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Behavior Change through Innovation Adoption: A Case Study of Alternative Mobility Solutions

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Aalto University School of Science Degree Programme in Computer Science and Engineering Master's Programme in International Design Business Management	ABSTRACT OF THE MASTER'S THESIS

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Abstract: The sustainability of urban transportation is becoming one of the biggest concerns in the field of mobility. Transportation behavior of urban citizens is highly car dependent. Alternative mobility solutions (AMS) like car-sharing services are seen as a potential innovative way to improve the environmental situation in cities. Despite AMS are present in the market, there are challenges for people to adopt this type of services and change their behavior towards more sustainable urban living. To address this challenge, it is important to identify *What are the factors influencing an individual decision to adopt AMS innovation and change user behavior*. There is no coherent framework to study innovation adoption in transportation related to AMS. This study aims at providing a fresh perspective on innovation adoption and behavior change in modern urban transportation with the focus on AMS. This includes synthesis of three theories to introduce a framework that presents factors which can be taken into account when developing an intervention in the transportation sector.

The factors of the proposed framework are tested and validated in this research through multiple case studies in the form of interviews with transportation experts (N=8) in Finland. Findings demonstrate an importance of understanding influential elements in an ecosystem that affect innovation adoption. These elements include involvement of every stakeholder in addressing individual behavior change, particularly, peers that individuals trust, and government representation. As a part of this study, the innovation characteristics are specifically emphasized as factors with an important role in AMS innovation adoption decision. For instance, minimum complexity, opportunity to try an innovation before making the adoption decision, competitive pricing, and compatibility to a prior-experiences were listed as the most influential characteristics.

The results of the study serve as a basis for the research on the development of interventions in the transportation sector with a particular focus on alternative mobility solutions (AMS).

Keywords: Behavior change, Innovation, Innovation adoption, Factors for behavior change, Sustainable transportation, Alternative mobility

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AMS – Alternative Mobility Solution

DoI – Diffusion of Innovation

Chapter 1: Introduction

1.1 Background

Urban areas are complex entities which in essence consist of living beings and allocated spaces. To make the city life functional, people and spaces are connected by different means. Mobility as a form of personal and public transportation plays a significant role in connecting people and places. Mobility and transportation are crucial to the socio-economic growth of the city and its individuals (Rodrigue et al., 2013). Still, in urban areas environmental challenges associated with transportation such as air pollution and traffic congestions are a known concern. (Steward and Kuska, 2010; Wheeler and Beatley, 2014). Some of these widely known challenges include parking problems, land consumption, and limitation in human mobility (Gong and Gao, 2014).

In recent years, urban transport grasped a lot of attention as one of the crucial element to promote sustainability in cities (Black, 2010). Sustainable urban living encompasses a lifestyle of individuals that aims to stimulate a long term social and ecological health of cities (Wheeler, 1998) by "*compact and efficient land use, less automobile use and better access*" (Ainoa et al., 2009). Understanding the need for change, countries employ various strategies to support sustainable urban living and particularly improve conditions of urban mobility (Wefering and Rupprecht, 2014). Unfortunately, government policies and strategies cannot solve all environmental challenges on their own (Black, 2010). Users of the transportation need to be a part of this change as well. Yet, a government can drive and encourage industries, academia and public sector working towards environmental-friendly solutions (Rodrigue et al., 2013). For example, one of the valuable solutions for positive environmental impact is an alternative mobility solution (AMS) (Chakrabarti and Lester, 2002). AMS is a mobility transportation service differing from conventional public

transport and car ownership, such as car-sharing and carpooling. AMS has received a lot of attention in the past few decades.

According to Rogers (1995), innovation is an idea or practice that is perceived as a new by a potential unit of adoption. This can be seen in the case of AMS; despite the fact first AMS (e.g. car-sharing) service was introduced already in the 1970s, only a few of them are at a status of established services nowadays, e.g. Car2Go (car2go.com) and DriveNow (de.drive-now.com) (Shaheen et al., 2000). In most of the countries, majority of the population still does not have any experience or knowledge about AMS services (Shaheen et al., 2000). Therefore, AMS can be considered as an innovation which faces a challenge to be adopted by users.

1.2 Research gap

According to Kastelle (2012), an innovation adoption always requires a change in behavior and way people act as a result of this change. In other words, innovation can be a trigger for behavior change or lead to a change in a behavior if individual deploys an innovation. Many researchers agree that the question, "How to adopt an innovation in transportation and change users' behavior?" is one of the most challenging to answer (Abraham and Michie, 2008; Heimlich and Ardoin, 2007). Choosing a relevant theory or method is another challenge that is faced by intervention designers (Michie, 2008) who develop innovative methods to modify the existing user behavior towards more sustainable transportation use (Arnott, 2014).

Due to a variety of available definitions, types of innovations and different approaches to study them, there is a lack of a single theory that covers all aspects of possible behavior changes that can

occur due to innovation adoption in a particular area of focus (Darnton, 2008; Michie, 2008). Moreover, a high number of activities to date on interventions design focus on implementation phase or barriers that discourage an adoption, instead of concentrating on exploration and aspects to consider before innovation is adopted (Wisdom et al., 2014).

It is critical to point out that innovation adoption in this current research is studied as an initial individual decision to accept or reject an innovation. This decision can be influenced by various factors which are further studied in the current research. The focus area of the research is a mobility that relates to transportation in a city area with particular focus on motorized vehicles.

1.3 Research scope

Current research aims to bring the light to innovation adoption phases and behavior change phenomena with the respect to innovation in mobility focused on transportation by motorized vehicles. This topic is selected as there is a clear need for an all-embracing framework with a primary emphasis on modern mobility that can help those working and researching in transportation field to affect individual behavior change and design interventions aimed at improving existing behavior with higher adoption rate.

There are different triggers that can stimulate behavior change, and innovation adoption is one of them. There is no clear distinction between theories on behavior change and innovation adoption. Depending on behavior or innovation emphasis, scholars tend to utilize different vocabulary. However, often theories which describe either of the phenomena are the same or provide similar information. For example, Diffusion of Innovation applied in various sources as both theories of

behavior change and innovation adoption (Darnton, 2008; Forest research, 2012). Thus, it was decided to explore and overview theories on behavior change with no additional research on innovation adoption theories. Apart from the similarities in both theories, it is beneficial for this study to consider behavioral theories as it provides fundamental insights about how behavior is structured.

The research scope of the study is built around innovation in the transportation sector. Proposed framework for this study discusses in the context of case studies from Finland. All the empirical data and evidences provided based on real life cases and challenges related to innovation adoption in transportation. Finnish mark et is relatively small, but at the same time demonstrates a big potential in the development of innovative solutions in transportation (Lovejoy, 2013). In recent years, Finnish government and other stakeholders have realized this need to address the challenges and bring changes to the conventional views on transportation. In this context, the last budgeting of main projects in the Transportation strategy (2013-2017) is estimated to be approximately 300 million where transportation innovations are the priority (Liikenteen ympäristöstrategia 2013-2020, 2013). Finland aims to be one of the leading European Countries in advanced and efficient transport systems. This is the reason they are making active contributions to the current Finnish transportation development.

1.4 Research question and approach

The current study aims to provide a comprehensive understanding of a behavior change and innovation adoption in the transportation sector with a particular focus on alternative mobility

solutions (AMS) utilizing motorized vehicles. The study suggests a combination of theories to design a framework that can be useful for intervention designers to increase the adoption rate of their innovative solutions. Thus, the research question in this study intends to answer:

> *What are the factors influencing an individual decision to adopt AMS innovation and change user's behavior?*

To gain a comprehensive understanding of the problem area, particular attention is paid to theoretical concepts related to alternative mobility services factors. Especially, factors that assist in behavior change process when AMS services are introduced. *Literature review* supports in defining the main theories that are further applied in the study framework. *Qualitative research* is used as a part of this study to test and validate the framework.

As part of the *literature review* for the foundation of the current research framework, Diffusion of Innovation Theory by Rogers is used (Rogers, 1995). This theory is well established and proved to be reliable in explaining innovation adoption in various areas and transportation particularly (Meijkamp, 2000). An extensive study by Rogers provides evidence on key attributes of innovations that affect an individual rate of adoption (Greenhalth, et al., 2005). However, these widely cited attributes are only a part of the overall framework described in this study. Hence, it is necessary to incorporate additional theories and methods to make this framework more specific to urban transportation, with consideration of the selected innovation type (AMS) and focus on users. For this purpose, the following theories were selected:

- *Decomposed theory of planned behavior (DTPB)* - DTPB is extensively applied in the transportation sector. It analyzes and studies individual behavior from psychological perspective (Hunecke et al., 2008);
- *Energy culture framework* is a culture-based approach that orients on changing the energy behavior (Stephenson, et al., 2010).

Together, the selected theories enhance Rogers' Innovation Adoption Process and form a framework that can be applied in the context of transportation to persuade potential adopters.

Qualitative research was conducted in a form of eight semi-structured interviews with transportation experts in Finland. The data explores the role of different stakeholders and examines factors underlying alternative mobility services adoption. Interviewees also had deep insights regarding factors that affect successful AMS adoption as most of them provide solutions and consultations regarding the transportation to a number of organizations. Findings from the interviews are compared to the factors identified by the framework in use.

1.5 Thesis structure

There are five chapters presented in the thesis. Chapter 2 covers the research background information by presenting an overview to the relevant theories in behavior change and behavioral theories. Chapter 2 also provides an overview of the main terms utilized in the thesis and summarizes theoretical data recommendations in application of theories with further use of the most relevant in the framework development. In addition, Chapter 2 proposes the framework which is based on three selected theories. Follows, Chapter 3 presents the research design and

methodology. Chapter 3 introduces qualitative approach as a data collection method in the form of interviews with experts in transportation sector. Interview structure and data analysis methods are discussed in details in the same Chapter 3. To present the result of the conducted interviews, the multiple case studies provided in the Chapter 4. Results of the study illustrates individual cases overview as well as the summary of all cases together. Interpretation of the results discussed in the following Chapter 5. The conclusions and future development as regards of the entire thesis is summarized in the same Chapter 5.

Chapter 2: Literature Review

The current chapter discusses the key literature related to behavior change and innovation adoption. To develop a better understanding of behavior change, this chapter starts by defining the main terminology and follows with the discussion of key concepts related to behavior change. Later in this chapter, the focus is narrowed to behavior change in transportation and adoption of innovative services. Theories were compared and three the most relevant for the current research were selected for further development. In order to adapt these theories for the research scope, theories were applied in the framework. A detailed description of the framework presented at the end of the chapter.

2.1 Behavior change as a challenge

There is a great number of terms and operational definitions in a field of innovation adoption and behavior change that vary depending on discipline, approach or sphere of study. At the same time, it can range from very specific to wide generalizations (Martins and Terblanche, 2003). Therefore, to create a comprehensive study following paragraphs present terms and definitions employed in the research.

Human *behavior is a phenomenon that consolidates different components such as human habits, emotions, social and moral norms* (Martiskainen, 2007). Various disciplines study human behavior in order to understand what leads a decision to change to a certain behavior and how to influence it (Zhou et al., 2005). It is important to consider each of individual behaviors as they structure larger behaviors in the environment (Heimlich and Ardoin, 2008). Human behavior is a

highly complicated phenomenon and encouraging behavior change can be challenging (Martiskainen, 2007). Thus, it is important to understand what causes a behavior change.

One reason of changes in human behavior is an innovation that is introduced to people. Regardless the fields of innovation application (e.g. workplace or everyday life), its form (e.g. product or service) or level of newness (e.g. incremental or radical); innovation adoption always requires from individuals to act differently and develop a new set of behaviors (Kastelle, 2012; Greenhalgh et al., 2005). In other words, innovation can be a trigger for behavior change.

There is a number of innovation concepts that belong to different school of thoughts (Vogel et al., 2005). Some researchers describe innovation as follows: "*Innovation as an idea, practice, or material artifact, perceived to be new by individual or relevant unit of adoption* (Zaltman et al., 1973; Rogers, 1985) *that can lead to behavior change if it gets adopted*". Others demonstrate their inclination towards innovation types highlighting radical and incremental innovations. Radical innovation represents fundamental changes in technology or knowledge, whereas incremental innovation is a minor or simple improvement in currently deployed product or service (Dewar and Dutton, 1986).

Other scholars categorize innovation according to its form such as product, service or process (Schumpeter, 1934). Often, studies tend to bring more specification to the innovation form description or synthesize and combine one or more forms (Kelley and Littman, 2006).

Recently emerged Product-Service Systems (PSS) concept illustrates an example of conventional innovation forms' modification (Williams, 2007). Coming from business and economic disciplines (Goedkoop, 1999) and later adapted by researchers focusing on the environment, PSS is a

combination of all three forms of innovation (product, service, and process). Mont (2002) describes Product-Service Systems as *"a system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models"*. A number of studies focusing on automobile industries, see PSS as an ideal innovation form that illustrates modern perspective of the industry (Cherubini et al., 2015; Williams, 2007; Ehrenfeld and Brezet, 2001). Subsequently, innovation considered in the study belongs to PSS innovation form and called Alternative Mobility Solution (AMS).

AMS innovation is an integrated offering of product (e.g. electric vehicle), service (e.g. car-sharing, on-demand car service) and infrastructure (e.g. power grid, various stakeholders) (Tietze et al., 2011) *that is perceived to be new for potential adoption unit.* AMS aims to satisfy customer needs and have a lower environmental impact than conventional transportation modes (Mont, 2002). For example, electric car sharing service. It provides an electric car rental service for a short period of time for urban residents based on a subscription fees and consists of infrastructure: electric vehicles fleet, parking and charging stations (Shaheen et al., 2001).

AMS innovation is considered to be an incremental innovation because most of the system elements are familiar to a consumer and customer can relate to the previous experience of a car use. Nevertheless, innovation has to be adopted by a user before change in his or her behavior can occur.

In order to bring difference in the behavior, AMS innovation has to be adopted by individuals. The concept of innovation adoption does not share a common understanding between researchers. Most

of them do not differentiate two concepts: innovation adoption as a choice (decision of acceptance or rejection) and innovation adoption as a process (Coatanea et al., 2007). *Innovation adoption as a choice is seen as a single event where individual accept or reject an innovation* (Moghavvemi et al., 2011). In contrast, *innovation adoption as a process represents a set of events (phases) that usually leads to further assimilation and diffusion of innovation in wider social groups* (Greenhalph et al., 2005). Mohr argues the need to understand a difference between those concepts in order to enhance the research rather than get lost in its mix and neglect valuable points of each concept (Mohr, 1982).

Numerous models of innovation adoption processes present in the research field. Most cited and respected study model is proposed by Rogers (1995) with five-stage representation on the process: Knowledge, Persuasion, Decision, Implementation, and Confirmation. Most studies accept a classification of pre-adoption, adoption and post-adoption (Damanpour and Schneider, 2006). However, terminology, phases and activities might vary from theory to theory (Rogers, 1995; Cooper and Zmud, 1990). Therefore, it is important to state classification utilized in the current research.

The process of an innovation adoption within this model consists of the first three stages of Innovation Adoption Process in Rogers theory. Some researchers argue all five stages being parts of an adoption process. Nevertheless, current research focus defines innovation adoption as follows:

Innovation adoption is an initial individual adoption choice (Peres et al., 2010) including a prior process (pre-adoption); with no further deliberation of assimilation and routinization among community (Cooper and Zmud, 1990).

In other words, the actual adoption decision occurs before Implementation stage in Rogers' theory. Following Rogers' (2002) five-stage model Knowledge, Persuasion and Decision stages are taken into consideration in innovation adoption decision. Individual goes through various activities to recognize the need of innovation, perceives all necessary information that leads to forming an attitude towards an innovation and further evaluates its effect. It further results in the individual's choice to adopt or reject an innovation (Moghavvemi et al., 2011).

Although the study emphasizes the Diffusion of Innovation theory for the Innovation Adoption description, innovation adoption choice and preliminary process has to be specified more for the particular AMS innovations in transportation sector. For this purpose, various taxonomies and overviews on behavior change and innovation adoption theories were reviewed and classification defined. In the early years, the focus was mostly on innovation itself, following the evolution in models towards process of interaction between an innovation and individual, or a group of potential adopters (Williams et al., 2009). Many theories are influenced by several disciplines and created by multidisciplinary researchers (Davis et al., 2015). Moreover, the choice of relevant theory can be challenging due to their large number (Michie and Johnston, 2012). Additionally, researches conducted in transportation sector often do not specify theories used for interventions' design with the primary focus on empirical research (Bunzeck et al., 2011).

2.2 Theories of behavior change

Researchers use different approaches to describe theories and models of human behavior and behavior change. Thus, it is difficult to find a comprehensive review that would cover all possible theories and interventions. Some researchers tend to categorize behavior change and behavioral theories based on disciplines theories utilized the most. However, in practice, in many cases it is not possible due to overlapping theories and its appearance in different disciplines (Wisdom et al., 2014).

Other school of thoughts stress the need to study behavior change by categorizing target audience. One of the popular segmentation approaches is proposed by Rogers (1995). He introduces five different user groups, based on their tendency or willingness to adopt a specific innovation (Robinson, 2009). In the field of transportation, three major approaches were identified to separate target audience. They are geographic, socio-demographic and attitudinal segmentations (Hunecke et al., 2010). Many studies of Hunecke demonstrate a better prediction of a particular transportation behavior adoption via attitudinal segmentation approach (Hunecke et al., 2010; Bamberg et al., 2007; Hunecke et al., 2001). However, he himself argues that none of the stated segmentations can be an absolute one. There are many other criteria apart from personal factors that have to be taken into consideration when study a behavior change in transportation (Hunecke et al., 2010).

Considerable number of behavior change studies focus on individual while others see a potential in focusing on social and group behaviors. Researchers that place an emphasis on social and group behavior put macro-level societal factors (e.g. economy, demography, culture) in the center of attention. Supporters of those theories argue that factors influencing individual behavior change

are not sufficient to enable the change (Darnton, 2008). Contrary, others claim that focus on the same factors from the individual perspective is more beneficial. Current research belongs to the school of thought that claims there is a need to focus on individual behaviors as they form a larger group's behavior in the society (Heimlich and Ardoin, 2008).

Many studies distinguish theories based on their study direction: theories that focus on modeling of a behavior and theories that study a behavior change (Darnton, 2008; Glanz et al., 1990). Moreover, scholars emphasize the need to consider both theory types. They argue it will help to understand human behavior and further develop a successful behavior change intervention (Darnton, 2008). To introduce behavioral and behavior change theories the current study derives three categories among behavioral theories and models:

- Theories of change;
- Models of behavior at the individual level;
- Integrated models and frameworks.

A detailed description of each category is provided in the paragraphs below. Further, the selection criteria in Section 2.2.4 demonstrateы an elaborate explanation why particular category was selected for the current research.

2.2.1 Theories of change

"Theories of change" category illustrates fundamental theories in the social science that facilitate our understanding about overall process of behavior change. There is a number of theories of

change that became a basis for many methods and frameworks of behavior change. The most cited single author theory across many disciplines and research fields is Diffusion of Innovation Theory (DoI) (Korpelainen, 2011).

DoI theory describes how new behavior spreads and diffuses in groups and society. It also discusses how different communication channels and different types of adopters form the diffusion of new behaviors. Rogers approaches the behavior change phenomenon from the cause of the change, instead of focusing on the behavior itself (Rogers, 2002). He introduces an *innovation* as the main trigger for the behavior change (Forest Research, 2012). Rogers stresses communication to be critical for the innovation diffusion. Moreover, the nature and channels that are used for the communication are critical for the innovation adoption (Mont and Plepys, 2003). Author emphasizes innovation characteristics that assist in better measuring of the adoption rate in comparison with characteristics of adopters (Rogers, 1995). Rogers also proposes a five-stage model of innovation decision process. This process consists of the knowledge that individual acquires about an innovation, the formation of the attitude towards that innovation, then goes to the decision of innovation adoption or rejection, follows implementation and use of the innovation and finishes with confirmation of this decision (Rogers, 2002).

As it was mentioned earlier, DoI is an extensively utilized theory in various fields and transportation is not an exception (Meijkamp, 1998). This theory is proved to be useful in studies related to identification of successful factors for alternative mobility solutions, e.g. car-sharing (Jakobsson 2002; Meijkamp, 1998). However, many of the researchers deploy DoI theory with modifications or adjustments. For example, Meijkamp in his early studies on behavior change through car-sharing points out emotional and motivational differences among individuals which

is not taken into consideration in DoI theory. He argues emotional and motivational differences are of a great importance for an individual decision-making. Moreover, it is even stronger in the area of transportation, where purchase and use of the vehicles might depend a lot on emotional and motivational differences (e.g. loyalty towards particular brand, depending on a reason of the trip (leisure activity, shopping, long distance trip), type of the vehicle may vary, etc.).

Another widely cited and utilized theory of behavior change is Stages of Change (SoC), also known as Transtheoretical model (Prochaska et al., 1992). Similar to DoI, SoC theory describes change as a process of stages. Transtheoretical model consists of five or six stages depending on the source (Forest Research, 2012; Prochaska and Velicer, 1997). In the current research the model is described using six stages. It starts from Precontemplation stage where an individual is not aware about the issue and consequently has no intention to change behavior. Continuing to the stage of understanding the problem and considering the change in his or her behavior, it follows the preparation stage where individual intends to take an action towards a behavior change. Next stage presumes an individual makes a move to modify his or her old behavior. The next stage requires from an individual to maintain a new behavior and finally, there is Termination stage that represents 100 percent efficacy that individual retains a new behavior and maintains it in the future. The last stage is considered the most difficult one, as it is usually hard to reach (Forest Research, 2012). There is a number of studies that regards model as useful to examine the adoption and progress of a sustainable transportation (Redding et al., 2015; Bamberg, 2007; Mundorf et al., 2013). Each stage in Transtheoretical model requires different actions depending on the stage the particular person is currently in. Yet, there is a limitation in the model that is critical for our research. This model does not elucidate such factors as social, economic or environmental. It does

not mean that model argues of its non-existence or uselessness, rather than neglecting it and placing outside the model boundaries (Forest Research, 2012).

Another fundamental theory proposed by social-psychologist Lewin (1951) became a basis for many behavior change approaches (Darnton, 2008). His theory emphasizes a need of a group work to change behavior. This group involves various factors from internal and external areas of human being. Internal factors contain human psychological factors such as believe and will, as well as factors related to human behavior that consists of factors like habits and human characteristics. External behavior change factors defined by Lewin consolidate areas in the society at the higher level - economy, politics, culture, science and technology. Despite the wide range of factors provided in Lewin theory, it lacks consideration of human feelings (emotional factors) and experiences. Still, this theory is extensively utilized in marketing field where marketers target particular behaviors to change (Chen et al., 2005). Contrary, there is no broad application of theory defined in transportation area. Some researchers working on exploration of transportation behavior, consider segregated aspects of the theory. For example, Thogersen (2009) in his research to promote a public transport, emphasizes External factors from the Lewin's theory and argues these factors are important parts to structure behavior and its change.

2.2.2 Models of behavior at the individual level

Category "*Models of behavior at the individual level"* describes theories and models primarily concerned with understanding the factors that influence behavior of individuals. An individual is seen as rationally behaving person who bases a decision to maximize personal benefits (Darnton,

2008). Adoption decision is seen here as a rational analysis of costs and benefits (Greenhalgh et al., 2005). Many researchers in this category explore and evaluate technological innovation adoption (Busse et al., 2013). Besides technological innovations, there is an increasing number of researchers who apply social-psychological models and behavioral science to study sustainable behavior in the fields of energy use, transport and waste (Matthies et al., 2002).

Theory of Planned Behavior (TPB) (Ajzen, 1991) is one of the most popular and widely cited theories in this category that aims to predict consumer adoption intention. Evolving from Theory of Reasoned Action (TRA) (Ajzen, 1985), TPB likewise the parent theory emits behavioral intention is a function of *attitude* and *subjective norm*. Attitude is considered as the most significant factor in most of the theories. *Attitude* is a positive or negative evaluation of a behavior outcome (Morris et al., 2012) as well as a product of people's beliefs about a behavior (Darnton, 2008). Some other models also tend to highlight the role of *emotions* in forming an attitude, e.g. Theory of Interpersonal Behavior (Triandis, 1977). *Subjective norms* describe a perception about the way individual has to act in accordance with opinion of others in his social circle (Morris et al., 2012). In addition to the original theory (Theory of Reasoned Action), TPB incorporates perceived behavioral control, which consists of two components: *facilitating conditions* and *self-efficacy*. *Facilitating conditions* demonstrates the level of available resources (e.g. time or money) required to engage in a behavior, whereas *self-efficacy* indicates individual's level of self-confidence to perform particular behavior (Taylor and Todd, 1995). Similar to TPB, Social Cognitive Theory emphasizes a must of self-efficacy in individual possession. In other words, individual believes that he is capable to perform a behavior and persists the action. It is also presumed to obtain incentives to facilitate a behavior (Kritsonis, 2005). Social Cognitive theory

states several factors that are essential to affect a behavior change. Those factors are personal factors, attributes of a behavior itself and environmental influences (Kritsonis, 2005).

Having continued the exploration and development of theories at individual level, Taylor and Todd (1995) propose an extended version of the original TPB – Decomposed Theory of Planned Behavior (DTPB). Authors decomposed the belief structure and applied innovation characteristics from Diffusion of Innovation theory to influence the adoption intention (Rogers, 2002). In other words, authors decomposed the attitudinal belief structure and utilized innovation adoption characteristics (relative advantage, compatibility, and complexity) from Rogers theory (Busse et al., 2013). DTPB is a good example of theory that uses physiological factors to predict individual transportation behavior (Hunecke et al., 2008). Hunecke and Schweer (2006) applied DTPB in their analysis of predicting travel mode of the citizens in Cologne, Germany. Results of their study demonstrate a high prediction of people travel mode selection.

2.2.3 Integrated models and frameworks

The last discussed category is *"Applied models and frameworks"*. This category consists of models and frameworks that aim at assisting non-experts who would like to engage in the research and development of interventions. Predominantly, those models and frameworks demonstrate detailed steps and actions to apply in one or another practical case. The main intention of the models in this category is to reduce the complexity of behavior and allow researchers to understand and contribute to the change (Forest research, 2012). Current research focus is placed on a sustainable living in urban area. Therefore, the study identifies models and frameworks that directly or

indirectly touch upon this area. Social marketing is a good example of the method that was further extended in other models. The feature of this method is the targeting a particular behavior to change or reinforce by creating optimal conditions for an action (Kotler and Roberto, 1989). The basic process of this model consists of defining the target audience and barriers, following by programs that can assist in reaching the target audience. Social marketing applies various behavior change tools throughout the process (McKenzie-Morh and Smith, 1999).

Another model in *"Applied models and frameworks"* category builds on social marketing – 4 E's. It emerged from the research of Jackson (2005) who identified four categories to consider while developing behavior change strategies (Forest research, 2012). Those categories (Encouraging, Enabling, Engaging, and Exemplifying) approach internal and external barriers to change through providing incentives, making systems and infrastructure more friendly for the change, involving target groups, and leading by example (Collier et al., 2010). Similar to Social marketing, a majority of interventions that applied this model aim at influencing consumer choice.

Finally, one of the areas where sustainable urban behavior was broadly studied and various models applied is the Energy Use. Energy use covers all possible activities by an individual that lead to the use of different type of energy. Energy Culture framework (Stephenson et al., 2010) is a recently proposed framework for the energy consumption behavior inspired by Litzenhiser (Lutzenhiser and Bender, 2008). This framework is a culture-based approach that oriented on changing the energy behavior. Acknowledging the complexity of the phenomena enables the authors to pose energy behavior as an outcome of the interaction of cognitive norms, material culture and energy practices. Each of three presented dimensions contains a broad set of factors and elements that enable a comprehensive framework of the energy use (Stephenson et al., 2010).

Although none of the presented frameworks or models in a current category was directly utilized in transportation interventions, it can be useful to consider those frameworks as they demonstrate practical applications and dimensions that specifically focused on sustainable living.

2.2.4 Theory selection

To choose an appropriate category and following theories for particular study specifications, the research focus has to be underlined one more time. Firstly, the study is concerned with factors influencing particularly individual behavior considering that changed individual's behavior can form a change in bigger groups. Therefore, the study does make a distinction between individual adopters and organizational or group adopters. The current specification clearly determines our selection of the first category *"Models of behavior at the individual level".*

Secondly, it is also important for the study to understand what fundamentals structure a behavior and lead to its change. This requires putting the attention to the theories that have already achieved recognition in behavioral studies. Behavioral theories can help current research to depict the right knowledge from the understanding of how human behavior is constructed and put it into the transportation context with a clear interpretation of factors that influence the human decision-making process. Therefore, *"Theories of change"* category can perfectly fulfill the requirement mentioned above.

Thirdly, the research relates to new services, ways to use new technology and infrastructure in transportation, namely alternative mobility solutions (AMS). In consideration of AMS focusing on reducing environmental impact, it might require a change in users towards more

environmentally friendly behavior. In comparison with conventional ways of using transport like public transport or using your own car, an AMS might require a new infrastructure which in turn can have a different culture of use. Thus, it is valuable to scrutinize theories that include practices dealing with the behavior of energy use or other practical examples of theory applications. Based on the reasons explained above, the last category of behavior change theories *"Applied models and frameworks"* serves the purpose of the research.

Apart from theory categorization selection, there is a need to narrow down the selection even further. It is necessary to point out one more time the interest in Alternative Mobility Solution innovations, which are a mixture of the elements: product, service and infrastructure. This means that selected theory has to be directly or indirectly applied or focused on either of the innovation elements. Moreover, research interest lies in the sustainable urban living that is another parameter for the theory selection. In other words, it is important to define if the theory has previous applications in the environmental or sustainable behavior change.

To obtain a final set of theories, the researcher conducted a systematic review of existing scientific studies to understand the relevance of theories for the particular research. Theories reviewed the aspects of theory focus, limitations, application area, and relevance to sustainable living (Table 1).

There are eight theories and methodologies allotted at the second round of selection (Table 1). All of the chosen theories are relevant for the research topic and have examples in innovation adoption area. Despite the fact Theory of Planned behavior is considered one of the most applied theories in the field of transportation at the moment, it was decided to add its extension theory instead - Decomposed Theory of Planned behavior. DTPB has been extensively applied in transportation

field. It has a solid foundation of the parenting theory (Theory of Planned Behavior) to analyze and study individual behavior from psychological perspective. In turn, Social Cognitive Theory by its own is widely utilized and well established. However, due to a broad application it lacks of clear description on ways to apply in particular cases (e.g. transportation). Similarly, Lewin theory provides a detailed description of factors to consider for intervention development, yet it does not state the steps of its application. Transtheoretical and Triandis theories reveal the least number of examples of application in technology and transportation innovation adoption, whereas extensive area of their application is health related behaviors. 4 E's model omits the consideration of technology and innovation which is in the core of the current research. Moreover, this model does not clearly allow reflecting on such factors as impact of dominant political, social or economic forces (Forest research, 2012). Application of 4 E's model in transportation sector has no clear evidence. Majority of interventions conducted with the use of the model directed on overall sustainable pro-environmental behavior.

Table 1. Review of behavior change theories

Theory	Application area	Focus and possible limitations	Category			Citation
			Individual level	Theory of change	Applied framework or model	
Diffusion of Innovation	Vast area of application, Technology, Transportation	1) Broad and generic description with no clear steps for application 2) No emotional and motivational differences between individuals are considered	0	1	0	Rogers, 2002
Lewin Theory	Technology, Marketing, Organizational change, Health	1) Social and individual focus 2) Emotional factors and previous experience are not considered 3) Detailed description of factors, but not clear application	0	1	0	Chen et al., 2005
Transtheoretical model	Addictive behaviors, Health, Transportation	1) Focus on individual level 2) Structural economic, environmental and social factors are not considered.	0	1	0	Redding et al., 2015
Social Cognitive Theory	Vast area of application, Technology, Health, Social	1) Focus on individual level 2) Broad and generic description with no clear steps for application	1	0	0	Lange et al., 2011

	psychology, Psychotherapy					
Triandis - Theory of interpersonal behavior	Social psychology, Organizational change, Health.	1) Application in technical innovations is not found. 2) Social factors and emotions. 3) Social support is vital in breaking habits and identify new social norms	1	0	0	Robinson, 2010
4 E's approach	Consumption (Forest research), Marketing, Sustainable living (Policy interventions)	1) Does not enable consideration of the influence of technology and innovation. 2) Affecting individual consumer choice.	0	0	1	Collier et al., 2010
Decomposed theory of Planned Behavior	Technology, Health, Transportation	1) Cultural value is important in affecting behavioral intention to adopt. 2) Focus in Individual level	1	0	0	Hunecke et al., 2008
Energy Culture	Energy consumption, Technology, Transportation	1) Heavily focused on social practice and socio-technical systems	0	0	1	Stephenson, et al., 2010
Diffusion of Innovation, **Decomposed theory of Planned Behavior,** **Energy Culture**	**Transportation, Sustainable urban living, Technology**	**1) Focus on individual level** **2) Cultural aspect is considered important**	**1**	**1**	**1**	**Current study**

DoI theory is well established and proved to be reliable in vast areas of application and transportation particularly. In spite of its profound contribution to the study of innovation diffusion phenomena, it can serve as a good basis for any intervention, but should not be the only theory to consider. Therefore, as the basis of the current research DoI is applied from the Theory of Change category. As it was discussed earlier, it lacks a clear application steps whereas in combination with some other theories it can demonstrate an all-embracing intervention that consider multiple factors. Decomposed Theory of Planned Behavior and Energy Culture Framework emphasize the importance of culture in behavior change. Many researchers state the importance of the cultural factor in any behavior change, particularly when it comes to behavior change in transportation (Meijkamp, 1998). Thus, Decomposed Theory of Planned Behavior and Energy Culture Framework are considered for further use in the current study.

In the following section, it is suggested to combine the selected theories for further application in transportation field. Hence, there is a detailed description of the framework provided.

2.3 Innovation adoption framework in transportation

Despite the fact our intention was to focus on theories applied in transportation area, each of the theories is seen as a standalone basis for intervention. Thus, current study proposes to adapt all three theories in one framework to obtain a comprehensive foundation for future transportation interventions development. Following, there is a detailed description of the framework that incorporates three selected theories.

The process of innovation adoption decision is presented by the first three steps in Diffusion of Innovation Theory: Knowledge, Persuasion, and Decision steps. Following the description, each step contains various factors that are either generally or specifically described further. To enhance each of the steps, the DTPB and Energy Culture theory are integrated to the innovation decision process. Depending on the process steps and its content, factors of DTPB and Energy Culture theories are placed in the process. Figure 1 illustrates the result of theories integration. The developed framework demonstrates three types of colored boxes. Each color represents a particular theory. Arrows demonstrate the flow of the process.

According to Rogers (2002) Innovation-Decision Process starts with *prior conditions* that individual possess before getting to know about innovation existence. It can be previous practices, facing a particular problem that needs to be solved or just simply having his or her baggage of previous experiences and expectations. Following is **Knowledge phase** where individual is getting to know about the innovation. This consists of three types of knowledge that individual obtains: *Awareness, How-to,* and *Principles*. *Awareness* knowledge is the first step for individual where he or she gets to know about innovation existence and obtains motivation to know more. This motivation leads individual to the next type of knowledge – *How-to*. This knowledge consists of information that is required from individual to operate or use an innovation. This is a critical step for innovation adoption in transportation. Considering that AMS innovation is relatively complex, it is crucial to provide a comprehensive description how an innovation works. Otherwise, if individual does not understand the value and the way the innovation functions, it is more likely to get a rejection of the innovation. The last type of the knowledge at this phase is a *Principles* - knowledge where individual obtains information about innovation functions and effectiveness.

The next phase in Innovation-Decision Process is a **Persuasion Stage** where potential adopter develops general perception and forms an attitude towards the innovation. This is the phase where an individual becomes more psychologically involved with the innovation. At this phase, an individual tries to reduce uncertainty that always comes with the innovation that is unknown for potential adopter. That is why at this stage many factors come into picture. At this phase, an individual analyzes the difficulty of performing the action where he or she has to use the innovation. Considering innovation in transportation, *Energy practice* and *Material culture* are factors that assist an individual with analyzing the bigger picture to perform an action. Information on those factors is freely available and forms a clear picture for individual if he can be in control over his own behavior. *Energy practice* itself contains the structure of the *energy pricing* and *information provided* by *social marketing*. In turn, *Material culture* demonstrates the information regarding *technology* and *resources available* at the individual disposal in the market. In other words, an individual analyzes the infrastructure and economy situation from a different perspective. Those factors partly affect an individual decision of innovation adoption in the later phase.

In **Persuasion phase** an important role is played by *Norms* that comes from social influence. Those Norms accommodate such factor as *demographics*. *Demographics* factor refers to a particular expectation from a society about an individual with certain demographics (e.g. middle age female is expected to behave in a different way in comparison with young girl). Similarly, *Moral Norms*, which are relevant in a particular location might play a role to form an individual attitude towards an innovation. *Education* is another factor that is considered to have an impact on attitude formation. To form a general perception about the innovation, it is especially important to

introduce *characteristics of innovation*. Valuable attributes to present are *Relative Advantage* (Why AMS is better in comparison with private car ownership), *Compatibility* (AMS innovation is compatible with prior-knowledge and experiences of the person), *Complexity* (It is easy to comprehend AMS innovation), *Triability* (There is a potential possibility to try out the AMS innovation), and *Observability* (Innovation is demonstrated in the market for potential adopters to see it in action).

Positive outcome of the persuasion phase is expected to be a favorable attitude towards the innovation. This outcome leads to the intention to adopt the innovation.

Similarly to Persuasion phase, **Decision phase** is also focused on seeking innovation evaluation information. This is a stage where individual is *"engaged with activities that lead to a choice to adopt or reject an innovation"* (Rogers, 2002, p.177). Before making the decision, an individual continues obtaining information via personal experiences or collecting information from trusted sources. Thus, *Subjective Norms* are for the primary and secondary sources of information that influence an individual decision. There is an obvious difference between *Subjective Norms* in this phase and *Norms* in Persuasive phase. Here, *Subjective Norms* are primary emphasizing "important" people in the individual life. Contrary, *Norms* in Persuasive phase are more oriented to general norms of the society where an individual live. *Primary source* is also referring to *Peer Influence* factor in Energy Culture. *Peer Influence* demonstrates an influence of people whom the individual trust and willing to know their opinion about the innovation. *Secondary sources of influence* refer primarily to marketing campaigns where public people or ones who close to end users demonstrate their opinion about the innovation.

An important factor at the Decision phase is the *innovation trial*. Many studies argue that individual who try an innovation (particularly in transportation field) before moving to the choice of adoption or rejection an innovation are more likely to make a positive decision to adopt the innovation. The trial by a trusted person can be sometimes a substitute for the trial of an individual. Moreover, it can have similar outcome as a personal trial.

After an individual obtained all the information mentioned above, a person makes a choice between the *innovation adoption* and *rejection*. In order to gain a positive adoption decision, it is critical to focus on each factor in previously mentioned phases of innovation-decision process. It is essential to state one more time that current study highlights innovation adoption as a single action of choice (adopt or reject) with pre-adoption stages: Knowledge, Persuasion, and Decision.

Further, the developed framework in application to transportation field is examined. Thus, it requires to investigate if the factors defined in the framework are critical for AMS innovation adoption decision. To achieve this, an empirical research in the form of semi-structured interviews with experts from the transportation field is conducted. Experts' interview allows to gain profound understanding about the factors influencing the adoption decision.

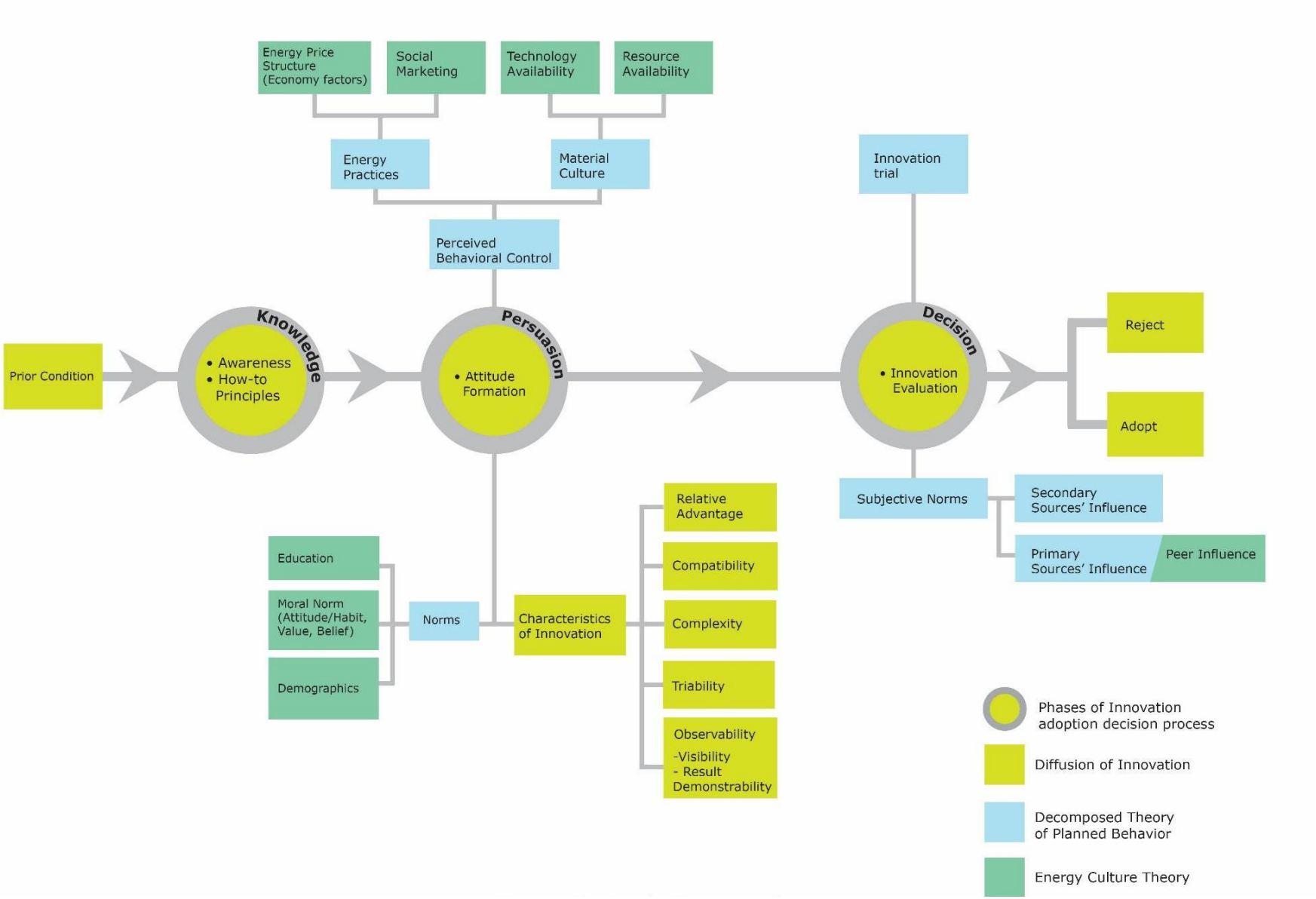

Figure 1. Study framework

2.4 Transportation challenges and need of a framework

Grown attention to urban transportation challenges such as air pollution and inefficient land use, mobilize countries to face challenges and start various activities to address the issue. One example of such activities is an approved new Finnish Environmental Strategy for Transport 2013–2020 that sets the goal to promote sustainable transport and mobility services, stimulate a cut of greenhouse gas emissions and reduce dependence on oil (Liikenteen ympäristöstrategia 2013–2020, 2013). Similarly, by the year 2030, European Commission aims to cut the use of cars that runs on fossil fuel by half in the city areas (Finland's Generation Intelligent Strategy for Transport, 2013).

Moreover, Finnish government together with academia and research centers such as Tekes is collaborating for many years to discover valuable solutions for positive environmental impact (Chakrabarti and Lester, 2002) where transportation and mobility is one of the key topics in this regard. There are many other examples worldwide where environmental concern related to transportation drove the emergence of product and service innovations in different industries (Struben and Sterman, 2008; Bishop, 2005). Many of these innovations were investigating about the vehicle technologies and alternative fuels development (Finland's Generation Intelligent Strategy for Transport, 2013). Hence, it seems that the next stage of innovation wave in transportation is focused on efficient services that can assist in enabling smooth and fast mobility in urban areas (Cornel et al., 2012).

In this regard particular attention has been given to AMS as these services can assist in reducing number of cars in a city. Moreover, lowers the negative impact on the environment and contributes towards a sustainable urban living (Busse et al., 2013; Mitchell et al., 2010). Therefore, industries

and academia are increasingly interested in integrating practices where greater number of urban citizens adopt services like AMS. Yet, there are a lot of challenges to adopt such AMS.

Challenges in adoption of innovative solution is not a nuisance. Besides AMS there have been multiple attempts to adopt innovation in transportation. However, not all of them succeeded and led to assimilation in the society. Researchers state various reasons like deficiency of recourses, policies, restrictions, lack of focus on the technology integration, and lack of information about users (Adner, 2006) can cause failure to adopt innovation. It is important to remember that any product or service cannot exist without its users, who directly or indirectly use the innovation provided (Kastelle, 2012). Still, there are not many studies available that are specifically focused on factors or other determinants that stimulate innovation adoption by users in transportation sector (Wisdom et al., 2014). Therefore, the development of the study framework is impactful for future innovation transportation. Following, there is a need to conduct an empirical research to test reliability of the proposed framework.

Chapter 3: Research Design and Methodology

This chapter presents details about the research design and methodology in order to answer the main research question "*What are the factors influencing individual decision to adopt AMS innovation and change his or her behavior?*".

3.1 Research approach

Many of the existing researches allow development of interventions that may lead to a change in individual behavior. However, in case of transportation and more specifically AMS there is a lack of coherent framework that focus on individual adoption. With the use of theoretical data, a comprehensive framework relevant to AMS intervention development is proposed. Nevertheless, there is a need in empirical research that can proof the framework reliability.

The empirical research uses a qualitative approach of data collection in form of interviews with transportation field experts in Finland. To present the result of conducted interviews the multiple case studies approach was utilized (Eisenhardt and Graebner, 2007). Instead of grouping interviewees by topic or question, data is organized according to each case and analyzed as a whole (Powell and Renner, 2003). Obtaining multiple case studies allows to use recursion to generate a theory. To analyze data gathered during the interviews a *narrative data and content analysis technique* (Powell and Renner, 2003) was used. The concept of interviews structure and its analysis are explained further in this chapter.

3.2 Data Collection

The primary source of data collection in this study is interviews. Eight experts in transportation sector in Finland provided responses for this study.

3.2.1 Subjects and their profiles

The Table 2 presents the background information about participated experts. Due to the reasons of confidentiality, it was agreed that the personal and professional information of respondents such as names, positions and company will not be revealed in the study. The names of the respondents were replaced by codes. Subsequently, codes with abbreviations starting with AMS represent respondents from organizations that have their own alternative mobility solution and provide services related to it. Abbreviations that stats with C refer to experts from a consultancy that specializing in transportation. ITS and PTO abbreviations refer to respondents from Intelligent transportation system organization and public transportation organization respectively.

The respondents participate in the interviews were selected based on their expertise and field of work. All participants were contacted via email or phone calls and requested to participate in the interview session. The interviewees can be divided into following categories:

- Experts in AMS application;
- Experts in transportation strategy and innovations.

Table 2. Interviewees' details

Interviewee code	**Organization**	**Job role**
AMS1	Alternative Mobility Service	Account Manager, Expertise in service development and marketing
AMS2	Software company that provides fully automatic solution for shared rides	CEO, Co-founder
AMS3	Alternative Mobility Service	Marketing and Communication manager
C1	Consultancy	Executive Consultant, Expert in intelligent transportation
C2	Consultancy in transportation (leading to smart transportation behavior)	Mobility Manager, Leading Specialist
C3	Consultancy in transportation (leading to smart transportation behavior)	Specialist in Energy and Material efficiency, Group Leader
ITS	Intelligent transportation system organization	CEO
PTO	Public transportation organization	Director of the Strategic Department

This diversity of respondents allowed the creation of rich data collection by obtaining the information from different levels and gaining various perspectives to the studied topic. Particular participation by companies that run AMS, broadened the research insights about design processes

and user engagement with the service. Depending on the interviewee, some discussed the topic in more details with the particular focus on concrete adoption factors while others were discussing a more holistic picture to the phenomena and revealing the overall situation on the innovation adoption in transportation. The extensive collection of views retrieved from interviews. builds an understanding about AMS innovation adoption and draws patterns of similarities that further structure the empirical research findings.

3.2.2 Interviews

Interview is widely utilized qualitative tool to conduct an empirical research. This tool assists in obtaining in-depth insights about important factors in transportation pertaining to AMS adoption. It also helps to identify information and individual experiences that are not always possible through quantitative research (McNamara, 2014). To mitigate the challenge of collecting a biased interview date, knowledgeable and highly experienced interviewees were approached in this research (Eisenhardt and Graebner, 2007). The main intention behind interviewing experts in the transportation is to gather insights and opinions from those people who have extensive experience in the field. These people were involved in multiple projects and can express the opinion from different stakeholders of transportation ecosystem. Moreover, one of the criteria to select an expert for the current research was his involvement in the work with end users which is critical for this study. It is important to reflect on actual users' behavior and to have witnesses who can share this information. Therefore, it was concluded to be more beneficial and efficient for the current study to focus on experts' interviews that can represent the opinion of both – experts from the industry as well as users. Furthermore, based on the theoretical studies reviewed in the research, majority

of the existing literature in innovation adoption in transportation discuss single case studies as the bases for their research. This reason partly contributed to the selection of expert interviews instead of analysis of a single case study.

This study adapts the method of semi-structured interviews where predefined list of questions was designed. Those questions serve as guidelines to discuss transportation opportunities and challenges in terms of AMS application. In this context, questions were also designed to lead interviewee to focus on innovation adoption factors that are in the core of this study.

Overall, eight in-depth interviews were conducted in the period of two months. Hence, there were two types of interviewees where five experts specialized on overall transportation strategies and innovation; another three experts are the ones who work specifically with AMS innovations. The data collected from interviews consists of string variables. String variables refers to variable with no intrinsic ranking (SPSS Guide, 2014). Following section demonstrates the details about interviewees' profile and data collection method.

As it was mentioned previously, primary source of data collection in this study is interview. This allows gathering comprehensive insights from respondents and construct a full picture about the topic at hand. The aim of this study is to define factors that determine a positive outcome in AMS innovation adoption. The interviews were designed to cover main phases described in the study framework with the focus on identifying factors in the phases that influence individual adoption choice. It is essential to point out the semi-structural approach on interview design. The research intends to gain broad insights about factors and does not claim to be limited to the proposed

framework. The research argues to be open to factors and phases that can emerge during the interviews.

The interview protocol consists of four main topics that are differently discussed depending on the interviewee type. Those topics are:

- General information transportation – opportunities and challenges;
- Service design and development activities;
- Adoption of AMS by customers;
- Supporting factors for AMS innovation adoption.

In case of respondents with the experience in transportation strategy and innovations, the questions ranging from overall situation in the ecosystem to specific questions related to AMS application in the context of sustainable urban living, its use, and potential. For the respondents that are currently involved in work with AMS, the questions were more specified to innovation design, features and development as well as questions about user behavior in those services. Appendix A demonstrates the example of interview outline for the interviewees who are directly involved in AMS services.

Following a technique of divergent to convergent approach, the interview was designed to first open up the conversation on a general level and further narrowing down the topics to obtain more detailed insights, and most importantly to define innovation adoption factors the current research is focusing on. The interviews were intended to also gather the opinion of experts about AMS innovations and overall understanding about adoption of such services. These insights open up another topic about people transportation behavior and factors that affect it. The transformation of

user behavior, reasons, and intentions were discussed to build a foundation for the next topic where interventions and factors were explicitly communicated.

At the beginning of each interview the introduction about the research, its aim and methods were briefly introduced. Each of the interviews timing varied from 30 minutes to one hour. All interviews were transcribed word by word utilized the Atlas.it software. Personal notes and respondents' comments were also included to the transcribing document.

3.3 Data Analysis

This section describes method applied to analyze the data collected during the interviews. To form the current data analysis a multiple case study approach is utilized. Each case study serves as an individual experiment and treats as a single analytical unit. Together with other case studies it forms a set of experiments that together enable to create a generalized theory based on replication, comparison and generalization (Eisenhardt and Graebner, 2007).

3.3.1 Narrative data and content analysis

The current study deploys a *narrative data and content analysis technique* proposed by Powell and Renner (2003). This technique presents a detailed description of process to conduct a qualitative analysis depending on the narration nature and purpose of the analysis (Powell and Renner, 2003). Moving back and forth between steps is likely to happen due to interview nature where data revision is needed several times for objective results and finding hidden and or missing

points. Following, steps of Powell and Renner technique utilized in this study is described in the details (Powell and Renner, 2003).

First step is to understand the collected data. To organize the collected data, the current research deploys the case study approach where each respondent was treated as a separate case study (Eisenhardt and Graebner, 2007). As it was discussed previously, each interviewee is an expert in transportation field that allows them to provide information based on their extensive experience and numerous projects with user. Therefore, it is beneficial for the study to analyze each interview data as a separate case.

Following step consists of categorization of the information gathered in interviews. Categorization in this research refers to coding the data. The coding does not apply a conversion of summarized qualitative data by means of counts to become a quantitative data as might happen in quantitative research. Coding in the current research refers to bringing the meaning to the text when you identify different themes and topic in the text and categorize them. There are two ways to categorize the narrative data: pre-defined codes (categories) and emerging codes (categories). Current study approach uses the combination of both. P*re-defined codes* employs categories from the study framework (see 2.5 paragraph) and mainly focuses on the adoption factors proposed in the framework. E*merging codes* refer to categories that occurred during the interview analysis and refers to topics and themes that are not mentioned in the study framework, but directly or indirectly effects on innovation adoption in transportation. During the analysis sub-categories may occur. The process continues till the moment all possible themes are defined and coded. This step is considered the most time consuming in the analysis process which require a lot of iterations and re-reading data (Powell and Renner, 2003).

Next step is to identify any patterns or relations in categories within one case and between them. This is natural continuation after categorizing the data. During the process of categorization similarities or differences in respondents' responses become visible. Moreover, at this step it is possible to show the relative importance of one category over the other. It is possible to utilize simple *univariant analysis* that examines categories using *frequency distribution* and *graphical methods* (SPSS Guide, 2014). In other words, researchers can count the appearance of each category or categories from narrative data to illustrate general patterns in the data (Powell and Renner, 2003). Visualization of frequency distribution is usually supports to convey the message.

The last step in narrative data and content analysis is the result interpretation i.e. providing elaborate description of findings defined during the analysis. The next chapter demonstrates the interviews analysis of each case study in separate and further illustrates a brief cross-case analysis of all cases.

3.3.2 Interview analysis in practice

In the current chapter there is a description of interview analysis conducted with experts in transportation sector. The interview analysis starts from the listing main themes and pre-selected codes obtained from the research framework. Thus, there are three themes that are predefined and contain multiple pre-selected codes (Table 3). In other words, each factor from the proposed framework is considered as preset code or sub-code for the interview analysis. Themes represent main steps retrieved from the proposed framework. In the current research there are two levels of sub codes that are preliminary defined. Such detailed division of the preset codes was achieved

through the consulting the framework of this study. Table 3 illustrates themes that consist of different preset codes. Depending on the code, it either splits into two levels of sub codes, or remains at the more general level with no specified sub coding. The detailed description of each code can be found from the proposed framework in Section 2.5 (each predefined code is based on factors retrieved from the study framework).

It is significant to point up that current analysis is not limited to only pre-set codes and themes obtained from the proposed framework. Categories from the framework is taken into consideration as guidance to structure the interviews, but not limited in obtaining new codes and themes throughout the interview analysis.

Process of interview analysis continued with open coding of each sentence or paragraph of the transcribed interview document. Next, open codes were compared to the existent pre-defined codes. In case of co-occurrence, open code was replaced with the existent pre-designed code. In case of emerging codes that does not belong to any of the existent themes, a new theme was formed and codes are added. Each step of the analysis conducted several time in order to reduce bias and minimize subjectivity. Main focus in the interview analysis was pointed on factors influencing adoption decision. This was reflected in the main predefined themes and particularly preset codes. Therefore, in the results section some of the themes and codes which are not related to the factors of innovation adoption in transportation were not discussed in details.

Table 3. Themes and preset codes

Themes	**Preset codes**	**1 level Sub-codes**	**2 level Sub-codes**	**Description**
Knowledge	Awareness,	-	-	Information about innovation existence when user introduced to innovation for the first time; how to use an innovation and its functions and effectiveness
	How-to	-	-	
	Principles	-	-	
Persuasion	Norms	Demographics	-	Factors that come from social influences through fundamental moral norms, education and demographics
		Moral Norms	-	
		Education	-	
	Innovation Characteristics	Relative Advantage	-	Attributes of the innovation
		Compatibility	-	
		Complexity	-	
		Triability	-	
		Observability	-	

	Perceived Behavioral Control	Energy practice	Energy pricing	External factors from infrastructure and economy situation in the market
			Marketing	
		Material culture	Technology	
			Resources available	
Decision	Innovation trial	-	-	Factors that comes from close interaction with people and trusted people as well as personal experience
	Subjective Norms	Peer Influence	-	
		Secondary sources of influence	-	

During the interviews analysis 25 research memos were written. Each of the memos aimed to bring clarity to some of the emerging codes and point up important aspects of innovation adoption in transportation mentioned by interviewees. Memos claim to reduce biased results and subjective interpretation by the researcher.

Atlas.lt software was utilized in the research to assist in interview analysis, by coding interviews, tracking relationship between codes and sub codes. It was also used to conduct basic univariant analysis via frequency distribution and graphic analysis.

Chapter 4: Results

The empirical research for this study consists of multiple case studies based on expert's interviews in transportation sector. Three case studies gather information from experts working in alternative mobility solutions (AMS), three experts from consultancies (C), one expert from intelligent transportation system organization (ITS) and one from public transportation organization (PTO).

First, an introduction of each case study together with the results are presented. The experience and findings in AMS innovation adoption decision process are reflected in the results with a particular emphasis on factors that determines a positive decision in AMS innovation adoption. Following, combined results of all case studies are introduced highlighting the similarities and differences between them. A wide range of topics related to transportation emerged during the interviews. However, based on the research focus on Innovation Adoption Decision Process, other topics are not discussed in this research. Figure 2 illustrates the flow of the results presentation in the current chapter.

Results of the case studies are based on the Innovation Adoption Decision Process and main phases of this process are reflected in the pre-defined themes. These pre-defined themes are briefly explained in the paragraph below. Each of the themes consist factors that are considered to be important in AMS innovation adoption process. To read more about the structure of innovation decision process and meaning of each factor, refer to 2.3 where innovation adoption framework in transportation is explained in detail.

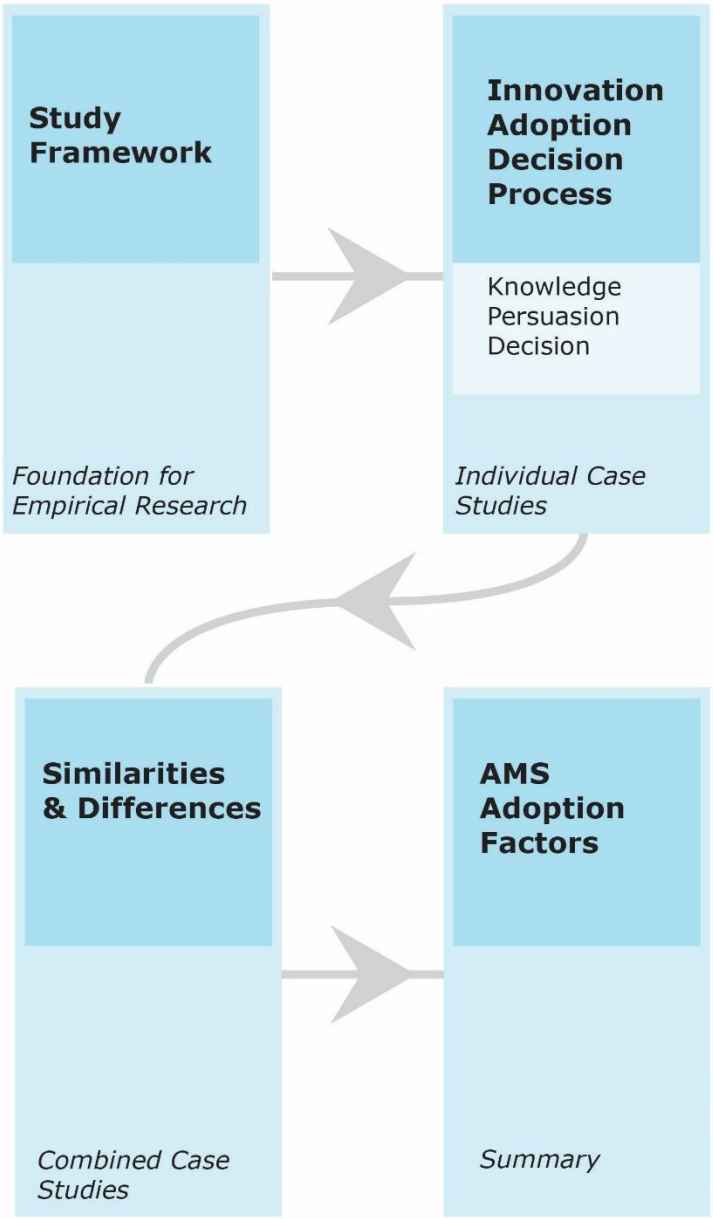

Figure 2. Results presentation flowchart

Knowledge. This theme refers to all activities in innovation decision process where a user obtains basic information about AMS innovation. For example, getting awareness about service, learning how to use it and collecting knowledge about main functionality and effectiveness on AMS.

Persuasion. This refers to the phase where individual develops an attitude towards an AMS innovation. This phase has the most number of factors.

Decision. In this phase individual searches for additional information to make a final decision to adopt or reject an AMS innovation.

The next section starts with general overview of the data gathered from all interviews and follows the individual case studies results with brief introduction to each interviewee and codes identified during the interview analysis.

4.1 Overview of the contextual data

To give an overview of the analyzed data, the word cloud of all interviews is presented in Figure 3. Word cloud illustrates graphical representation of all respondents' interview data based on the use of the words' that appear the most frequently in all of the case studies. The size of the word depends on the number of times the specific word was mentioned in the text data – the higher the occurrence of a particular word in the data, the bigger is the size of the word displayed in the word cloud. Pronouns, prepositions and conversational fillers such as "as you said", "like" and similar are eliminated from the word cloud. Different variations of words using singular and plural form were substituted to only one word (e.g. cars-car). Similar, verbs and adjectives in different

tenses or forms were replaced to one word (e.g. change-changes, changed-changing, develop-developing, easy-easier).

Figure 3 highlights the most frequent contextual data points from the case studies. This allows to understand the overall context of the gathered empirical data and assist in identifying the most popular topics and aspects in the interviews. In addition, word cloud enables the researcher to confirm the correctness of the interviews direction. Expectedly, the most frequent words in the interviews are: Car, Service, Transport, Sharing, and people. Data from the word cloud ensures the main theme of the empirical study. This reflects the research focus on *alternative mobility services* in transportation, which are mainly contains services and main focus lies in the people behavior and attitude to such services.

Figure 3. Word cloud – All interview dataset

4.2 Individual case studies results

This section introduces general findings from each interview in separate. It shows expert's opinion on factors that influence AMS adoption and reveals their expertise and area of work.

4.2.1 Intelligent transportation system expert

ITS: Overview

ITS expert is a CEO and co-founder of intelligent transportation systems organization. This is a non-profit organization comprising of 80 employees; having a collaboration with 50 companies, transportation authorities and number of universities. Operating in Finland, the core of the company is to provide efficient and safe solutions in transportation system through innovation and communication technologies. Company has a solid experience in conceptualizing and developing interventions in transportation and new services in particular. These interventions aim to improve transportation situation and help people to adapt to new changes. Respondent has an extensive experience in transportation, and information and communication technologies.

ITS: Interview results

Informant clearly stated a positive impact of AMS innovations for the urban environment. He especially emphasized the reduction of cars in the city area that can enable better transportation flow. This is natural that people obtain a new behavior when adopting a new transportation service. If the service efficient and sustainable, it is obvious that new behavior and transportation routines will improve. ITS respondent pointed out the difficulties in bringing AMS to current market. One

reason is alternative mobility services are still new to Finnish market and it might require a change in all areas of transportation system and people's' perception about transportation. On the other hand, ITS understands that in order to be adapted, service has to provide a good service offering to the users. This means that service has to have a good value proposition and high level of service agreement. Potential adopter from the beginning has to see comprehensive service in order to change his behavior in the future. Main key parameters that can have effect on service adoption defined by the respondent from ITS are *convenience* or *accessibility* of the service and *pricing*. If the user clearly sees the advantage of the service, it will change his or her transportation behavior.

> *If people have a good service elsewhere which is cheaper and more convenient people would adopt that.*

Respondent admitted there are no such services currently in the market that can beat private car ownership. Yet, there is a potential that people will adopt a new service if the offering is good. There is a trend that changes car status among people. It is no longer an item that has a special meaning. People will go for new services instead of owning a car, if the service is more efficient and price competitive in comparison with owning a car.

Another aspect to be considered in AMS adoption which respondent emphasized is the cultural differences, such as different norms in particular areas. However, it is necessary to understand that some factors can be more influential than others. For example, ITS claims that key parameters mentioned before would be in a priority in making the decision of adopting an innovation in comparison with cultural differences.

> *Cultural difference exists, but do not overestimate it.*

Similarly, the emotional aspect in decision making was highlighted by the respondent. According to ITS, emotions and feelings towards an innovation can play a positive role in the decision of adopting an AMS. Still, this factor can consider less persuasive in comparison to pricing and accessibility.

An important role in AMS development and adoption is played by the government, and particularly policies and legislations. Respondent believes that changes in legislations that have transport mode in it can speed up the adoption of AMS innovation. Currently, due to various policies in the field, the development of such services is not possible and highly discouraged. According to ITS respondent current legislations and policies are very restricted to the particular modes of transportation - public transports, private cars, taxis and airplanes. Often, AMS does not lie to any of these types. Therefore, when an alternative mobility solution comes to the market, it is very difficult to make it legal to operate.

4.2.2 Public transportation expert

PTO: Overview

PTO respondent has a leading role in the public transportation organization which provides a public transport in seven municipalities. The respondent leads a department that focuses on long term plans for development of transportation system. This department works with all different aspects of transport system and is also responsible for road transport and logistics. Their work is not limited to only public transportation, but overall transportation structure in capital area. In addition, the department conducts and analyzes different kind of surveys of user's transportation

behaviors and traffic forecasts. Interviewee had a profound knowledge about transportation and a long experience in leading the research in studying user behavior in transportation.

PTO: Interview results

Alternative mobility solutions (AMS) undoubtedly more environmentally efficient and have a better energy performance than private cars. PTO claims AMS can be a good addition to the existing transportation system to fill the gap where current system cannot provide a transportation assistance. For example, there are some areas in cities where public transport does not operate or there are poor connections between certain areas in the city. Moreover, he stated this can lead to a reduction of private cars because all needs of transportation can be fulfilled without a hassle of owning a car. In respondent's opinion, one of the barriers in AMS development is lack of proper urban planning. For example, due to scattered populated areas, it is difficult to arrange a good transportation service. Following the topic of barriers in AMS development and adoption, PTO believes that the legislations can challenge current AMS penetration to the market and become an obstacle to introduce AMS to the public. Therefore, respondent emphasizes the need of changing legislations related to transportation system in order to enable AMS enter the market without any obstacles.

According to PTO, *pricing* is one of the most significant factor that can influence and lead to behavior change in transportation. Following this main point, there were several other points that respondent considered important and can positively influence on AMS adoption. Those points

referring to characteristics of AMS are *minimum complexity*, *low pricing* and *emotional attachment* towards the innovation.

> *If you want people to use certain mode or service - it should be the easiest, the cheapest, and the funniest thing to use.*

PTO brought attention to the cultural aspect of the area where the AMS innovation is applied. Giving the example of Finnish culture and its characteristics, respondent points that consideration and adaptation of AMS innovative to the culture can create a positive environment for innovation adoption.

During the interview, respondent also highlighted the possibility to try an innovative service before coming to conclusion of its adoption. PTO believes that this opportunity can increase the probability to adopt an innovation. Main reason behind this thought was the current tendency among residents to show unwillingness to commit to various things.

> *Nowadays, people do not commit to things so much, and they change preferences very fast.*

4.2.3 Executive consultant and intelligent transpiration expert in international consultancy

C1: Overview

C1 respondent has an executive consultant role in the International Management Consultancy and one of his main expertise lies in the intelligent transportation. Company specializes in ecosystem businesses; for example, businesses involving several companies or several industries. Respondent

has an extensive knowledge in the field of transportation and innovation related projects. Interviewee is a coordinator for several projects focusing on transportation service development and namely technology driven services that enable better value for investments in traffic - both in infrastructure as well as in transportation methods.

C1: Interview results

Having a long experience in transportation, respondent is aware about many environmental issues in this sector. Based on this knowledge, informant states that AMS can definitely help in reducing number of vehicles which can lead to more effective use of urban space and lowering the carbon footprint of a big cities. Respondent sees a clear possibility to bring an AMS innovation in transportation. To prove this point, C1 respondent refers to the company study where they identified that 76% of people in Helsinki region are flexible in choosing the type of transportation. Thus, with consideration of various factors that assist in making an AMS innovation smoothly adopted, it might be possible to influence behavioral change of citizens towards more sustainable. Among those factors respondent emphasizes *accessibility*, *pricing* and *minimum complexity* as the most important factors for AMS innovation adoption. Following the accessibility factor, AMS can also depend on such factor as weather condition. Depending on the AMS, this factor is seen as an opportunity or an obstacle for adopting an AMS innovation.

Based on the C1 respondent experience while working in various transportation projects, the possibility to try out the innovation by the users can positively influence a decision to adopt an innovation and leads to behavior change. Together with possibility to try, respondent highlighted

importance to educate individuals about AMS innovation. Stressing the need of both, interviewee pointed to have both in order to increase innovation adoption probability.

There is a strong aspect to consider while adopting an AMS innovation – network effect or peer influence. This type of influence that can have an effect on individual decision, emerged in many projects conducted by the respondent. Having a trusted source to share the experience can make a difference in individual decision to adopt.

4.2.4 Mobility manager and leading expert in transportation consultancy

C2: Overview

C2 respondent is a mobility manager and a leading specialist in the consultancy that specializes in transportation management. One of the direction in the company's work is to stimulate their customers, changing their behavior towards more sustainable and efficient transportation. Respondent is also a founder of the company. This company provides service that creates an access for users to various transportation options through the app. Having an experience in studying user behavior in transportation, respondent specializes in work with end users to improve their commuting behavior to be more economical and ecological. Respondent's personal interest lies in mobility services and ways to improve them. C2 also studies how to integrate different mobility modes and different services into one comprehensive service.

C2: Interview results

Interviewee conveyed that there is an important need to integrate more innovative services to the current transportation system. Those services can undoubtedly assist in more efficient urban living and lead to sustainable transportation behavior. C2 respondent has a strong believe that providing an information about AMS innovation and improving knowledge of people can be critical at the beginning of innovation adoption decision process. This improvement can lead to a positive decision to adopt this innovation later in the process. However, it is important to understand the need of other factors in this consideration. Making individual informed about innovation is not enough for a positive innovation adoption decision.

> *Even if people are educated well, they might not believe. That's why it is important to try an innovation service.*

In order to change people's behavior, it is essential to motivate them to act differently. Providing a possibility to try out a new service can be a good motivation trigger. Trying is the most efficient way to make a positive influence on AMS innovation adoption decision. When people try an AMS service, they can obtain an experience of the use of innovation without committing to it. Thus, it makes the adoption smooth and easy that will help in further behavior change.

> *People have their prejudices towards something they do not experience themselves and often, when they try it themselves, they realize their thoughts were different. The same in transportation and particularly in services.*

According to C2 respondent main factors influencing a positive AMS adoption decision are *pricing* and *minimum complexity*.

> *People would adopt new mobility service if it is economical for them, cheaper than other traveling modes, and has no hassle.*

Following this thought, there is a phenomenon which was identified by the respondent in many of his projects. When few people first try out an innovation and receive a positive experience, they will share this experience with others. This feedback can then go viral and other people will also engage with the same innovation as a result. Therefore, C2 respondent considers peer influence as an important factor that has impact to the adoption decision.

4.2.5 Energy and material efficiency expert in resource efficiency consultancy

C3: Overview

C3 respondent is a specialist in energy and material efficiency. He is also a group leader in the department. There are two main specializations in the organization's transport department: mobility management and vehicle matters (ex.: car purchase, eco driving). Overall focus of the organization is to promote efficient and sustainable use of energy and materials (specializing in energy, renewable energy and material efficiency). Previously, interviewee has an experience in transport research science and logistics; he currently specializes in projects related to transportation and sustainability.

C3: Interview Results

Informant is a strong supporter of alternative mobility solutions (AMS) especially those that include use of electric vehicles. C3 believes that this combination is perfect for urban context because it will dramatically reduce carbon footprint of cities and at the same time reduce number of cars for better mobility flow. However, there is no need to have both elements (AMS and electric vehicle) to have a good impact to sustainable urban living because AMS itself without specifications to electric vehicles is already a good solution. C3 respondent admits that creating awareness and educating individuals certainly affects positive AMS innovation adoption decision. Throughout his experience there were number of cases where education of individuals on how to use an innovation lead to a clear change in their behaviors through innovation adoption.

> *If you introduce a new alternative vehicle or service, you have to make sure that driver really knows how to use it.*

Possibility to try an innovation was also considered as an important factor in adopting the innovation. Among other innovation characteristics, respondent emphasizes minimum complexity of a new service. In his opinion, easy to use service can encourage potential users to adopt an AMS innovation. In addition, C3 respondent argues that policies and legislation affect transportation system and development of AMS in particular. Thus, it has to be considered in AMS innovation adoption decision.

The age of the individual who adopts an AMS adoption is also an important factor to consider. Depending on the age group and some other demographical characteristics, the innovation can be perceived differently and thus innovation adoption rate will vary.

Finally, interviewee stresses that the use of different channels to promote an innovation can be a positive factor in innovation adoption. Various marketing activities that communicate information about AMS innovation can be beneficial for innovation adoption decision.

4.2.6 Customer relations expert in public transportation organization

AMS1: Overview

AMS1 respondent is a chief of customer relations in the public transportation organization. The department where respondent world focuses on service development and marketing and specializes on the development of new transportation services. Currently respondent is working on a project with alternative mobility service with approximately 17000 people who are registered to the service.

AMS1: Interview results

Respondent believes that individual might change his transportation behavior in case of AMS innovation adoption. Giving the example of their service, respondent pointed out that those users who had private cars and adopted company's service, dramatically reduced usage of their own cars and started following more sustainable transportation behavior. According to the respondent, AMS has a big potential to positively influence towards sustainable urban living, yet there are a lot of challenges that has to be addressed. For example, one of the important factors that can stop AMS adoption is a comprehensiveness of the service. It is critical to have a service that is always available and has enough vehicles to cover individuals' need.

One of the factors that has to be present throughout all AMS innovation adoption process is marketing. It is something that comes from the beginning when individual hears about service for the first time and later when he gets more information and even later in the process when innovation is adopted. Respondent argues it is essential to always provide people with information and educate them about an innovation. It is also valuable to communicate clearly the advantage of the AMS in comparison with other existing services.

> *It should be better than regular transportation services and easier than driving your own car.*

Another factor that can positively effect on service innovation adoption is recommendation or suggestion by a trusted person. Trusted person can be friend, colleague or a family member. In the experience of the respondent, this played a critical role in many cases of their AMS adoption. This also incorporates another factor that respondent consider influential on AMS adoption decision. Creating a reliable service can have a positive impact on AMS innovation adoption decision.

> *Many times I faced this argument to adopt our service: "I have heard so much good things about this service, I want to try it too".*

Using a technique of giving the opportunity to try the AMS before registration enabled the company to attract potential users to adopt the service. Respondent claimed that the possibility to try a new AMS is an important factor in AMS innovation adoption. Trying without a commitment is a good way to speed up innovation adoption, when people are introduced to something new that they have not experienced before. Besides giving the possibility to try, it is critical to provide a relation of a new service to something that individual is familiar with. According to interviewee,

in order to increase the probability of AMS adoption and change individual's behavior, it is important to give an understanding that it is not complicated service and it is similar to the existing services that he or she has used before.

4.2.7 Expert in automatic software solutions for shared-rides

AMS2: Overview

AMS2 respondent is a CEO and co-founder of the company that provides fully automatic solution for shared rides. Companies' main offering is to provide on demand shared ride system with a high automation and quality. Having a multidisciplinary team and focusing on customer needs, company has collected a good knowledge in user behavior in transportation. Personally, respondent has a technical background and an extensive experience in transportation and logistics.

AMS2: Interview results

Informant claims that AMS is a great way to promote transport sustainability. Adoption of AMS services can have a big impact in solving parking problems in city areas and solve the limitation in residents' mobility. Moreover, if there is a good AMS service which individuals can easily adopt, they would be willing to change routings and obtain a new behavior. In order to help residents to adopt such services and change their behavior, respondent argues that it is critical to educate people when AMS innovation is introduced. If this is an innovation that is totally new and requires a new way to behave, this is the first step to do – educate people about an innovation and

provide examples. Education can go through comprehensive marketing messages which are valuable at the first stages of AMS innovation adoption process.

> *Providing an information is very important when you bring an innovation to the market.*

One of the most important factors emphasized by the respondent is the *simplicity* of AMS innovation. In respondent's opinion, this has an important role in AMS innovation adoption decision that assists in behavior change.

> *Service should be so understandable and easy that every individual can go with the flow.*

Technology and other resources available to make the innovation feasible are crucial for bringing an innovation to the market. Therefore, it has to be considered during the service development. Moreover, innovation has to be accessible for potential adopters; otherwise there is no chances for AMS to stay in the market.

Another factor that can play an important role in AMS innovation adoption decision is to communicate a clear advantage of using the service. Respondent stated that showing this benefits of innovative service, can create an interest towards AMS and further have a positive influence on its adoption. For example, a competitive pricing is a parameter that AMS2 respondent pointed out in the interview. He believes that low price has an influence on people's decision to adopt an AMS.

In order to adopt AMS, individual has to create a trust toward the service. Therefore, it is essential to communicate that the new service is reliable. One way to achieve it is to enable people to try an innovation. According to respondent, this is a shortcut to create a perception of the reliable service.

4.2.8 Marketing and communication expert in alternative mobility service

AMS3: Overview

AMS3 respondent as a marketing and communication manager in local alternative service providing company. Company has a long history and considered first in the country to launch AMS. Their service provides flexible solutions for corporate and private user. Facing various challenging in the beginning of the service launch, company obtained an extensive experience in user studies and service transportation development.

AMS3: Interview results

Respondent states different challenge in AMS adoption from technical and user perspective. AMS3 mentioned the need to balance flexibility of the service and maintaining a profitability for the company. Yet, *flexibility* is critical for AMS innovation adoption when it comes to potential adopters. Interviewee points out simplicity of the service which might also positively effect on service innovation adoption. However, flexibility stated with a higher importance in comparison with simplicity. According to respondent, creating an awareness among people about such AMS innovation definitely increases the probability to adopt it. In case of the company, this is often achieved by various marketing campaigns.

Another aspect that assists company in increasing innovation adoption rate is to provide a comparison for their service offerings to other existent services that are familiar for potential adopters. Based on the interviewee experience, compatibility is an important factor that cannot be underestimated in AMS innovation adoption.

Current discovery of the service was to provide a possibility to experience service without any commitment. According to the respondent, this enables potential users to adopt the innovation faster and change their behavior towards more sustainable services use. Another factor that AMS3 mentioned is the visibility of the service. There is a number of individuals that adopted their AMS based on the fact that they have seen service in use and observed it in the urban environment.

Demographics plays a big role in AMS innovation adoption. For example, depending on the age group of the potential adopters, the rate of an adoption can be of a great consequence.

4.3 Combined case studies results

Current section describes the key findings from all interviews and illustrates common factors that support AMS innovation adoption decision. Considering the previous section provides an overview of each case, some of the factors presented in this section are not mentioned there.

Figure 4 below illustrates frequency of pre-defined and emerged codes identified during the interviews. Those codes represent factors that can effect on the decision to adopt an AMS innovation. It is critical to note that codes' frequency does not necessary reflect its popularity among all respondents. For example, there are cases when codes were pointed out several times

by only one interviewee. However, current representation (Figure 4) of the factors assists in giving an overall picture of most common factors identified in the case studies. Details regarding the meaning of pre-defined codes can be found in Section 2.3. Due to irrelevance or insignificance, some of the codes were not discussed in this study.

Most of the respondents admit alternative mobility solutions (AMS) to be an important element in transportation system that can contribute to the reduction of automobile dependence in the urban area and lead to more sustainable development. AMS adoption by city residents can play a significant role in reducing urban carbon footprint and fight against traffic congestion. Interviewees stated the innovation adoption can lead to behavior change. Some respondents provided examples from their projects where individuals obtained a different behavior after adopting an innovation. In most of the cases it was a positive behavior towards a sustainable urban living.

Half of the informants highlight a need to integrate AMS to a transportation ecosystem, so that it can function together and fill the gap where other traveling modes are not accessible (except private cars). In case an innovative mobility service is seamlessly integrated to the transportation system, it can become easier for an individual to change their behavior. Most of the respondents (N=6) discussed *policies and legislations* in transportation that are currently restricted on particular types of transportation (private car, public transport, taxi), which they identify as a great essence for AMS development and its adoption. According to respondents, in order to make an AMS more accessible in the market, policies and legislation have to reconsider transportation types and determine more open definition for mobility solutions like AMS.

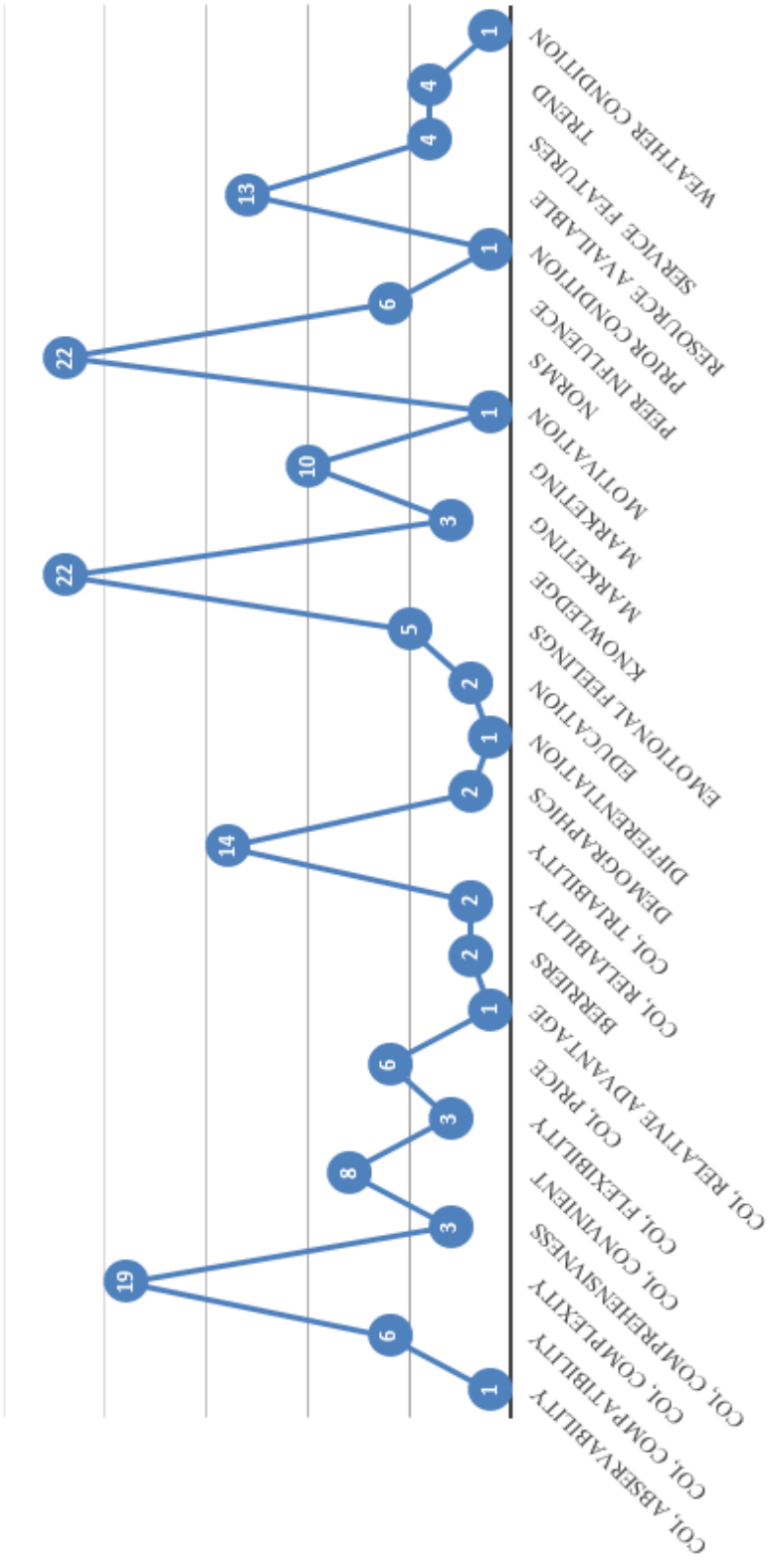

Figure 4. Codes frequency from all interviews

Half of the factors identified during the interviews focus on *characteristics of innovation*. Particularly, respondents who directly involved in AMS development highlights characteristics of innovation as the most important factors. Each respondent mentions significance of AMS innovation to be with a *minimum complexity*. Moreover, according to half of the interviewees, combination of simple and *price competitive* service, together with *convenience,* can dramatically increase AMS innovation adoption rate.

All of the respondents evaluate *possibility to try* out an innovation (before making a decision about its adoption or rejection) as a focal for its future adoption. Experience of the service without a long-term commitment proved by many respondents to be a good way for potential adopter to form a positive attitude towards an innovative service. Moreover, it gives individual a better understanding of how an AMS service functions and advantages of its use.

One third of the interviewees provides their agreement about *marketing and advertising* to be influential for innovation adoption. Interview results also declares that marketing can be a valuable channel for educational purpose about AMS innovation. Majority of the experts states the need to provide all necessary information and educate people about innovation. Delivery of a comprehensive message with all necessary tools and description how to use an innovation are of the essence for the process of innovation adoption decision. Furthermore, all types of *knowledge* that assist individual to understand the innovation are critical.

Many of respondents admit challenges to explain an innovation to potential adopters. One way, which is pointed up by several respondents, is to provide an *analogy to other services* which are compatible with prior-knowledge and experiences of the person. The most effective way to create

an analogy is to create a reference to the service that is well known and familiar to a potential adopter. Such approach can positively effect to the AMS innovation decision proceeds towards accepting it.

Large majority of interviewees agreed that cultural aspect has a focal in AMS adoption decision among. Service has to be developed with consideration of cultural features in order to be adapted. Demographics and level of education of a potential adopter are only slightly mentioned by few respondents. In contrast, advices and suggestions received from a trusted people (*peer influence*) have a high influence on individuals' decision towards innovation adoption.

Chapter 5: Discussions and Conclusions

The current chapter reflects the main findings from the interviews and discusses them in comparison with selected theories for this research. All the empirical data gathered in the form of multiple case studies enabled to answer the research question *What are the factors influencing an individual decision to adopt AMS innovation and change behavior?* In addition, there is the evaluation of the study described in the chapter. To summarize all work and findings together with prospects for the future research, the conclusion of the research is presented at the end of this chapter.

5.1 Factors behind innovation adoption and behavior change

The research explores the relation between phases in innovation decision process as well as parameters that have to be present in each phase. The real life examples in transportation field particularly helped to identify factors that are critical for positive AMS adoption decision. Those factors can play a critical role in intervention development in transportation sector and assist in behavior change.

Here it is to point out that behavior change literature affirms that any innovation adoption leads to behavior change with different routines and ways of acting (2012). Similarly to Kastelle (2012), interviewees stated the innovation adoption as one of the triggers for behavior change. It was evidently discussed that many projects focusing on transportation behavior and AMS adoption witnessed a change in users' behavior after adopting a new transportation service.

Empirical study confirms the possibility to improve environmental impact through AMS application. Case studies support an idea that innovate transportation solutions like AMS are resource efficient way to move in urban area (Busse et al., 2013). The possibility to use AMS can also allow to optimize the resource usage, reduce number of cars in the city area and bring efficiency in transportation. All these changes can lead to more sustainable urban living with less pollution and traffic conjunctions.

According to various sources (Finland's Generation Intelligent Strategy for Transport, 2013; Mitchell et al., 2010), government understands the environmental impact of transportation and is willing to help in AMS penetration to market. Contradictory, the current study results show that government does not stimulate AMS adoption. The main argument in the most case studies was a conventional transportation law that was not changed for many decades. Legislations and policies were identified as a one of the major obstacles to developing AMS innovation in urban areas. Particularly emphasizing legislations and policies that describes transportation modes, interviewed experts argue that AMS do not fit to any of the modes, and therefore faces challenges to be officially accepted to operate in the urban market. Case studies advice to reconsider transportation policies to enable more flexible definition for transportation modes and services to be present in the urban scene.

The role of innovation characteristics discussed in all case studies with many practical examples. It was revealed that different characteristics of innovation play a focal role in the AMS innovation adoption. Most of the characteristics mentioned in Rogers theory appear in the interview results (Rogers, 1995). Especially, *compatibility, triability,* and *complexity* were emphasized by the majority of the experts. In real cases it is clearly seen that *triability* or *possibility to try* has a critical

place for individual to make a positive decision about innovation adoption. Similarly, *complexity* was a challenge that many innovative services faced while attracting new users to their innovation. All services from real cases attempted to overcome this challenge through *compatibility* with prior-experience of their potential users. By finding an analogy to explain their services, most of the cases obtained a positive feedback from individuals. *Observability*, however, was not common characteristics identifying during the interview, only one respondent defined this factor as a characteristic enabling positive AMS innovation adoption decision which is in contradictory from Rogers' theory of innovation adoption.

Among other characteristic of innovation, *pricing* was rated as one of the most influential factor that interviewee accentuate. Interestingly, pricing emerged as a key characteristic that was not clearly stated in Diffusion of Innovation (Rogers, 1995). Each case used different terminology to describe this factor. Yet, all of them communicate a high economical concern of individuals at the stage of making a decision to adopt an innovation. Findings reflect that individuals tend to choose the most efficient ways of living and pricing plays a leading role when they define efficiency.

It was revealed in the interviews that during the phase of forming an attitude towards an innovation, the *level of education* that individual has does not play a critical role. Which contradicts with Energy Culture Theory (Stephenson, et al., 2010). In contrast, *cultural aspect* (moral norms) is considered to be significant factor to pursue individual to adopt an innovation (Stephenson, et al., 2010; Meijkamp, 1998). Findings also show different norms that come from social influence to be effective in influencing a decision of individual to adopt (Hunecke et al., 2008). However, subjective norms like *peer influence* are considered more powerful factors in later stages of

innovation adoption in comparison with other norms. *Peer influence* was the factor that has a high influence on the AMS innovation decision adoption (Hunecke et al., 2008).

5.2 Practical Implication

Current study defines an innovation adoption as a single decision to adopt or reject an AMS innovation. The decision prerequisites are factors that stimulate a positive decision to adopt innovation. Some literature argues to study innovation adoption as a process that has to consider after adoption decision stages in order to have a long commitment with innovation. However, to study prior conditions with factors that leads to the decision to adopt an innovation can be beneficial for AMS intervention designers who seeks for a practical examples and concrete factors to design an intervention in transportation sector.

A positive AMS innovation adoption decision can be only possible with consideration of multiple factors. Single factors are not enough to design a comprehensive intervention that can effect an individual decision to adopt an AMS innovation. The set of multiple factors was proposed in this study in the form of the framework that combines three behavior change theories. Most of the factors mentioned in the framework found a proof during the empirical research. To give a better understanding of the framework application, factors from the framework were analyzed and discussed in the study. Moreover, the framework design is based on the Diffusion of Innovation process with clear steps and comprehensive factors in every step that enables designers to know when and where to put their particular attention on one or another factors. In addition, the proposed

framework allows to see a holistic picture of the process and understand who are the stakeholders involved in the innovation adoption.

5.3 Evaluation of the study

The current study used qualitative approach for empirical data collection. However, it would have been more beneficial to utilize a mixed method where qualitative and quantitative approaches applied together. Qualitative approach brings a deep understanding of the research topic and provides comprehensive data and reach insides. While quantitative approach can assist in providing detailed assessment of patterns (Driscoll et al., 2007). Combination of both would have been useful to tackle a complicate phenomenon like human behavior. It would have been especially suitable to objectify the research and minimize subjective interpretation of all data gathered in the research.

The qualitative data for the study was collected in the form of interviews. The research focused on individual decision to adopt an AMS innovation. That is why it would have been valuable to collect insides from the potential adopter or individuals that have already adopted various AMS innovation. Due to the time constraints there was not possible to arrange an extensive user study. To overcome this constrain, the decision was made to focus on transportation experts in Finland that have a profound experience in various projects in transportation related to user studies. Considering there were eight interviews and results were discussed based on co-occurrence of common themes, it would have been more insightful to have a larger interview sample from both – experts and users of AMS innovations.

To analyze collected data, the research utilized multiple case study approach with *narrative data and content analysis technique*. The selected technique reflected a narrative nature of the collected data and purpose of the analysis. To eliminate bias in the findings and minimize subjectivity, each step of the analysis was conducted several time. Therefore, the analytic process of the research was time consuming and did not let the researcher to test the results of the study with end users.

Results presented in a form of multiple case studies preliminary focused on factors assisting positive innovation adoption decision. Case studies were discussed individually as well as together. Findings provided comprehensive details what factors essential for AMS innovation. Since the research was conducted in Finland, it could have been beneficial to compare consistency in factors' selection among transportation experts from other countries. However, it was not possible to arrange due to the time constrains.

Limitations emphasized in this chapter can be deliberated in future research and overcome by thorough planning and consideration of the available resources.

5.4 Conclusions and future challenges

Environmental challenges lead cities to shift towards more efficient and sustainable means of transportation. Alternative mobility solutions (AMS) have a big potential in cities with major issues in transportation. To address the adoption of such services and trigger citizens' behavior change, it is vital to involve all stakeholders and influence each step in innovation adoption process. To do so, it is important to apply practical framework that can reflect transportation sector features and trigger sustainable behavior change.

Lack of concrete frameworks in transportation sector that study AMS innovation adoption, makes the current research an important milestone to contribute to sustainable transportation development. Development of innovative solution in transportation plays a critical role in sustainable urban living. To study opportunities of those solutions and enable citizens to change their behavior was in the scope of this study.

Based on the literature review, the main theories for the study were identified. Literature review advocates an understanding about overall concept of behavior change and introduction to other disciplines which study behavior change topic. It further narrowed down the focus on behavior change in transportation and various theories of innovation adoption that leads to behavior change. There was no clear distinction between behavior change theories and theories focusing on innovation adoption. Thus, it was concluded to explore and overview theories on behavior change with no additional research on innovation adoption theories.

With a particular focus on AMS, three the most suitable theories were selected for the study. Theories particularly study fundamentals of a behavior change, changes in individual behavior and behavior of a sustainable energy use. These theories reflect the research scope and bring a valuable contribution to the content of the research. Based on the theories, the framework was developed. In order to extend the results, the framework was examined through the empirical study. Additionally, to ensure the credibility of factors in the framework, they were studied in real life cases. Factors identified in multiple case studies were in line with factors obtained from the proposed framework. Moreover, one of the most popular emerged factor was identified and described in the results.

It was proved that all identified stages of AMS innovation adoption decision are equally important for individual positive adoption decision. Particular attention was made towards characteristics of innovation. Some of the characteristics have a higher influence to the adoption decision than others. Thus, *complexity*, *triability* and *compartibility* emphasized as the most influential factors. An emerged characteristic *price* was also among the most significant characteristics that has an impact on individual behavior change.

Apart from characteristics of innovation, it is consequential to understand an overall ecosystem that has an influence on innovation adoption process and involve all stakeholders to address individuals' behavior change. Moreover, influencing on different levels can bring the greatest impact for future behavior change. For example, social influence was identified as one of the important factor that influences an individual decision to accept or reject an innovation. Even a greater influence comes from people whom individual trust and willingness to know their opinion. Furthermore, it was proved that various available resources can be a focal for innovation decision. Among those resources, legislations and policies played the most influential role. That is why it is important to make authorities work together and particularly focus on policies and legislations in transportation.

The current work contains enough foundation for further research. The framework proposed in this study (including all factors incorporated) do not consider some aspects from user perspective. Those aspects are described as follows as a part of the future research areas.

One of the future research direction can be to conduct a comprehensive user studies where proposed framework can be tested with real users. It is valuable to continue research and conduct

a user study that will help to make the proposed framework more accurate. User study can be done in a form of interviews or set of workshops where users can share their opinion and experience about adopting an AMS innovation.

Another interesting aspect to explore is to study different user groups and types of users. For example, it was mentioned in few case studies, innovation adoption rate can also depend on different age group of the potential AMS adopter. The current study was only generally specifying individuals living in urban areas. However, there is a possibility to extend the study and research more specific user groups that can for example have gender or age difference.

Based on the research results it was revealed that some of the factors were more influential for individuals than others. Continuing this thought, it would be interesting to study more, why some of the factors have more influence to the adoption decision over the others. For example, why such factors like *pricing* and *triability* (possibility to try an innovation) are more critical in comparison with *observability* (innovation characteristic to be visible in the city environment).

An AMS innovation consists of product, service and infrastructure. The current study touched upon service and infrastructure, it would be interesting to study if the type of transportation mode would also effect an AMS innovation adoption decision.

As an additional aspect to consider for the future research, more theories can be studied to enhance framework in this study. There was an interesting finding identified during two interviews. Two experts pointed out that creating an emotional attachment to a new AMS can increase a probability to adopt an innovation. None of the theories utilized in this study consider emotional aspect. Nevertheless, there are other theories like Theory of Interpersonal Behavior (Triandis, 1977) that

highlight the role of emotions in forming an attitude towards an innovation. Therefore, it would be interesting if other theories can possibly provide additional factors to study the framework.

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Appendix A

Interview outline example for AMS1

1 - General background questions related to company, job role, etc.

- What is your background, role in the company?
- What is (name of the company) service?
- How did the idea of the service come up?
- What was the reason behind?

2 - AMS design and development activities (challenges, advantages, cultural aspects, etc.)

- What were the **main challenges** in service development/ launch/ implementation?
- What **opportunities can bring AMS**?
- What **characteristics** of the service company try to emphasize for your users?
    - Advantage. Advantage of using the service
    - Compatibility with pat user experiences, social norms
    - Complexity. Difficult to understand the service for end user (ex.: Pricing)
    - Trialability. Was it easy to try service once?
    - Observability. Did you notice any pattern of users who sign up for the service? For example: neighbors come one by one, did you notice any peer influence among your customers?
- Did you consider **cultural aspect** during AMS development?

- Did if affect somehow in practice?

3 - Adoption of (name of the company) AMS by the customers and their behavior change

- What was majority **response** about the service before they adopt?
- Did you notice their behavior changed after adopting the service?
- What is in your opinion important for **AMS adoption**?
    - Any factors on mind?
    - Any particular steps?

4 - Supporting factors for AMS adoption

- What factors can assist in new transportation service adoption?
- Collaboration and feedback of customers:
- Do you consider customer feedback to improve the service?
- Communication channels to reach customers:
    - What are **communication channels** you use to be in contact with user?
    - How did you **inform** potential users about the service?