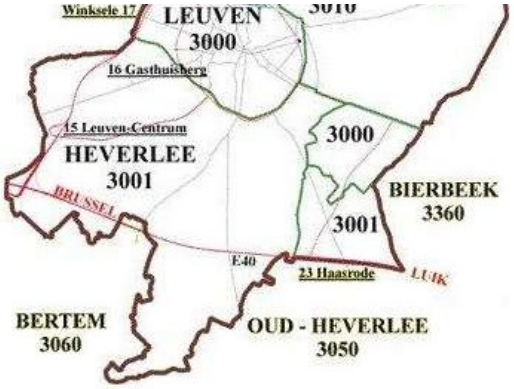
*S1Q01.* Do you live in the city or an area of the Leuven municipality?

- ○ Yes, and I'm also **domiciled or legally residing** in Leuven
- ○ Yes, but I'm not a legal resident or domiciled in Leuven
- ○ No, I don't live in Leuven

*S1Q02.*
Where is your legal residence?

| | |
|---|---|
| Postal code (if applicable) | |
| City and district | |
| Country (if you're not in Belgium) | |

*S1Q03.* Which part of Leuven do live in?




- ○ 3000 Leuven
- ○ 3010 Kessel-Lo
- ○ 3001 Heverlee
- ○ 3012 Wilsele
- ○ 3000 Korbeek-Lo
- ○ 3018 Wijgmaal
- ○ Other - namely:

*S1Q04.* What is your year of birth?

▾

*S1Q05.* What is your sex?

- ○ Male
- ○ Female

*S1Q06.* What is your nationality?

- ○ Belgian
- ○ Not Belgian

*S1Q07.*
Do you live on your own?

*If you live together with other people (partner, family, roommates, parents, friends, ...) then you do not live alone.*

- ○ Yes
- ○ No

*S1Q08.*
The composition of my household is:

- ○ (Un)married and living together with partner but without child (ren)

- (Un)married and cohabiting with partner but with child(ren)
- Single with child(ren)
- Other (living in private household) eg with housemates / parents / family / etc.
- Collective living e.g. a retirement home or student in a student dorm
- Other:

*S1Q09.*
Not counting yourself, how many people does your household count in the following categories

| | | 0 | 1 | 2 | 3 | 4 + |
|---|---|---|---|---|---|---|
| Children less than 12 yrs | | | | | | |
| Teenagers (13-17 yrs) | | | | | | |
| Adults (18-29 yrs) | | | | | | |
| Adults (30-64 yrs) | | | | | | |
| Adults (65+ yrs) | | | | | | |

*S1Q10.* Indicate your highest diploma or certificate you have obtained:

- None
- Primary school
- Secondary school
- Post secondary education - technical college, associate degree
- Higher non-university education - Master's degree at a university of applied sciences
- University education

*S1Q11.*
Are you employed?
*(jobs while you're a student don't count)*

- Yes
- No

*S1Q12.*
For what reason are you not professionally active?

- Student (non-university level education)
- Student (university level)
- Job seeker
- Retired
- Disabled
- Homemaker
- Other:

*S1Q13.* In which city or (sub) municipality is your primary place of work or schooling?

- ○ In the main city area of Leuven
- ○ Outside the city center of Leuven (eg in the Leuven subareas of Kessel-Lo, Heverlee, Haasrode, Kessel-Lo, Wigmaal, Wilsele)
- ○ In an adjacent municipality (eg Bertem, Haacht, Roselaar, Holsbeek, Bierbeek, Oud-Heverlee, Lubbeek)
- ○ Other (sub-) municipality / district (postcode, town name, etc.): _____

*S1Q14.*
What is your average **monthly** after tax **household** income?
*This data are processed anonymously.*

- ○ 0-1000€
- ○ 1001 – 2500€
- ○ 2501 - 4000€
- ○ 4001 - 5500€
- ○ More than 5500€
- ○ I rather not leave a response
- ○ I don't know the household income

**2. Mobility behaviour and technology use**

*S2D02.*
## Section 2: mobility & travel behaviour

-

*S2Q01.*
Are you in possession of a valid driving license to drive a car?

- ○ Yes
- ○ No

*S2Q02.* For each of the following travel options, please indicate how often you use them for everyday life:

| | never or less than once a year | about once, or up to a few times a year | about once, or up to a few times a month | about once, or up to a few times a week | daily |
|---|---|---|---|---|---|
| Walking | ○ | ○ | ○ | ○ | ○ |
| Car as a driver | ○ | ○ | ○ | ○ | ○ |
| Car as a passenger | ○ | ○ | ○ | ○ | ○ |
| Train | ○ | ○ | ○ | ○ | ○ |
| Bus | ○ | ○ | ○ | ○ | ○ |

| | never or less than once a year | about once, or up to a few times a year | about once, or up to a few times a month | about once, or up to a few times a week | daily |

| | | | | | | |
|---|---|---|---|---|---|---|
| Tram/Metro | | ○ | ○ | ○ | ○ | ○ |
| Bicycle | | ○ | ○ | ○ | ○ | ○ |
| Electric bicycle | | ○ | ○ | ○ | ○ | ○ |
| Motorcycle | | ○ | ○ | ○ | ○ | ○ |
| Moped/ scooter | | ○ | ○ | ○ | ○ | ○ |

*S2Q03.*
How many cars does your household have?

- ○ None
- ○ 1
- ○ 2
- ○ 3 or more

*S2Q04.* Is one of these household cars yours personally?

- ○ Yes
- ○ No

*S2Q05.* Is this vehicle a company car?

- ○ Yes, I got it from my employer
- ○ No, I brought it or leased it myself

*S2Q06.* Please choose the mode of transport that you use most to perform the following activities.

| | | Walking | Car | Biking | Bus | Train | Scooter/Moped |
|---|---|---|---|---|---|---|---|
| To work or school | | ○ | ○ | ○ | ○ | ○ | ○ |
| Running errands | | ○ | ○ | ○ | ○ | ○ | ○ |
| Visiting family or friends | | ○ | ○ | ○ | ○ | ○ | ○ |
| Going to the train station | | ○ | ○ | ○ | ○ | ○ | ○ |

*S2Q07.* Do you have a bicycle?

- ○ Yes
- ○ No

*S2Q08.* Select the type of bicycle that you or your household own.

- [ ] Normal bicycle (without pedal assistance)
- [ ] Electric bike (with pedal assistance)
- [ ] Electric cargo bike (with pedal assistance)
- [ ] Normal cargo bike (without pedal assistance)

*S2D03.*
**Use of smartphones**

*S2Q09.*
Choose best answer:

- I possess and use a smartphone
- I don't have a smartphone but I would like one
- I don't have a smartphone and have no desire to have one

*S2Q10.* Chooses which apps you have used in the last month.

| | Less than once per month | > 1x per month but < 2x per week | More than twice per week |
|---|---|---|---|
| Apps to use public transport (eg GoogleMaps, De Lijn, NMBS app, ...). | O | O | O |
| Apps to navigate on the road (eg Google Maps, Waze, ...). | O | O | O |
| Apps for banking. | O | O | O |
| Apps to order food. | O | O | O |

**3. 'Golden' mobility lifestyle segmentation questions**

## *S3D01.* Section 3: travel style

*S3Q01.* Have you driven a car or van in the last 12 months?

- Yes
- No

*S3D02.*
**To what extent do you agree with the following statements?**

*S3Q02.*
For most journeys, I prefer to use the car rather than another form of transport.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q03.*
I like to drive just for the fun of it.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q04.*
I'm not interested in reducing my car use.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q05.*
Driving gives me a way to express myself.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q06.*
How likely are you to drive in the next 12 months?

- Very likely
- Likely
- Unsure
- Unlikely
- Very unlikely

*S3D3.*
**To what extent do you agree with the following statements?**

*S3Q07.*
I like cycling.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q08.*
I feel I should cycle more to keep fit.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q09.*
I find cycling stressful.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q10.*
Cycling is the quickest way to travel around in the city.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q11.*
I like travelling with the bicycle.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q12.*

I like to walk in the city.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q13.*
Walking in the city keeps me fit.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q14.*
I like travelling by walking.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q15.*
I like to travel with the bus.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q16.* Generally I rather cycle than use the bus in the city.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3QX.*
I like to travel with the train.

- Strongly agree
- Agree

- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q17.*
I feel a moral obligation to reduce my emissions of greenhouse gases.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S3Q18.*
People should be allowed to use their cars as much as they like.

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

**4. MaaS paradigm and attitudinal assessment**

## *S4D01.* Section 4: Mobility as a Service (MaaS)

*S4Q01.*
**To what extent do you agree with the following statement:**
I am familiar with the term Mobility as a Service (MaaS) / 'Mobility as a service' and / or with the concept of combined / integrated mobility.

-

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S4D02.* Imagine that you have no access to a car or bicycle, **but** that you can only use external transport options for your daily activities (work, shopping, visiting friends, ...).

-


*S4Q02.*

**To what extent do you agree with the following statement?**

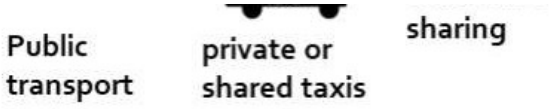
"The use of different transport options to replace a car is NOT a problem."

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S4D03.*

**Mobility as a Service (MaaS) is an integrated solution for mobility**

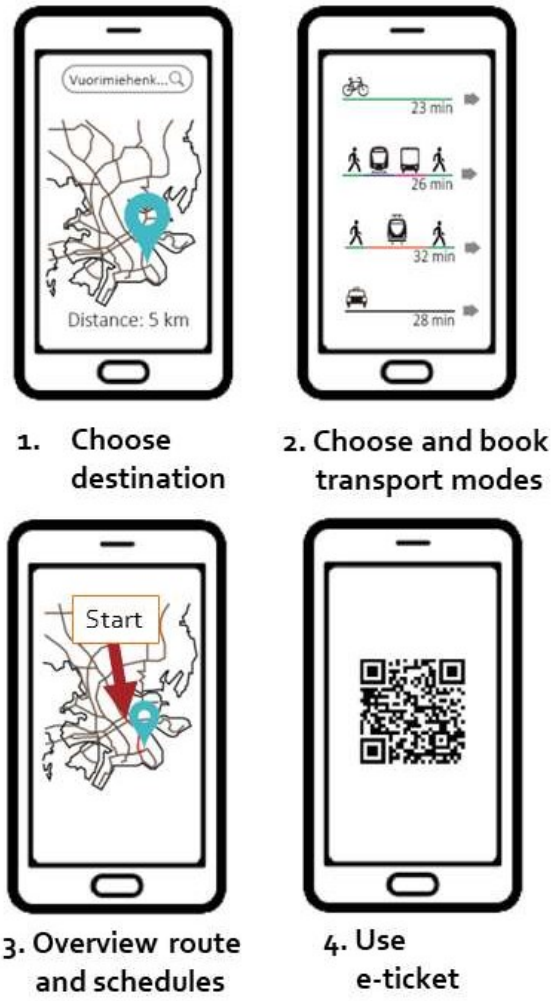
Imagine that - instead of doing all the work to coordinate the different transport services - there is someone else who arranges everything: your personal mobility manager. *This personal assistant is digital (in the form of an advanced app).*




**Transport services that can be offered through MaaS:**

- a ride (e.g. public transport or taxi) or,
- a vehicle (e.g. car, bike, scooter, electric biclycle)

**A MaaS app would work as shown as below:**




Source: Ratilainen, H. (2017)

*S4Q03.*

**To what extent do you agree with the following statement?**

"I would definitely use the MaaS app."

- ○ Strongly agree
- ○ Agree
- ○ No opinion
- ○ Disagree
- ○ Strongly disagree

*S4Q04.*

Drag and arrange the following properties according to importance (the main item must be at the top)

Travel information and planning for travel by combining different means of transport

Electronic tickets instead of manually purchased paper tickets

Access to different services without individual subscriptions

Travel costs that are charged on a single (personal) account

*S4Q05.*
To what extent do you agree with the following statement?
"I can imagine that a MaaS app is advantageous for me."

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

**5. Transport services attitudinal assessment**

*S5D01.* **Section 4: transport services**
MaaS integrates various transport services. The following questions aim to gauge your interest of services within a hypothetical MaaS offer that are based on your personal preferences.

*S5Q01.*
**To what extent do you agree with the following statement?**
"It is important to me that public transport services (eg De Lijn, NMBS, STIB-MIVB, TEC) are present in a MaaS app."

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S5Q02.*
There are other transport services that offer people a ride, just like public transport, but in a more flexible way and on a smaller scale e.g. taxis or like Uber.

**To what extent do you agree with the following statement?**
"It is important for me that taxis are part of the offer in a MaaS app."

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S5Q03.*
Taxis are usually for individual use, but they can be shared with other people traveling in the same

direction.

**To what extent do you agree with the following statement?**
"It is important for me that shared-taxis are available on request in a MaaS app."

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S5Q04.*
The idea behind shared taxis can extend to (mini-) buses that can accommodate around 15 people, and people can pick up and drop off by finding an efficient route. This kind of service is called an on-demand mini-bus and is cheaper than a shared taxi.

**To what extent do you agree with the following statement?**
"It is important for me that on-demand minibuses that picks up other passengers are available on request in a MaaS app."

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

*S5D02.*
Instead of using a transport service that gives you a ride, you can also opt to drive a vehicle yourself, for example a car, van, bicycle, electric bicycle, cargo bike bicycle or scooter.


Car (petrol, hybride, or electric)


Service or utility van


Bike


Electric bike (provides pedal support)


Scooter


Cargo or child transporting bike

*S5Q05.*
Select which of the following vehicles would be intersting for you in the MaaS app:

| | | not interesting | possibly interesting | interesting |
|---|---|---|---|---|
| petrol or diesel car | _ | O | O | O |
| normal bike | _ | O | O | O |
| van | _ | O | O | O |
| scooter | _ | O | O | O |
| electric bike | _ | O | O | O |
| electric or hybrid car | _ | O | O | O |
| (electric) cargo bike | _ | O | O | O |

*S5D03.* Access to vehicles may be based on two systems:

1. **Fixed locations** or stations, where you pick up and return the vehicle at a defined point, such as Cambio or Blue-bikes, or
2. **Free-floating**, without a fixed station or location, where the vehicles (bicycles and / or cars) are spread over the city.

*S5Q06.*

Cambio is a system voor car sharing where cars are available from fixed locations from various locations in Leuven. Choose the answer that best suits you:

- O I've never heard about car-sharing and therefore of Cambio.
- O I've heard about the concept of car-sharing, but not Cambio.
- O I know about Cambio, but I have never used the service.
- O I have already used the Cambio service.

*S5Q07.*

Blue-bikes, a system for bike sharing operates from fixed locations, are available at the Leuven railway station. Choose the answer that best suits you:

- O I don't know about bike-sharing and therefore have never made use of Blue-Bikes.
- O I already know about the bike sharing concept, but not about Blue-Bikes.
- O I know about Blue-Bikes, but I have never used them.

○ I have a Blue-Bike subscription.

*S5Q08.*

Please check off the extent to which you want the following vehicles to be included in the MaaS app:

| | Not interesting | Possibly interesting | Interesting |
|---|---|---|---|
| free-floating bikes | ○ | ○ | ○ |
| Bike sharing with fixed locations (such as Blue-bike) | ○ | ○ | ○ |
| Car sharing with fixed locations (such as Cambio) | ○ | ○ | ○ |
| Mopeds/ scooters | ○ | ○ | ○ |
| free-floating car sharing | ○ | ○ | ○ |

*S5D04.*

- Transport services can provide (electric) bicycles and scooters for **long-term use, almost as you would have them (like a lease)**, but in the form of a long-term rental.
- The service includes maintenance and also the possibility to replace the bike or to terminate the service.

*S5Q09.*

**Check which of the following vehicles, for long-term use, are important to you in the MaaS app:**

| | Not interesting | Possibly interesting | Interesting |
|---|---|---|---|
| Cargo Bikes | ○ | ○ | ○ |
| Scooters | ○ | ○ | ○ |
| Normal bikes | ○ | ○ | ○ |
| Electric bikes | ○ | ○ | ○ |

*S5Q10.*

- You now have an overview of the many different transport services that can be integrated via a MaaS app.

- However, the MaaS concept also offers the possibility to bundle access to these means of transport (eg, as telecom companies do for their products).
- You then choose a plan that corresponds to your use of the transport services. Just like your mobile phone services, MaaS transport services can then be paid via a subscription formula or via consumption.

**To what extent do you agree with the following statement?**
"I think it is advantageous for me to use an integrated mobility plan from a MaaS provider, which is more advantageous than paying the costs individually."

- ○ Strongly disagree
- ○ Disagree
- ○ No opinion
- ○ Agree
- ○ Strongly agree

*S5Q11.*
**To what extent do you agree with the following statement?**
"I can imagine that a MaaS app leads me to no longer have the need to own a car."

- ○ Strongly agree
- ○ Agree
- ○ No opinion
- ○ Disagree
- ○ Strongly disagree

*S5Q12.* **To what extent do you agree with the following statement?**
"I can imagine that a MaaS app leads me to no longer have the need to own my own bike".

- ○ Strongly agree
- ○ Agree
- ○ No opinion
- ○ Disagree
- ○ Strongly disagree

**6. end of survey**

*S6.1.*
## Conclusion of the survey

*S6.C.* Enter any comments about the survey or additional information you think that may be useful for my study.

*S6.2.* **A big thank you for your time and your participation!**

If you want to be kept informed of the results of this study and any follow-up questions, please fill in your e-mail. All collected e-mails are not shared with third parties and by June 2018 (the end of my thesis) all e-mails will be destroyed.

You can email me via damian.robinson@student.uhasselt.be or connect via LinkedIn: linkedin.com/in/damiangrobinson/

*S6.3.*
My sincerest thanks for your time in filling out my survey!

You have indicated that you are a resident of Leuven. That is why you can take part in a lottery for the chance to win a cinema ticket. By registering for this lottery with your email address the following conditions:

- All collected e-mails are not shared with third parties and by June 2018 (the end of my thesis) all e-mails will be permanently erased.
- Communicating via email the final report of the research and possible follow-up questions.
- The selection of lottery winners is entirely random and supervised by my UHasselt thesis supervisors.
- Winners of the lottery received a voucher for the cinema ticket to their home address in Leuven.

If you agree, please enter your e-mail address below:

*S6.4.*
Enter your email:

*S6.5.*
Good luck with your chance of recieving the cinema tickets!
If you have questions you may always email me via via damian.robinson@student.uhasselt.be and connect with me via LinkedIn: linkedin.com/in/damiangrobinson/

*S6.7.* **Survey text and image references**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Bral, L., Jacques, A., Schelfaut, H., Stuyck, K., & Vanderhasselt, A. (2014). Stadsmonitor 2014: Een monitor voor leefbare en duurzame Vlaamse steden. Brussels.

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Reumers, S., Polders, E., Janssens, D., Declercq, K., & Wets, G. (2016). Onderzoek Verplaatsingsgedrag Vlaanderen 5.1 (2015-2016). Brussels. Retrieved from http://www.mobielvlaanderen.be/pdf/ovg51/ovg51-analyse-globaal.pdf


*S6.7.*
**Click on [>>] to submit your responses and end the survey.**

Nederlands

**0. Survey introduction**

*S0S00.*

***Option to change language to English***

## Mobility as a Service (MaaS) enquête voor inwoners van Leuven

*S0S01.* Beste Leuvenaar,

Ik ben student mobiliteitswetenschappen en woonachtig te Leuven. Als stadsgenoot waardeer ik ten zeerste uw deelname aan dit onderzoek omtrent 'Mobility as a Service - MaaS' (mobiliteit als een dienst) in het kader van mijn masterthesis.

Via MaaS worden vervoersmiddelen als een dienst aangeboden, waarbij er een toekomst mogelijk is zonder privé autobezit of zelfs fietsbezit. Met deze enquête wil ik onderzoeken: of er een draagvlak is voor de introductie van MaaS in Leuven; en welke diensten dan het meest interessant zijn.

**Voor deze enquête ben ik op zoek naar volwassenen (18+) die in Leuven of één van de deelgemeenten wonen. Dit is mijn target-groep.**

Alle resultaten worden anoniem verwerkt. De enquête neemt slechts 10 minuten van uw kostbare tijd in beslag, maar uw deelname helpt me enorm verder!

**Als dank voor uw deelname maakt u kans om een van 12 bioscoopkaartjes te winnen! Die zullen verloot worden onder de deelnemers van deze enquête. De registratie voor de loterij vindt u aan het einde van de enquête.**

Ook als u niet in Leuven woont, kan u deelnemen. Zo kunt u bijleren over MaaS en nieuwe mobiliteitsdiensten!

**→ Als u klaar bent om de enquête te beginnen, scrollt u naar beneden om de enquête te starten!**

Bedankt voor uw hulp en met de beste groeten,
Damian Robinson

*S0D02.* Masterstudent mobiliteitswetenschappen aan de Universiteit Hasselt. Thesis onderzoek getiteld: "Het bekomen van transport usership via Mobility as a Service: welke diensten zijn het belangrijkst?". Masteronderzoekdoelen via deze link. Masterthesis promoter: Prof. D. Janssens, en supervisor: Prof. A. Neven. Contact via:
damian.robinson@student.uhasselt.be

imob INSTITUUT VOOR MOBILITEIT
UHASSELT

**1. Core sociodemographic variables**

*S1D01.*

## Sectie 1: demografie

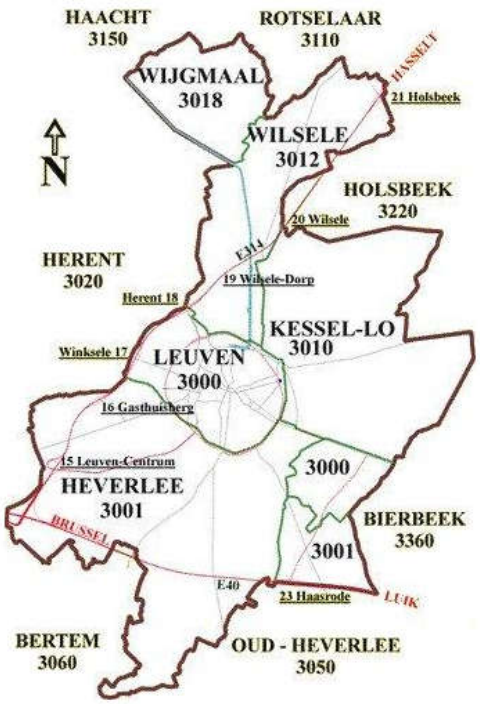
*S1Q01.* Woont u in (een deelgemeente van) Leuven?

- ○ Ja, en ik ben ook **gedomicilieerd** in Leuven
- ○ Ja, ***maar*** ik ben niet gedomicilieerd in Leuven (b.v. in de gemeente van mijn ouders)
- ○ Nee, Ik woon niet in Leuven en ben er ook niet

*S1Q02.*
In welke gemeente bent u gedomicilieerd?

| | |
|---|---|
| Postcode | |
| (Deel-)gemeente | |
| Land (enkel indien u buiten België woont) | |

*S1Q03.*
In welke deelgemeente van Leuven woont u?




- ○ 3000 Leuven
- ○ 3010 Kessel-Lo
- ○ 3001 Heverlee
- ○ 3012 Wilsele
- ○ 3000 Korbeek-Lo
- ○ 3018 Wijgmaal
- ○ Andere - namelijk:

*S1Q04.* Wat is uw geboortejaar?

▾

*S1Q05.* Wat is u geslacht?

- Man
- Vrouw

*S1Q06.* Wat is uw nationaliteit?

- Belg
- Niet-Belg

*S1Q07.*
Woont u alleen?
*Als u met andere mensen (partner, familie, huisgenoten, ouders, vrienden, ...) samenwoont dan woont u niet alleen.*

- Ja, ik woon alleen
- Nee, ik woon met anderen

*S1Q08.* De samenstelling van mijn huishouden is:

- (On)gehuwd samenwonend met partner maar zonder kind(eren)
- (On)gehuwd samenwonend met partner en met kind(eren)
- Alleenstaand met kind(eren)
- Anders bv. met huisgenoten/ ouders/ familie/etc.
- Collectief wonend bv. een rusthuis of student op kot
- Andere:

*S1Q09.*
Uzelf niet meegerekend, hoeveel personen telt uw huishouden in de volgende categorieën

| | 0 | 1 | 2 | 3 | 4 of meer |
|---|---|---|---|---|---|
| Kinderen onder 12 jaar | ○ | ○ | ○ | ○ | ○ |
| Tieners (jonger dan 18 jaar) | ○ | ○ | ○ | ○ | ○ |
| Volwassenen tussen 18-29 jaar | ○ | ○ | ○ | ○ | ○ |
| Volwassenen tussen 30-64 jaar | ○ | ○ | ○ | ○ | ○ |
| Volwassenen ouder dan 65 jaar | ○ | ○ | ○ | ○ | ○ |

*S1Q10.* Duid uw hoogst behaalde diploma of getuigschrift aan.

- ○ Geen
- ○ Lager onderwijs
- ○ Middelbaar onderwijs
- ○ Hoger niet-universitair onderwijs - korte type/ professionele bachelor
- ○ Hoger niet-universitair onderwijs - masterdiploma aan een hogeschool
- ○ Universitair onderwijs

*S1Q11.*
Oefent u momenteel een beroep uit?
*(Studentenjobs niet in aanmerking genomen)*

- ○ Ja
- ○ Nee

*S1Q12.*
Omwille van welke reden bent u niet beroepsactief?

- ○ Student (niet-universitair onderwijs)
- ○ Student (universitair onderwijs)
- ○ Werkzoekend
- ○ Gepensioneerd
- ○ Arbeidsongeschikt
- ○ Uitsluitend werkzaam in eigen huishouden
- ○ Andere: _____

*S1Q13.* In welke stad of (deel)gemeente ligt uw vast werk of school-adres?

- ○ In de binnenstad van Leuven
- ○ Buiten de binnenstad van Leuven (bv. in de Leuvense deelgemeenten van Kessel-Lo, Heverlee, Haasrode, Kessel-Lo, Wigmaal, Wilsele)
- ○ In een aangrenzende gemeente (bv. Bertem, Haacht, Roselaar, Holsbeek, Bierbeek, Oud-Heverlee, Lubbeek)
- ○ Andere (deel-)gemeente/stadsdeel (postcode, gemeentenaam, etc.): _____

*S1Q14.* Wat is uw gemiddelde maandelijkse netto gezinsinkomen?
*Deze gegevens zijn volstrekt anoniem en zijn noodzakelijk om analyses te maken.*

- ○ 0-1000€
- ○ 1001 – 2500€
- ○ 2501 - 4000€
- ○ 4001 - 5500€
- ○ meer dan 5500€
- ○ Ik zou hierop liever geen antwoord geven
- ○ Ik weet het niet

**2. Mobility behaviour and technology use**

## *S2D02.* Sectie 2: mobiliteit & verplaatsingsgedrag

*S2Q01.*
Bent u in het bezit van een geldig rijbewijs om een auto te besturen in België?

- ○ Ja
- ○ Nee

*S2Q02.* Duid voor elk van de volgende mogelijkheden aan hoe vaak u er gebruik van maakt in het alledaagse leven:

| | nooit of minder dan één keer per jaar | één tot enkele keren per jaar | één tot enkele keren per maand | één tot enkele keren per week | dagelijks |
|---|---|---|---|---|---|
| Te voet | ○ | ○ | ○ | ○ | ○ |
| Als wagen bestuurder | ○ | ○ | ○ | ○ | ○ |
| Als wagen passagier | ○ | ○ | ○ | ○ | ○ |
| Trein | ○ | ○ | ○ | ○ | ○ |
| Bus | ○ | ○ | ○ | ○ | ○ |

| | nooit of minder dan één keer per jaar | één tot enkele keren per jaar | één tot enkele keren per maand | één tot enkele keren per week | dagelijks |
|---|---|---|---|---|---|
| Tram/Metro | ○ | ○ | ○ | ○ | ○ |
| Fiets | ○ | ○ | ○ | ○ | ○ |
| Elektrische fiets | ○ | ○ | ○ | ○ | ○ |
| Motor | ○ | ○ | ○ | ○ | ○ |
| Snor-bromfiets | ○ | ○ | ○ | ○ | ○ |

*S2Q03.*
Over hoeveel auto's beschikt uw huishouden?

- ○ Geen
- ○ 1
- ○ 2
- ○ 3 of meer

*S2Q04.* Is één van deze auto's uw persoonlijk bezit?

- ○

- Ja
- Nee

*S2Q05.* Is dit een bedrijfsauto?

- Ja
- Nee

*S2Q06.* Gelieve de vervoerswijze aan te duiden die u het meest gebruikt om de volgende activiteiten uit te voeren.

| | te voet | wagen | (e)fiets | bus | trein | Snor-bromfiets |
|---|---|---|---|---|---|---|
| Naar mijn werk/school gaan | ○ | ○ | ○ | ○ | ○ | ○ |
| Boodschappen doen | ○ | ○ | ○ | ○ | ○ | ○ |
| Familie of vrienden bezoeken | ○ | ○ | ○ | ○ | ○ | ○ |
| Naar het treinstation gaan | ○ | ○ | ○ | ○ | ○ | ○ |

*S2Q07.* Beschikt u over een fiets?

- Ja
- Nee

*S2Q08.* Duid aan welk soort van fiets u of uw huishouden bezit.

- ☐ Gewone fiets (zonder trapondersteuning)
- ☐ Elektrische fiets (met trapondersteuning)
- ☐ Elektrische bak/kinderfiets (met trapondersteuning)
- ☐ Gewone bak/kinder fiets (zonder trapondersteuning)

*S2D03.*
**Gebruik van een smartphone**

*S2Q09.*
Kies het antwoord dat het meest bij uw voorkeur past

- Ik heb en gebruik een smartphone
- Ik heb geen smartphone, maar ik zou er graag een hebben
- Ik heb geen smartphone en wil er ook geen

*S2Q10.* Duid aan welke gsm apps u in de laatste maand gebruikt heeft.

| | 1x of minder per maand | > 1x per maand maar < 2x per week | 2x of meer per week |
|---|---|---|---|
| Apps om gebruik te maken van publiek transport | ○ | ○ | ○ |
| Apps om te navigeren op de weg | ○ | ○ | ○ |
| Apps om te bankieren. | ○ | ○ | ○ |
| Apps om eten te bestellen. | ○ | ○ | ○ |

**3. 'Golden' mobility lifestyle segmentation questions**

*S3D01.* **Sectie 3: reisstijl**

*S3Q01.* Heb je een wagen of bestelwagen bestuurd in de afgelopen 12 maanden?

- ○ Ja
- ○ Nee

*S3D02.*
**In welke mate bent u het eens met de volgende stellingen?**

*S3Q02.* Voor de meeste verplaatsingen maak ik liever gebruik van de auto dan van een andere vorm van vervoer.

- ○ Helemaal mee eens
- ○ Mee eens
- ○ Geen mening
- ○ Niet mee eens
- ○ Helemaal niet mee eens

*S3Q03.*
Ik rijd graag auto voor het plezier.

- ○ Helemaal mee eens
- ○ Mee eens
- ○ Geen mening
- ○ Niet mee eens
- ○ Helemaal niet mee eens

*S3Q04.*
Ik ben geïnteresseerd in het verminderen van mijn autogebruik.

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S3Q05.*
Autorijden is voor mij een statussymbool.

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S3Q06.*
Hoe waarschijnlijk is het dat u in de komende 12 maanden een auto bestuurt?

- Zeer waarschijnlijk
- Waarschijnlijk
- Noch waarschijnlijk noch onwaarschijnlijk
- Onwaarschijnlijk
- Zeer onwaarschijnlijk

*S3D3.*
**In welke mate bent u het eens met de volgende stellingen?**

*S3Q07.*
Ik fiets graag.

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S3Q08.*
Ik vind dat ik meer moet fietsen, om fit te blijven.

- Helemaal mee eens
- Mee eens
- Geen mening

- Niet mee eens
- Helemaal niet mee eens

*S3Q09.*
Fietsen bezorgt me stress.

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S3Q10.*
Fietsen kan de snelste manier zijn om mij in de stad te verplaatsen.

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S3Q11.*
Ik verplaats me graag op de fiets.

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S3Q12.*
Ik hou van wandelen/stappen in de stad.

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S3Q13.*
Wandelen/stappen in de stad houd me fit.

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens

- Helemaal niet mee eens

*S3Q14.*
Ik verplaats me graag te voet.

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S3Q15.*
Ik verplaats me graag met de openbare bus.

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S3Q16.* In het algemeen fiets ik liever in de stad dan dat ik met de bus ga.

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S3QX.*
Ik verplaats me graag met de trein.

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S3Q17.*
Ik voel een morele plicht om mijn bijdrage aan de klimaatverandering te verminderen.

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S3Q18.*
Mensen moeten hun auto zo vaak kunnen gebruiken als ze zelf willen.

- ○ Helemaal mee eens
- ○ Mee eens
- ○ Geen mening
- ○ Niet mee eens
- ○ Helemaal niet mee eens

**4. MaaS paradigm and attitudinal assessment**

## *S4D01.* Sectie 4: Mobility as a Service (MaaS)

*S4Q01.*
**In welke mate bent u het eens met de volgende stelling:**
Ik ben bekend met de term Mobility as a Service (MaaS)/'Mobiliteit als dienst' en/of met het concept van gecombineerde/geïntegreerde mobiliteit.

- ○ Helemaal mee eens
- ○ Mee eens
- ○ Geen mening
- ○ Niet mee eens
- ○ Helemaal niet mee eens

*S4D02.* ***Beeldt u in*** dat u geen enkele toegang heeft tot een wagen of fiets, ***maar*** dat u enkel gebruik kan maken van externe vervoersmogelijkheden voor uw dagdagelijkse activiteiten (werk, winkelen, vrienden bezoeken, ...).


*S4Q02.*

**In welke mate bent u het dan eens met de volgende stelling?**

Het gebruik van verschillende vervoersmogelijkheden om een auto te vervangen is GEEN probleem.

- ○ Helemaal mee eens
- ○ Mee eens
- ○ Geen mening
- ○ Niet mee eens
- ○ Helemaal niet mee eens

*S4D03.*

**Mobility as a Service (MaaS) is een geïntegreerde oplossing voor mobiliteit**

Beeldt u in dat – in de plaats van zelf al het werk te doen om de verschillende vervoersdiensten op elkaar af te stemmen- er iemand anders is die deze taak op zich neemt: *uw persoonlijke mobiliteitsmanager*. *Deze persoonlijke assistent is digitaal (in de vorm van een geavanceerde app).*


**Vervoersdiensten die kunnen aangeboden worden door MaaS:**

- een rit (vb. openbaar vervoer of taxi) of,
- een voertuig (vb. auto, fiets, bromfiets, elektrische fiets)

**Een MaaS app zou werken zoals hieronder getoond:**


Bron: Ratilainen, H. (2017)

*S4Q03.*

**In welke mate bent u het eens met de volgende stelling?**

"Ik zou de MaaS app zeker gebruiken."

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S4Q04.*

Versleep en rangschik de volgende eigenschappen volgens belangrijkheid (het belangrijkste item moet bovenaan komen)

Reisinformatie en planning voor reizen door combinatie van verschillende vervoersmiddelen

Elektronische tickets i.p.v. handmatig gekochte papieren tickets

Toegang tot verschillende diensten zonder individuele abonnementen

Reiskosten die worden aangerekend op een enkele (persoonlijke) account

*S4Q05.*

**In welke mate bent u het eens met de volgende stelling?**

"Ik kan me voorstellen dat een MaaS app voor mij voordelig is."

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

**5. Transport services attitudinal assessment**

*S5D01.* **Sectie 5: vervoersdiensten**

De volgende vragen zijn bedoeld om uw voorkeur voor bepaalde typen mobiliteitsdiensten in een hypothetisch MaaS-aanbod te bepalen.

*S5Q01.*

**In welke mate bent u akkoord met de volgende stelling?**

"Het is voor mij belangrijk dat diensten voor publiek transport (vb De Lijn, NMBS, STIB-MIVB, TEC) aanwezig zijn in een MaaS app."

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S5Q02.* Er zijn andere vervoersdiensten die mensen een rit aanbieden, net zoals het openbaar vervoer, maar dan op een meer flexibele manier en op kleinere schaal vb taxi's of de Uber dienst.

**In welke mate bent u akkoord met de volgende stelling?**

"Het is belangrijk voor mij dat taxi's deel uitmaken van het aanbod in een MaaS app."

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S5Q03.*

Taxi's zijn meestal voor individueel gebruik, maar ze kunnen worden gedeeld met andere mensen die in dezelfde richting reizen.

**In welke mate bent u akkoord met de volgende stelling?**

"Het is belangrijk voor mij dat gedeeldetaxi's op vraag beschikbaar zijn in een MaaS app."

- Helemaal mee eens
- Mee eens
- Geen mening
- Niet mee eens
- Helemaal niet mee eens

*S5Q04.* Het idee achter gedeelde taxi's kan zich uitbreiden tot (mini-)bussen die plaats bieden aan ongeveer 15 mensen, en mensen kunnen oppikken en afzetten door een efficiënte route te vinden. Dit soort service wordt een on-demand mini-bus genoemd en is goedkoper dan een gedeelde taxi.

**In welke mate bent u akkoord met de volgende stelling?**
"Het is belangrijk voor mij dat op vraag (on-demand) gedeelde minibusjes beschikbaar zijn in een MaaS app."

- ○ Helemaal mee eens
- ○ Mee eens
- ○ Geen mening
- ○ Niet mee eens
- ○ Helemaal niet mee eens

*S5D02.*
In plaats van gebruik te maken van een vervoersdienst, kunt u ook opteren om een voertuig zelf te besturen, bijvoorbeeld een auto, bestelwagen, fiets, elektrische fiets, bakfiets / kinderfiets of bromfiets.

Wagen (gewoon, hybride, elektrisch)

Bestelwagen

Fiets

Elektrische fiets

Brommer/ scooter

Bakfiets / kinderfiets

*S5Q05.*
Kruis aan welke van de volgende voertuigen voor u belangrijk zouden zijn in de MaaS app:

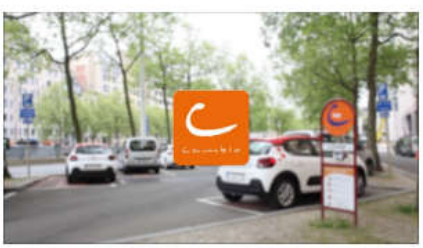
| | niet interessant | mogelijks interessant | interessant |
|---|---|---|---|
| brommer/ scooter | ○ | ○ | ○ |
| elektrische fiets | ○ | ○ | ○ |

| | | | |
|---|---|---|---|
| benzine- of dieselauto | ○ | ○ | ○ |
| gewone fiets | ○ | ○ | ○ |
| (elektrische) bak- of kinderfiets | ○ | ○ | ○ |
| elektrische of hybride auto | ○ | ○ | ○ |
| bestelwagen | ○ | ○ | ○ |

*S5D03.* Toegang tot voertuigen kan gebaseerd zijn op twee systemen:

1. **Vaste locaties of stations, waar u het voertuig afhaalt en terugbrengt** zoals Cambio of Blue-bikes, en
2. **Free-floating - zonder vaste locatie** waarbij de voertuigen (fietsen en/of auto's) verspreid zijn over de stad.

*S5Q06.*



Cambio is een system voor autodelen dat werkt via vaste locaties en is beschikbaar op verschillende locaties in Leuven. Kies het antwoord dat het meest bij u past:

- ○ Ik heb nog nooit gehoord over auto-delen of Cambio.
- ○ Ik heb al gehoord van het concept auto-delen, *maar niet van Cambio.*
- ○ Ik ben bekend met Cambio, maar ik heb er geen abonnement op.
- ○ Ik heb of had al een Cambio abonnement.

*S5Q07.*

Blue-bikes, een systeem om fietsen te delen, werkt via vaste locaties en zijn beschikbaar aan het station van Leuven. Kies het antwoord dat het meest bij u past:

- ○ Ik heb nog nooit gehoord over gedeeld gebruik van fietsen of Blue-Bikes.
- ○ Ik heb al gehoord van het concept fiets-delen, *maar niet van Blue-bikes.*
- ○ Ik ben bekend met Blue-bikes, maar ik heb er geen abonnement op.
- ○ Ik heb een Blue-bikes abonnement.

*S5Q08.*
Kruis aan in welke mate u wenst dat de volgende voertuigen opgenomen zijn in de MaaS app:

| | niet interessant | mogelijks interessant | interessant |
|---|---|---|---|
| free-floating fiets | ○ | ○ | ○ |
| brommer/ scooter | ○ | ○ | ○ |
| free-floating auto's | ○ | ○ | ○ |
| deelauto's met vaste locaties (zoals Cambio) | ○ | ○ | ○ |
| deelfiets met vaste locaties (zoals Blue-bike) | ○ | ○ | ○ |

*S5D04.*

- Vervoersdiensten kunnen (elektrische) fietsen en scooters leveren voor **langdurig gebruik, bijna zoals u ze zou bezitten (zoals een lease),** maar in de vorm van een langetermijnverhuur.
- In de service zit het onderhoud inbegrepen en ook de mogelijkheid om de fiets te vervangen of de dienst te beëindigen.

*S5Q09.*
Kruis aan welke van de volgende voertuigen, voor langdurig gebruik, voor u belangrijk zijn in de MaaS app:

| | niet interessant | mogelijks interessant | interessant |
|---|---|---|---|
| elektrische fiets | ○ | ○ | ○ |
| kinder/ bak-fiets | ○ | ○ | ○ |
| gewone fiets | ○ | ○ | ○ |
| scooters | ○ | ○ | ○ |

*S5Q10.*

- U heeft nu een overzicht gekregen van de vele verschillende vervoersdiensten die kunnen worden geïntegreerd via een MaaS-app.
- Het MaaS-concept biedt echter ook de mogelijkheid om de toegang tot deze vervoersmiddelen te bundelen (vb zoals telecombedrijven dit doen voor hùn producten).
- U kiest dan een plan dat overeenkomt met uw gebruik van de vervoersdiensten.
- Net als uw gsm-diensten kunnen MaaS-vervoersdiensten dan via een abonnementsformule of per verbruik betaald worden.

**In welke mate bent u akkoord met de volgende stelling?**
"Ik denk dat het voordelig voor mij is om een geïntegreerd mobiliteitsabonnement van een MaaS-provider te gebruiken. Dit is voordeliger dan het individueel betalen van de kosten."

- ○ Helemaal mee eens
- ○ Mee eens
- ○ Geen mening
- ○ Niet mee eens
- ○ Helemaal niet mee eens

*S5Q11.* **In welke mate bent u akkoord met de volgende stelling?**
"Ik kan me voorstellen dat een MaaS app ertoe leidt dat ik niet meer de noodzaak heb om een eigen wagen te bezitten."

- ○ Helemaal mee eens
- ○ Mee eens
- ○ Geen mening
- ○ Niet mee eens
- ○ Helemaal niet mee eens

*S5Q12.* **In welke mate bent u akkoord met de volgende stelling?**
"Ik kan me voorstellen dat een MaaS app ertoe leidt dat ik niet meer de noodzaak heb om een eigen fiets te bezitten."

- ○ Helemaal mee eens
- ○ Mee eens
- ○ Geen mening
- ○ Niet mee eens
- ○ Helemaal niet mee eens

**6. end of survey**

*S6.1.*
## Conclusie van de enquête

*S6.C.* Voer eventuele opmerkingen of indien u extra informatie wenst kan u dit hier weergeven.

*S6.2.* **Hartelijk bedankt voor uw tijd en uw deelname!**

Als u op de hoogte wilt blijven van de resultaten van deze studie en eventuele vervolgvragen, vul dan uw e-mail in. Alle verzamelde e-mails worden niet gedeeld met derden en tegen juni 2018 (het einde van mijn proefschrift) zullen alle e-mails worden vernietigd.

Je kunt me mailen via damian.robinson@student.uhasselt.be of connecteren met me via LinkedIn: linkedin.com/in/damiangrobinson/

*S6.3.* Hartelijk bedankt voor uw tijd en uw deelname!

Je hebt aangegeven dat je een inwoner bent van Leuven. Daarom kunt u deelnemen aan een loterij met de kans om een bioscoopkaartje te winnen. Door te registreren voor deze loterij met uw e-mailadres gaat u akkoord met de volgende voorwaarden:

- Alle verzamelde e-mails worden niet gedeeld met derden en tegen juni 2018 (het einde van mijn proefschrift) zullen alle e-mails worden vernietigd.
- U krijgt toegang tot het eindrapport van het onderzoek en mogelijke vervolgvragen.
- De selectie van loterijwinnaars gebeurt helemaal willekeurig en onder supervisie van mijn UHasselt-scriptiebegeleiders.
- Winnaars van de loterij zullen een tegoedbon voor het bioscoopkaartje via post naar hun thuisadres in Leuven of deelgemeente opgestuurd krijgen.

Als u akkoord gaat, vul dan hieronder uw e-mailadres in a.u.b:

*S6.4.*
Voer een e-mail adres in:

*S6.5.*
Veel success met de verloting van de cinema tickets!
Als u vragen heeft kunt u me altijd mailen via damian.robinson@student.uhasselt.be of met me connecteren via LinkedIn: linkedin.com/in/damiangrobinson/

*S6.7.* **Enquêtetekst en afbeeldingsreferenties**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*S6.7.*
**Klik op volgende [>>] om in te dienen en de enquête te sluiten.**

# Auteursrechtelijke overeenkomst

Ik/wij verlenen het wereldwijde auteursrecht voor de ingediende eindverhandeling:
**Mobility as a Service: segmenting preferences for transport usership**

Richting: **Master of Transportation Sciences-Mobility Management**
Jaar: **2018**

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

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Voor akkoord,

**Robinson, Damian Glenn**

Datum: **1/06/2018**