CHALMERS
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## A qualitative study of potential adopters in Sweden

*Master's Thesis in the Master's Programme*
*Management and Economics of Innovation*

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*David Hallén & Erik Sällberg, Gothenburg, September 2018*

## Abstract

A new industry for AVs (small autonomous shuttle buses) is emerging in Sweden, partially through an initiative that is driven by RISE (Research Institutes of Sweden). With only a few cases of adoption of AVs worldwide, the technology is still in an early phase and there is still no common understanding of what factors are influencing whether an eventual adopter will adopt the technology. Through eleven in-depth interviews with organizations that are about to adopt the AVs, the study aims to answer what factors adopters themselves perceive to be influencing their eventual adoption. In addition to the interviews, data has been gathered through participation in four workshops together with adopters and public authorities that were organized by RISE. The areas of factors are labeled as *Perception of the Innovation*, *Collective Adoption*, *Facilitation by Demonstration Projects*, *Barriers in the Environment*, and the *Length of adoption process*. These factors have different influence on the outcome of adoption, the rate of adoption, or the speed of adoption. This framework provides a useful structure for any actor that is aiming to diffuse AVs, including vehicle manufacturers and public transport operators.

Key words: *Adoption of innovations, Autonomous vehicles*

# Contents

# 1. Introduction

Since the 1980s, the technology of automated vehicles has taken major advancements through better sensors and data processing (Janai et al., 2017). Accordingly, the number of initiatives for autonomous vehicles has grown and a market of actors is starting to emerge. Now, all major car manufacturers are claiming that within a few years they will be able to make their cars drive fully autonomously on public roads (Royer et al., 2016). A major shift towards to autonomous vehicles from the situation of today with manned vehicles is theorized to give opportunities to improve traffic safety, reduce fuel consumption and emissions, reduce congestion in urban areas, and the possibility to change planning in cities (Victor et al., 2017). Anderson et al. (2014) suggest that benefits such as improved safety and reduced congestion incur a substantial reduction of external costs, why a shift towards autonomous vehicles would be beneficial for the society as a whole. Therefore, it is of interest to understand how an increased rate of adoption of such vehicles may be accomplished.

Over the past few years, a segment within autonomous vehicles has started to emerge, namely small shuttle buses with electric propulsion and capacity of around 15 passengers. We have chosen to study what influences the adoption of such vehicles, hereafter referred to as AVs (for Autonomous Vehicles). Currently, there are a few initiatives in Sweden, aiming to introduce AVs. For reasons similar to those previously presented by Victor et al. (2017), a team at RISE (Research Institutes of Sweden) lead by Birger Löfgren aims to introduce AVs in a few different contexts in Sweden. This team has both supported us in understanding the technology and helped out in reaching potential adopters who have been our interviewees. Some specific conditions are present for the diffusion of AVs in Sweden, which motivate a closer investigation of which factors have an important influence. Firstly, whereas adoption of autonomous cars to some extent depends on purchasing decisions among individuals in the consumer market, the final purchasing decision for AVs takes place in organizations although the AVs are assumed to be used for private traveling by consumers. In other words, the adoption decision and usage are in one sense separated, and therefore previous findings from studies of what affects adoption of autonomous cars cannot readily be generalized to the adoption of AVs. Nevertheless, it is still uncertain how the end-users affect the adoption decision by organizations.

Secondly, adoption of AVs currently occurs in demonstration projects conducted by networks, consisting of various types of actors, including both private and public companies in different industries, as well as public authorities. Therefore, there are many different types of organizations that are regarded by Löfgren and his team at RISE as potential adopters. There is a lack of knowledge about the factors that affect adoption among the variety of actors. Knowledge of the reasons for why actors wait or completely stay away from adopting the technology, as well as the motives for adopting, is needed in order to understand how to increase the rate of adoption. According to Vowles et al. (2011), factors influencing an adoption decision stem from three different generic categories of factors that could be explained as *Perceived characteristics of the innovation*, *Firm traits and characteristics*, and *External influences*. Since Frambach (1993) suggests a similar structure of factors and Rogers (2003) provides factors that can be divided into similar categories, a more generic framework should include *Factors within the Adopting Organization*, *Factors in the Environment of the Adopting Organization*, and *Factors Related to the Innovation*. Since both generic factors and innovation-specific factors may have an influence on adoption (Ruppel and Howard, 1998),

the factors related to the three categories above help only partially to understand what factors apply specifically to AVs in Sweden, and how these affect adoption. There is a need to investigate empirically what specific factors are in the specific industry.

The study has been conducted during an early phase of the emerging industry in Sweden, during which only partial adoption has yet been made. For that reason, the best data available that provides insight into what factors influence adoption AVs are interviews with potential adopters. Such insight gives a better understanding of the potential adopters, which in turn is useful for change agents, such as RISE, that is aiming to facilitate the diffusion of the technology in question.

In order to describe the adoption of AVs in Sweden, we suggest a framework consisting of the five main areas of factors found in in-depth interviews with twelve respondents representing eight adopting organizations. These areas of factors that affect adoption are labeled as *Perception of the Innovation, Collective Adoption, Facilitation by Demonstration Projects,* and *Barriers in the Environment*. They have a different influence on the outcome of adoption, the rate of adoption, and the speed of adoption. This framework provides a new structure that may help change agents to facilitate the diffusion of AVs, that takes into account the special conditions for the diffusion of AVs in Sweden, which have been presented above.

## 2. Aim and Research Question

There is a need for understanding what factors are perceived by potential adopters to have an impact on their adoption or intent to adopt electric, autonomous shuttle vehicles in Sweden. There is a gap in current research about what factors are important under the specific circumstances for adoption. This study aims at contributing to a better understanding of the adoption by organizations, by studying the factors that determine whether they adopt or not. The intention is to provide a tool that can guide change agents such as suppliers, and other organizations aiming to facilitate the diffusion of the technology. Therefore, this report investigates the following questions:

1. What do adopters of electric, autonomous shuttle vehicles in Sweden perceive as the factors influencing an eventual adoption?
2. How do adopters of electric, autonomous shuttle vehicles in Sweden perceive that those factors are influencing their eventual adoption?

# 3. Theoretical Framework

In previous research, many factors have been described to increase or reduce the outcome of adoption, the rate of adoption, or the speed of adoption. A theoretical framework has been developed in order to categorize the origin of the factors while also explaining in which ways the factors affect adoption.

The framework developed in this thesis will adopt the distinction between factors related to the adopting organization, factors related to the environment of the organization, and factors related to the innovation. It is an adaptation of the conceptual model proposed by Vowles et al. (2011) who directed attention to multiple factors that have been described to have an impact on the organizational adoption of radical innovations. The factors proposed were categorized into the three groups: "Perceived characteristics of the innovation", "Firm traits and characteristics", and "External influences", which are described to be interrelated by Vowles et al. (2011). This model has to a high degree similar content as the integrated model of organizational adoption and diffusion of innovations by Frambach (1993), which refers to factors that are at the adopter side, factors at the supplier side, factors in the environment, factors that relate to the innovation and the interaction between the supplier and the adopter. It is suggested which relation the factors have to diffusion, increasing or decreasing diffusion. Also the factors that Frambach (1993) suggests to have an influence on adoption, may arguably be sorted into the three boxes of the framework in our thesis since they relate to *Factors within the adopting organization* (including information processing characteristics and adopter characteristics), *Factors in the environment of the adopting organization* (including information, innovation development, competitive environment, marketing strategy, and network participation) and *Factors related to the innovation* (including innovation characteristics). Thus the factors from Frambach (1993) are complementing the factors from Vowles et al. (2011) and are therefore also complementing our framework of factors.

The factors can, according to previous research, increase or reduce the outcome of adoption, the rate of adoption, or the speed of adoption which will be explained in more detail below in this section (also see Definitions in the Methodology section for an explanation of the three types of effects). We regard the distinction as important since there are differences in how the adoption is affected in the three cases, for example, a factor that increases the rate of adoption may or may not have any effect on the speed of adoption. However, in previous research, there is not a consistent way of describing the effects, since some research only describes how factors increase or reduce adoption without mentioning in which way. We use these three types of effects in our theoretical framework to describe the influence of factors on adoption, but do not exclude the possibility of relations between the three effects.

Below is the suggested framework (see Figure 1) with three main categories of factors: *Factors within the adopting organization*, *Factors in the environment of the adopting organization* and *Factors related to the innovation*. Within these categories, there are many other subcategories of actual factors mentioned above. A closer description of these is provided below in separate sections, including what factors can be related to each category and how those factors affect adoption according to previous research. The category *Factors within the adopting organization* is defined as all the factors within the boundaries of the adopting organization with its decision-making process and implementation of the AVs. The category *Factors related to the innovation* include all the factors that potentially can influence adoption and are related to the AVs, in other words, the object being adopted. The

category *Factors in the environment of the adopting organization* are all the factors that can influence the adoption but are neither within the boundaries of the adopting organization nor related to the innovation specifically. Below a description of previous research is provided for each of the three groups of factors in the framework.

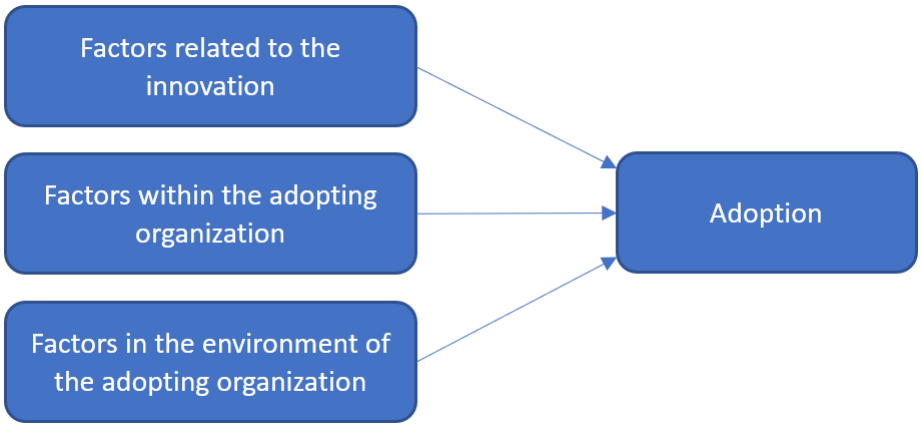


*Figure 1.* Suggested framework of factors that potentially influence adoption of AVs in Sweden.

## 3.1 Factors within the Adopting Organization

As will be elaborated on in this section, several factors within the boundaries of the adopting organization are related to whether, and how an organization, adopts an innovation: the individuals who make the decisions, the way they make decisions, and the process that the organization uses for adopting innovations. In the special case where an innovation is tested and promoted through demonstration projects in particular, that becomes part of the adoption process. Thus, factors related to demonstration projects affect the adoption as well.

Scholars such as Rogers (2003) have noted that the way that influential individuals within the adopting organization perceive factors affect their adoption-decisions and adoption-actions, in what is referred to as the innovation-decision process. Kristian Häggman (2009) highlights that individuals in the adopting organization perceive the innovation differently, and since the adoption is dependent on the individuals, this has an impact on the outcome and duration of the adoption process. Secondly, Rogers (2003) suggests that adoption of an innovation in an organization occurs through what is referred to as the innovation process, where individuals' decisions and actions, affected by the distribution of mandate in innovation-decisions, translate into the adoption in the organization. Thirdly, the adoption process in an organization is described as a sequence of steps, referred to by Rogers (2003) as the innovation-process.

Next, factors that are related to the adopting organization itself, such as its structure and culture, and its ability to recognize the fit of an innovation, are suggested by several scholars to have influence on the outcome of each step in the innovation process (Rogers, 2003; Ramirez et al., 2014; Klerkx et al., 2013; Vowles et al., 2011; Ruppel and Howard, 1998; Kristian Häggman, 2009).

Then some obstacles with adopting discontinuous or radical innovations may be attributable to the organization's readiness to adopt. According to Bisack (2003), adoption of particularly novel innovations demands learning processes. There is a barrier for incumbent firms to react

to discontinuous innovations because of their limited absorptive capacity (Pfefferman et al., 2013; Ruppel and Howard, 1998).

Further, demonstration projects are described to play a role in bringing the innovation from development to the market adoption (Auerswald & Branscomb, 2003; Macey & Brown, 1990). The demonstration projects can have different functions for adoption depending on what phase it is for the innovation (Zhou et al., 2015, Bossink, 2015). Below, we elaborate on the relation between each of these areas and describe in which way the factors have previously been described to affect adoption.

### 3.1.1 Innovation-Decision Process

This process, which has been recognized by many researchers, describes how a decision-making member of the social system goes from the first awareness of an innovation, through decisions and actions, to continuing or discontinuing the adoption (Rogers, 2003). The process consists of the five steps below:

1. Knowledge
2. Persuasion
3. Decision
4. Implementation
5. Confirmation

As Rogers (2003) describes, the knowledge stage represents where the adopter becomes aware of what the innovation is and how it works. In the persuasion stage, the perceived characteristics of the innovation are important factors that affect whether the potential adopter makes a positive decision in the next stage. The innovation can be accepted or rejected in the decision stage, and then, after the implementation, it can be confirmed by further adoption or discontinued.

### 3.1.2 Perception Differences within an Organization

Within the adopting organization, there may be several functions that are involved in the process of adopting the new technology, and these functions may perceive the innovation differently, resulting in different duration and outcomes of the adoption process (Kristian Häggman, 2009). Rogers (2003) explains the relation between how innovations are adopted by individuals and by organizations and suggest that innovations are diffused more rapidly the fewer individuals are involved in making the decision. As he describes, although the diffusion of an innovation among organizations is described similar to the diffusion among individuals, it is overly simplified to assume that the adoption by an organization is equivalent to the adoption by an individual. Rogers (2003) states that when organizations adopt innovations, the decision typically involves both individuals who are opposing the idea and individuals who are championing the idea, so-called innovation champions. This is supported by Kristian Häggman (2009) who found that in collective adoption by several functions within a firm adopting a new technology, the different functional actors involved in the adoption decision process can both gate and advance the adoption process for the technology, and the differences in their perceptions of the innovation can influence both the duration and the outcome of the innovation. According to Rogers (2003), there may sometimes also be ambiguity about who in the organization makes the decision to adopt.

How the decision is made in an organization has been described by Rogers (2003) as different types of decisions:

| | |
|---|---|
| Optional innovation-decisions | Optional innovation-decision means that each member of the system makes the decision independently of the other members. |
| Collective innovation-decisions | The collective innovation-decision usually has the slowest rate of adoption, and can be described as a consensus decision by all the members of a system, such as an organization for instance. |
| Authority innovation-decisions | The authority innovation-decision, where a few individuals in the social system of adopters have the power to decide about adoption, usually implies the fastest rate of adoption. |

*Table 1. Adaptation of the three types of organizational adoption-decisions by Rogers (2003)*

### 3.1.3 Duration and Outcome of Innovation Process in the Organization

Since adoption is not instantaneous but takes time, it can be described as a process, consisting of several stages (Rogers, 2003). The innovation process for an organization consists of the two main activities *initiation* and *implementation*, each consisting of several stages. The factors that affect adoption are not affecting the adoption equally in these stages, as described below.

In the initiation, the organization defines a need for an innovation in what is called the agenda-setting stage and then matches the need with an innovation. Usually, an active search for a solution triggers the initiation, for example, because of an identified performance gap that catches the attention, but sometimes in the awareness that an innovation exists can lead to a perception of a need of the innovation. This is applicable both at an individual level and at an organizational level. An agenda has the power to focus the attention of search for innovations that match the organizational needs. However, the stage can require several years.

The agenda-setting stage is followed by the planned and designed matching stage where the members of the organization try to anticipate what benefits and drawbacks the innovation will bring. The degree of fit between the innovation and the need is to a high extent determining how sustainable the innovation will be in the implementation, and that is related to the compatibility of the innovation, which is described in *Factors Related to the Innovation*, later in this chapter.

The implementation includes “all the events, actions, and decisions involved in putting the innovation to use” according to Rogers (2003). It consists of redefining, clarifying, and routinizing. The redefining stage is the stage that starts when the adoption decision is made and the innovation starts to be adapted to the organization’s needs and structure, at the same time as the organization’s structure may be adapted to fit with the innovation. The reason that this occurs is that innovations rarely fits perfectly with the organization. The fit of the innovation is perceived to be higher when the origin is within the organization, which also usually facilitates the adoption speed, learning, and innovation receptiveness. The likelihood

of a successful implementation is powerful because the innovation is perceived by the individuals in the organization to be theirs and to fit the needs. For an innovation that is imported from outside the borders of the organization more redefining may be needed in order for the innovation to be successful through the implementation. The more members of the organization participate in the innovation process and the more redefining and implementation of the innovation, the more it is perceived to be their own innovation, and thus the higher the likelihood that the innovation is sustained within the organization even when the initial resources allocated for implementation diminish.

Next, after the redefining stage, there is a clarifying stage, where the meaning of the innovation to the organization and its members is made clearer through a social process as the members of the organization discuss what the innovation does and how it will affect them. The innovation is put into more widespread use while the meaning is gradually clarified. If the innovation goes through the stage with undue haste, the implementation can fail because of misunderstandings or unwanted side effects.

The routinization stage is the final stage of the innovation process and means that the innovation becomes incorporated into the everyday activities of the organization. Here the innovation can be sustained or discontinued.

Since stages of the innovation process potentially require a long period of time, the rate of adoption depends on the total amount of time spent by the adopter in the innovation process. For some innovations, it has been observed that the widespread use of an innovation within the organization has been a very rapid part of the adoption process because the clarification stage has not been needed and routinization has occurred just after the redefining because the innovation has come from within the organization and met an identified need.

### 3.1.4 Organizational Structure and Culture

Some organizations have a higher tendency to adopt innovations than others. That may be attributable to the structure and culture of the organizations, as well as the eventual existence of especially influential individuals, called innovation champions.

In their study of adoption of environmentally-sustainable offerings, Ramirez et al. (2014) found that intra-organizational structure and culture can act as barriers to adoption. Structural characteristics that impeded organizations to adopt were related to for example firms' missions and power relations, such as authorities to make decisions within specific business units. Variables related to the organizational structure that Rogers (2003) argues are inhibiting adoption are centralization and formalization. This means that organizations with less concentration of power and less focus on that the employees follow the rules and procedures are more innovative. On the other hand, there are also organizational factors supporting innovativeness. According to Rogers (2003), such positive factors are the level of knowledge and expertise among employees, available resources in the organization, and the size of the organization.

The organizational culture is also described by Ramirez et al. (2014) to be a barrier when the mindsets, habits, and routines among both leaders and employees are not matching well with an eventual adoption. They found for example biases favoring certain suppliers due to old relationships or nationalistic preferences.

Rogers (2003) note that studies aiming to find organizational characteristics explaining organizational innovativeness, or an organization's tendency to adopt innovations, have not been particularly successful. The relations found have generally not been strong. However, one organizational characteristic that provides a relatively good indication of innovativeness is the size of an organization (Rogers, 2003). The reason why organizational size has been a successful indicator of innovativeness is that it coincides with other important dimensions, including total resources, slack resources, technical expertise, and organizational structure.

The notion of champions is frequently mentioned in adoption literature (Klerkx et al., 2013; Vowles et al., 2011; Rogers, 2003; Ruppel and Howard, 1998). The definition of champions used by Rogers is "a charismatic individual who throws his or her weight behind an innovation". That way, a champion may overcome resistance towards the innovation within an organization. The importance of a champion for achieving adoption is tested by, for example, Vowles et al. (2011) and Ruppel and Howard (1998), both of which found a positive relationship. Kristian Häggman (2009) rather describes the interaction between functional actors within the firm as key for overcoming resistance to adoption and thereby puts the focus slightly differently on the function rather than on an individual. He showed that in case studies of technology adoption, a lack of interaction between the functional actor benefitting the most from the adoption, and the other functional actors having an impact on the decision to adopt, would result in lack of incentives for the other functional actors. Therefore, it would not only prolong the adoption process but also result in a negative outcome for the adoption.

### 3.1.5 Readiness to Adopt

Some obstacles with adopting discontinuous or radical innovations may be attributable to the capability of the organization to search for innovations and understand an innovation and how it creates value for the organization. We label the capability to these things readiness to adopt.

According to Bisack (2003), valid assessment and adoption of particularly novel innovations demand learning processes. There is a barrier for incumbent firms to react to discontinuous innovations because of their limited absorptive capacity (Pfefferman et al., 2013; Ruppel and Howard, 1998). The absorptive capacity builds on previous knowledge and for discontinuous innovations, new knowledge must usually be acquired in order to understand and apply the value of the innovation commercially (Cohen and Levinthal, 1990).

Vowles et al. (2011) hypothesized that the depth of knowledge resources within the adopting organization would relate positively with adoption of radical innovations. In their study, this hypothesis was given some support. They argue that it would require more effort to adopt for an organization that is not already knowledgeable in the field because such an organization would need to acquire new information. The authors note that previous experience seems to be particularly important for high tech innovations. Moreover, they note that organizations that actively search for information about innovations are more likely to become adopters. Similarly, Srinivasan et al. (2002) use the notion of technological opportunism for describing organizations that are able to sense and respond to technological change. They argue that an organization must have the capability to acquire and understand new technology development in order to adopt a technology. That could be accomplished through actively searching and evaluating new technology in meetings with vendors or competitors. Thereafter, an adequate

response to the development is required and an ability to change the business strategy if needed.

### 3.1.6 Demonstration Projects

For decades, the effectiveness of publicly funded demonstration projects for promoting innovation has been criticized by academics and considered to face problems (Lefevre, 1984). However, more recently it has been shown that demonstration projects play a role for many phases of the innovation process, including market adoption of a technology (Auerswald & Branscomb, 2003; Macey & Brown, 1990). In addition, Zhou et al. (2015) suggest factors that have an influence on how much demonstration projects affect adoption, thereby mediating the effect of demonstration projects.

The nature of demonstration projects varies a lot, and therefore the effect on further adoption is arguably dependent on what kind of demonstration project is conducted. In the research, there is a diversity in the descriptions of the function of demonstration projects and how they affect adoption. Bossink (2015) suggests that the demonstration projects can be of a character that is exploring or related to market creation. Further, demonstration projects are suggested by Karlström and Sandén (2004) to occur in two phases: the *experimental phase* where the aim is to maximize learning about the technology, and the *diffusion phase* where the aims are to focus on the market growth and gain both credibility among customers and public acceptance for the technology, as well as reducing the opposition from different stakeholders. This can be compared with the similar view by Zhou et al. (2015), that demonstration projects can typically have one or two functions: testing or showing the technology. Without conflicting with that, Lefevre (1984) states that the demonstration project has a role to shorten the time for a technology to go from a prototype to widespread adoption at a market. A study of how demonstration projects of personal electric vehicles affected the emergence of an industry, in the “Ten Cities, One Thousand Vehicles” program in China, showed that the demonstration projects improved information dissemination, viability of applications and diffusion of the new technology, collectively called innovation performance (Zhou et al., 2015). The study supports that innovation performance can be enhanced, and an industrial emergence can follow, as a consequence of the innovation that occurs through the demonstration project. Demonstration projects with both a testing and showing function are the most effective for innovation performance (Zhou et al., 2015). Other effects of demonstration projects for later stages of the innovation process, namely the market creation and network formation for the technology, have recently been suggested by a qualitative case study of fuel cell technologies in Sweden by Karlström and Sandén (2004).

Further, it has been shown that the learnings of the demonstration projects have a positive influence on the rate of adoption of the innovations that are tested (Harborne et al., 2007; Zhou et al., 2015). The effects of demonstration projects arguably imply that demonstration projects have an effect on adoption of vehicles.

However, there may be problems with realizing the benefits of demonstration projects. According to Macey and Brown (1990), a demonstration project may not contribute as much to the commercialization of a technology that faces technical problems, institutional problems or weak demand. After quantitatively testing the correlation between these three factors and the innovation performance, Zhou et al. (2015) conclude that technological readiness and institutional readiness, each have an impact on innovation performance in the context of a demonstration project, whereas the market readiness is not proven to be significant. However, the readiness to adopt is a factor that has been treated above as a part of the internal factors,

and could arguably be regarded to be similar to market readiness. Thus, market readiness would possibly be important for adoption directly, but possibly not for the effect of the demonstration project on adoption.

Previous research agrees to a high extent on when in the life cycle of an innovation a demonstration project is relevant, although the descriptions sometimes distinguish between several phases. Lefevre et al. (1984) broadly define the phase as before the full-scale adoption occurs on the market, which Hendry et al. (2010) refer to as the "uncertain middle", the later stages of technical development. Therefore, demonstration projects have for example proven to be an effective organizational form for diffusion of clean technologies by bringing it from a prototype stage to a marketable product, which was recognized in a lot of research according to Bossink (2015).

The effect of demonstration projects on adoption can be regarded to depend on several mediating factors (Bossink, 2015). A literature review of research about demonstration projects for clean technologies during 39 years, showed that the factors that are important for the effect of demonstration projects depend on whether the project had a technical, organizational, or market-related focus (Bossink, 2015). Bossink (2015) describes each of these three types of demonstration projects as follows:

- Technical demonstration projects (T) are used to improve a prototype
- Organizational demonstration projects (O) aim to build a production organization
- Market demonstration projects (M) further adapt the product and production to the needs and preferences of customers while improving the sales and marketing organization

The factors that affect the innovation's performance in the different phases, denoted below as T, O and M, of the demonstration project are listed by Bossink (2015) based on the literature review:

- Balancing of risk/reward ratios of all participants (T, O, M)
- Cost reduction of new technology (T, O, M)
- Experimental learning of participants (T, O, M)
- Policy, regulation, and legislation in favor of innovation (T, O, M)
- Market demand for innovative products (T, O, M)
- Positive communication (T, O, M)
- Technology demonstration and deployment expenditure (T, O, M)
- Use of innovation labels (T, O, M)
- Formation of networks of cooperating organizations (T)
- Performance review of new technology (T)
- Entrepreneurs' commitment to the demonstration (O)
- Governmental demand for innovative products (O)

Referring to experimental learning of participants in the list above, Bossink (2015) suggests that demonstration projects can play a very important role for the participating organizations' learning, both the learning about technical aspects and about the possibilities to exploit the innovation commercially. Baer et al. (1976) point out that a demonstration project can provide new information that addresses some uncertainties. In a study about demonstration

projects of fuel cell buses, Harborne et al. (2007) noted that operators and customers involved in the project got the chance to learn about the technology without the risks that are involved with a purchase.
Referring to the innovation attributes described by Rogers (2003), this increased the trialability of the innovation. The actors involved in the project, including operators, manufacturers, passengers, city planners, emergency services and media, learned about the features of the innovation such as complexity, compatibility with other products and work practices, and the advantages of the product (Harborne et al., 2007). Thus, the demonstration projects arguably also reduced uncertainties in several ways and arguably should have a positive impact on adoption related to the perceived attributes of the innovation, which will be described in detail in the section called *Factors Related to the Innovation* below.

Furthermore, seen from the perspective of Rogers (2003), the commitment of resources to a technology is a part of the innovation process. Therefore, we suggest that participation in a demonstration project, which implies allocation of resources, should be viewed as a partial adoption of a technology, as well as a potential factor that could affect continued adoption (see also *Definitions* as part of the *Methodology* section).

## 3.2 Factors in the Environment of the Adopting Organization

This second category of the framework is in turn divided into three sub-categories depending on where the factors have their origin: institutions, suppliers and other influencers. All these factors are arguably external factors in relation to the adopting organization and refer to factors influencing adoption that can neither be accountable by the adopting organization nor how the innovation itself is functioning or appearing.

Numerous previous studies point out institutions and regulations to be influencing the diffusion, either in a positive or negative way (Kemp et al.,1998; Brown and Hendry, 2009; Talke and Hultink, 2010; Norberg-Bohm, 2000; Nykvist and Nilsson, 2015). In addition, a government's communication may have a mediating effect on adoption when a demonstration project is taking place (Moore and Higgins, 2016).

In studies of diffusion patterns in consumer markets, Horsky and Simon (1983) and Simon and Sebastian (1987) found support for the argument that external influence on adopters of an innovation indeed has an impact. However, Simon and Sebastian (1987) found that the coefficient of external influence on adopters is larger in the intermediate stage of the diffusion than in the early stage, because the marketing efforts provide adopters with information and in the intermediate stage of the life cycle the potential adopters are evaluating other customers and experiencing a social pressure. In general, the different lines of research are not giving a consistent description regarding the significance and relative importance of different factors in the environment of the adopting organization. For example, supplier marketing is not proven to have a significant effect on adoption according to Vowles et al. (2011). However, in the study of Vowles et al., the supplier marketing is the only external influence on adoption that is tested. In the field of industrial marketing and innovation management, the decision not to adopt an innovation is usually considered to depend on the individual in the prospective adopter firm (Rogers, 1992), but it may well be a result of a failure on the supplier's side to understand the customers' needs (Frambach, 1993). Therefore, according to Frambach (1993), there are reasons for considering the impact of a supplier on the adoption rate and not only the adopter side.

We argue that factors in the environment of the adopting organization potentially have importance for adoption in a context of the AV adoption in Sweden. In particular, since there may be innovation-specific factors (Ruppel and Howard, 1998) in the category *Factors in the environment of the adopting organization*, the suggested factors from previous research should be investigated, although they have not previously been proven to be significant empirically.

### 3.2.1 Institutions

In a study of 113 recently launched products with high innovativeness on business-to-business markets, Talke and Hultink (2010) evaluated the companies' respective launch tactics. They found that launch tactics aiming to lower the diffusion barriers related to the further firm environment, including legal and political organizations, are effective. Involvement of such organizations mitigates the risk for controversial innovations to be hindered by legal regulations.

In a study of why Stockholm is not yet a leader in electric vehicles, Nykvist and Nilsson (2015) get considerable support for their landscape hypothesis. That hypothesis claims that a slow diffusion may result from a weak political determination and leadership, including a lack of economic incentives programs promoting the transition. Ambivalence among national policymakers leads to uncertainty in the industry which inhibits the development. A lacking policy direction hinders an assessment of whether purchasing or marketing the innovation is viable in the long term. Similarly, Kemp et al. (1998), which also study the transition towards sustainable vehicles, point out that manufacturers become reluctant to invest in new technology when there is a lack of clear political messages and direction.

The same study by Kemp et al. (1998) raises the issue of overly harsh regulation in regards to safety, which result in high costs and low diffusion. However, regulations do not only inhibit innovation, it may also impact positively. Walker et al. (2008) found in their study of seven organizations' barriers and drivers towards adopting a green supply chain, that regulation was a major driver for implementing such supply chains.

Despite good intentions, Kemp et al. (1998) note that legislation aimed to stimulate innovation, may fail and give unfair support. That was the case in California when giving support for zero emission vehicles, but not to hybrid-electric vehicles, although hybrid-electric vehicles were cleaner if the energy production was taken into account. This, in turn, discouraged the development of hybrid electric vehicles.

Norberg-Bohm (2000), assessing the role of the government for the development and diffusion of more sound energy technologies in the US, argues that public policy support is needed, both as supply push and demand pull. In order to develop environmentally preferable energy sources, governments may create demand pull by subsidizing the technology, or through government-funded demonstration projects and field trials. Demonstration projects and field trials may also function for pushing the supply.

Research about demonstration projects and their effect on adoption suggest factors that have a mediating effect on how much demonstration projects affect adoption (Zhou et al., 2015). One such factor, as found in a study by Moore and Higgins (2016) on Australian urban development demonstration projects, is related to governments' communication. The results

emphasize the need for the government's communication of the project outcomes to the stakeholders in an industry in order to influence the adoption by an emerging industry.

### 3.2.2 Suppliers

Factors regarding suppliers mentioned in previous research are related to either the availability of suppliers and their capabilities, or the supplier marketing.

#### *Availability of Suppliers and their Capabilities*

Ramirez et al. (2014), studying the factors influencing the adoption decisions of environmentally sustainable offerings in a business-to-business context, found that the potential adopters frequently mentioned the supplier capabilities as a barrier to adoption. Respondents pointed out that a too narrow product line, low production- and service capacity, and deficient reliability are hindering them to adopt. Similarly, Simon and Sebastian (1987) point to the importance of the supplier production capacity and suggest that it has a positive impact on the rate of diffusion. Meeting the above-mentioned requirements is, according to Ramirez et al. (2014), especially challenging for environmentally sustainable suppliers because the companies tend to be relatively small.

To solve the above-mentioned problem, incumbent firms of larger size would arguably need to take a step into the market. Nykvist and Nilsson (2015) argue that both prevalent normative and cognitive structures among the general public could inhibit the acceptance of battery electric vehicles in Stockholm. Their study showed that consumers had perceptions of what attributes cars should have, that didn't match with the proposition of the emerging electric vehicles. Kemp et al. (1998) argue that this gap between consumers' perceptions and the value proposition of vehicles makes incumbent vehicle manufacturers reluctant to invest in the new technology. That calls for a change of consumer demand, which incumbents, according to Kemp et al. (1998), tend not to believe is possible.

Within the incumbent car industry, there is an inertia for development towards battery electric vehicles due to the human capital that has been built up around combustion engines (Nykvist and Nilsson, 2015). A company that shifts over to electric propulsion, Nykvist and Nilsson (2015) argue, makes much competence obsolete, and loses its identity, as well as its revenue generated from after sales. Hence, incumbent manufacturers are more likely to proceed developing innovations than shift over to radically new technologies.

An innovating firm often needs to cooperate with indirect suppliers or dealers for creating an attractive offering to customers (Talke and Hultink, 2010). In their study of the introduction of environmentally sustainable vehicles, Kemp et al. (1998) point out the need of a supporting infrastructure in terms of distribution systems for natural gas, hydrogen, and electricity, in order for the respective vehicle technology to gain traction. The current infrastructure of mechanics in garages would also need an update. Without such infrastructure, it would be impossible to maintain the fleet of vehicles. However, what Talke and Hultink (2010) noted was that these market actors is also a group that faces uncertainty in regards to strategic fit with the current offering and market acceptance of the innovation. It is, therefore, an important, but potentially challenging factor to get in place in order to get adoption.

#### *Supplier Marketing*

The external influence that is highlighted by Frambach (1993) is supplier marketing. It is suggested, for example, that the supplier's development of the innovation can influence the acceptance of the innovation after its introduction at the market, especially since the supplier may also work together with the potential adopter during the development process. In addition, it is claimed that the supplier can affect the diffusion of the innovation through a conscious marketing strategy, as described in industrial marketing literature (Frambach, 1993).

Further, the AVs are arguably perceived to be environmentally friendly innovations because they are electric and thus avoid pollution of carbon dioxide. Ramirez et al. (2014) presented in their research on twenty companies that had faced and overcome barriers to adoption of their environmentally-friendly innovations, that supplier firms may through communication, actions, and improvement of their offerings, overcome different barriers related to either the supplier itself or to the adopter. In order to create product awareness, the supplier may communicate effectively that it is making an effort to develop environmentally-sustainable offerings. The suppliers may need to create different presentations for different levels of the customer company, that appeal to different interests in the company, and be able to quantify the benefits associated with adoption or how the short-term costs for adoption can be offset by goodwill or similar (Ramirez et al., 2014). Regarding such actions as part of supplier marketing, this can arguably imply that supplier marketing is important for adoption of environmentally-friendly innovations. Similarly, Kristian Häggman (2009) showed in case studies of organizations adopting a new technology that iterative cycles of communication between the technology provider and the adopting organization may be needed and that the direct interaction between the technology provider and the adopting organization is highly important to "identify applications for the technology and manage technological risks". As the case studies showed, those interaction cycles significantly prolong the duration of the adoption process, making the speed of adoption slower, but are essential for the outcome of the adoption process.

### 3.2.3 Other Influencers

In addition to institutions and suppliers, a number of different external influencing factors have been identified in previous research. Adoption is shown to be affected by opinions of the general public, non-governmental organizations (NGOs), lobby groups, so-called contagion from other adopters, social learning, opinion leaders, and networking between potential adopters.

As suggested above, regulators may influence adoption. Talke and Hultink (2010) point out that the legal authorities that possibly impose the regulations, may be influenced by the general public. They describe that the public can affect the public policy through for example complaints, protests, and boycotts. In addition, since the end users of an innovation are part of the larger group of the general public, they are important to consider. Portouli et al. (2017), studying the attitude of passengers and other citizens towards AVs in a demonstration project in Greece, suggest that in order to create markets and demand for such vehicles, public attitudes are crucial. However, in the case of this demonstration project, the public attitudes were rather positive and did not comprise a problem.

Societal pressure may also take a more organized form. Walker et al. (2008) found that environmental non-governmental organizations (NGOs) pressure other organizations to improve their supply chain practices in regards to the environment, which seemed to influence some of their respondents to adopt. The NGOs exercise their power through their potential to embarrass organizations.
Another form of organization, potentially impacting the diffusion of innovations, is lobby groups. Companies that have invested both human and capital resources in the incumbent technology will, according to Kemp et al. (1998), try to defend the technology. They do so by forming lobby groups, attempting to prevent their investments to become sunk investments.

Another kind of external influence that has been empirically proven to affect adoption decisions is the so-called "contagion effect", in other words, the influence that adopters have on other adopters through legitimizing an innovation by word of mouth or adoption of an innovation (Bianchi et al., 2017; Frambach, 1993). Bianchi et al. (2017), studying the role of early adopters for diffusion of innovations, note that previous diffusion literature is ambiguous on whether early adopters will affect subsequent purchases in a contagious manner. Arthur and Lane (1993) argue for the theory of information contagion, assuming that customers are risk-averse and are therefore more likely to purchase something that they have obtained information about. The information stems from both publicly available sources and private sources, i.e. previous purchasers. Since customers are more likely to learn about products that are commonly purchased, the chances are larger that they will purchase these products.

According to the social learning theory, individuals may not only learn from others through verbal interaction but also by merely observing each others (Rogers, 2003). That means that actors can either mimic blindly or adopt particular elements of behaviors that they observe. Such observations can take place either in person or in mass media. One difference, according to Rogers (2003), is that the two sources function well in different phases of the adoption process; mass media is effective for creating knowledge, whereas personal communication works better in later stages of persuasion. Opinion leaders are, according to Rogers (2003), individuals or organizations that pose an informal position as especially influential on the attitudes of the rest of the members within a social system. Once the opinion leaders have adopted an idea, their followers in the proximity begin to adopt. Networks are the structures in which opinion leaders and other individuals interact with each other, as well as where social learning takes place Rogers (2003). An individual's network kinships are, therefore, an important determinant of whether adoption will occur.

## 3.3 Factors Related to the Innovation

Finally, some factors are more related to the innovation itself than the adopting organization or the environment of the adopting organization. Previous studies on diffusion of innovations point out that the innovation itself, and its corresponding attributes, should be considered for predicting the rate of adoption. Rogers (2003) presents a general classification scheme over the attributes of innovation that affect adoption. That is a classification scheme that, for example, Bagozzi and Lee (1999) and Frambach (1993) largely adheres to. Even though the concept of an innovation's attributes may lead one's thoughts to the inherent, physical characteristics of an innovation, that is not what Rogers (2003) refers to. Instead, he has a rather subjective approach, arguing that it is the receiver's perception, not an expert's judgment, that matters.

Rogers (2003) claim that the characteristics, as perceived by the individual, are part of the explanation of the rate of adoption of an innovation. Between 49 and 87% of the variance in the rate of individual adoption is claimed to be explained by the perceptions of five attributes of innovations and also for adoption of innovations among organizations, these five attributes explain most of the variance according to Rogers (2003).
Among what Rogers refers to as the five perceived attributes of innovation there are relative advantage, compatibility, trialability, and observability, that positively affect the rate of adoption, whereas complexity affects the rate negatively. These five attributes are widely used in the literature of diffusion of innovations (Bagozzi and Lee, 1999; Frambach, 1993). Since it is the individual perception of the attributes that matters, as Rogers (2003) argues, it is up to the individual to assess the value of the innovation. Therefore, Talke and Hultink (2010) argue that the customer faces an uncertainty of the expected benefits and the usage options of the innovation. When the adopting unit is an organization, the adoption is affected by the radicalness (Rogers, 2003) and whether the innovation is a product or a process innovation, below labeled as the degree of process-orientation.

### 3.3.1 Relative Advantage

Relative advantage is defined by Rogers (2003) as "the degree to which an innovation is perceived better than the idea it supersedes", and has more to do with the perception of the individual than the objective advantages. Economic aspects of relative advantage have also been shown to have an effect on the rate of diffusion in other research (Kamakura and Balasubramanian, 1988; Jain and Rao, 1989; Ramirez et al., 2014). Ramirez et al. (2014) also show that an increased brand value as a consequence of the adoption can inflate the perceived value of the innovation. According to Rogers (2003), relative advantage is, together with compatibility, the most important innovation attribute. The importance of relative advantage is consistent with Trommsdorff and Steinhoff (2013), who state that the most important factor for success of an innovation at the market is the competitive innovation advantage, meaning the performance delivered by the innovation that beats competition in the perspective of the target customers and is hard to catch up with for other suppliers.

Vowles et al. (2011) tested "Significant increase in benefits" as a part of the perceived characteristics of the innovation, and partially confirmed that an increase in benefits indeed positively impacts product success. The same study shows that early adopters perceive the increase in benefits as higher than do the early majority or late majority among adopters. The factors that have importance during the early stage of the product life cycle are different from the factors later during the lifecycle (Vowles et al., 2011; Montoya-Weiss and Cantalone 1994).

Innovations that are preventive are claimed by Rogers (2003) to have a slower rate of adoption. Preventive innovations are, in contrast to incremental innovations, such innovations that are adopted in order to prevent an unwanted future consequence from happening. It is more difficult for adopters, in general, to perceive the relative advantage, because the benefits are delayed in time. Unless the relative advantage of the preventive innovation is promoted effectively to facilitate the adoption, it is likely to be adopted with a lower rate.

### 3.3.2 Observability

The definition by Rogers (2003) of observability, as one of the innovation attributes, is "The degree to which the results of an innovation are visible to others". This observability of an

innovation is positively related to the rate of adoption. Often, the innovation includes both a so-called hardware component (the physical object) and a software component, which is usually not as observable to others because it can be more ambiguous. One consequence is that when the software content is big compared to the hardware content, the rate of adoption is lower (Rogers, 2003).

### 3.3.3 Trialability

Trialability refers to "the degree to which an innovation may be experimented on a limited basis" (Rogers, 2003). When a new technology can be tried on an installment base before investing in a full-scale deployment, the uncertainty is reduced for adopting individuals who can "give meaning to an innovation under one's own conditions" (Rogers, 2003). Therefore, the rate of adoption tends to be higher than when the technology is indivisible, especially for early adopters who cannot observe results for peers who have already adopted the technology (Rogers, 2003).

### 3.3.4 Complexity

One innovation attribute that Rogers (2003) consider as reducing the rate of adoption is called complexity. Complexity is referred to as how difficult and complex adopters perceive that an innovation is to understand and use. The importance of this attribute is confirmed by Ramirez et al. (2014). Their respondents were suffering from a lack of "ease of use" in two different ways. Firstly, finding and accessing the products was perceived as problematic. Secondly, implementation of the products required new skills or extra after sales support by the supplier.

The perception of complexity may vary widely between different adopters, which Rogers (2003) illustrates with an example from the inception of the personal computers. In the early 1980s, the first adopters of the personal computers were hobbyists that were interested in technology gadgets. Among these people, many were engineers with previous experience from mainframe computers. They did not find the computer as complex to understand and use, however, others with less experience had difficulties. The complexity of the early home computers did, according to Rogers (2003), impede the rate of adoption significantly.

### 3.3.5 Compatibility

An innovation that does not clash with adopters' current values, experiences, and needs, is to be considered as compatible with adopters (Rogers, 2003). Innovations that are perceived as more familiar by its adopters, will experience a higher rate of adoption. Rogers (2003) suggest that there are three instances of compatibility issues. Firstly, there may be incompatibility issues in regards to people's values and beliefs. An example that is brought up by Rogers (2003) is when new variations of rice that would increase the yields for farmers were introduced in the Philippines in the 1960s. Despite the dramatic productivity gains of the new variety, it did not become an immediate success because it did not match the taste of the traditional varieties. Secondly, an innovation should be compatible with previously introduced ideas. Since one's previous experiences and ideas are used to understand new phenomena, it is crucial that what is new does not deviate too much. Lastly, an innovation ought to be compatible with the needs of potential adopters. A good match between the innovation and the potential adopter's perceived need increases the rate of diffusion. Though, Rogers (2003) notes that adopters may need certain innovations that they are not aware of.

### 3.3.6 Radicalness

Rogers (2003) describes that the radicalness of an innovation in several ways can be a barrier to adoption. A radical innovation refers to the condition that a major change in how a task is carried out. The radicalness of an innovation can be measured by the amount of new knowledge that is required in order to adopt the innovation. The higher the degree of radicalness, the more uncertainty it creates and therefore the more difficult the implementation becomes, and sometimes also the decision process likewise. The process for adopting a radical innovation may be unstructured (Vowels et al. 2011).

### 3.3.7 Process-Orientation

In a study of 101 commercial banks in the USA, it was noted that product innovations were adopted at a higher rate and higher speed than process innovations (Damanpour and Gopalakrishnan, 2001). Some of this effect may be explained by the fact that product innovations are perceived by adopting organizations to have higher relative advantage and observability than process innovations (Damanpour and Gopalakrishnan, 2001).

In addition, product innovations are more easily imitated by other adopters because they are industry-specific rather than organization-specific, which contrasts them with process innovations (Damanpour and Gopalakrishnan, 2001). Since process innovations are more organization-specific, they will have to be adapted to the culture and structure of the adopting organization, which makes them more difficult to imitate (Damanpour, 1996).

## 3.4 Summary of Previous Research

A conceptual framework for the factors that affect adoption of AVs has been developed with three main groups of factors: Factors within the adopting organization, factors in the environment of the adopting organization, and factors related to the innovation. The three groups of factors are broken down and elaborated on based on the general phenomenon of adoption of an innovation. The structure of that framework draws on the framework for factors that affect adoption of innovations in general by Vowles et al. (2011) and adds input from other research on adoption and on demonstration projects.

The framework that has been elaborated from previous research is of a general character and may be used for studying different kinds of innovations, however, specific factors need to be considered for explaining the adoption of a certain innovation (Ruppel and Howard, 1998). In order to understand the adoption of AVs in Sweden, a mapping needs to be made of what factors affect adoption of AVs in Sweden, and how they affect adoption. In particular, since there is not a lot of research about what affects the adoption of AVs, the framework is broad in order not to limit the empirical search for the most significant factors. In addition, previous research does not provide any structured view of what affects adoption that is performed by networks of organizations, starting with demonstration projects. Thus, a study of adoption in this context could contribute to exemplify how specific factors can influence adoption for an innovation.

# 4. Methodology

In the following chapter it is described how the research was performed. That includes a description of the process, how empirical data was sampled and collected, how data was analyzed, and ultimately reflections on the quality of the findings from the study.

## 4.1 Research Process and Design

This master's thesis was done in close collaboration with RISE in Gothenburg. Before the start of the master's thesis project, RISE had already initiated a demonstration project of AVs that, however, not yet had gone live. This demonstration project was coordinated by RISE, but several other organizations were project partners.

Initially, discussions were held together with both the representatives from RISE and with the university tutor, how to design the thesis in a way that is academically rigorous, and yet valuable for RISE. In parallel, a literature overview was initiated to stimulate the discussions with both parties.

Once the subject of the study was set, a more extensive literature study was performed, searching for a suitable framework. In order to understand what factors the potential adopters perceive are affecting their adoption of AVs, the literature on diffusion and adoption of innovations was studied. Different streams of research provided different perspectives on the topic. The different complementing perspectives provided with their respective explanatory factors for determining diffusion of innovations. However, no single framework was considered exhaustive. Therefore, the influencing factors, identified from previous literature, were in turn synthesized into a larger framework. The aim was to map out possible factors affecting the ongoing adoption of AVs in Sweden, that could guide towards what questions to use throughout the interviews.

The theoretical framework did not aim to exclude alternative factors explaining adoption that were not found in the literature. Since the body of literature on diffusion of AVs is relatively scarce, the theoretical framework is consciously constructed in a rather general character, not meant to be specific to AVs. On the contrary, the existing knowledge of adoption originates from a range of studies of a much wider population than only AVs. However, the framework is applied to the specific situation of diffusion of AVs in Sweden. Consequently, the result of the study is equally specific.

There are three conditions that Yin (2014) sets up for whether a case study is a suitable research method to use. Firstly, the research questions that are to be answered should be of an explanatory or exploratory character. Indeed that applies to this study since the question asks for exploration of factors that potential adopters perceive to be influencing them. Secondly, case study research may be a viable method when the study object cannot be manipulated effectively, and isolation of variables being studied is difficult. It is arguably hard for us, as researchers in this study, to influence the decisions taken by the studied organizations. Moreover, the decision-making process is in many cases a longer period of time than the time scope of this master's thesis. Isolation of factors affecting adoption is difficult because the potential adopters make decisions influenced by a set of factors and cannot be studied while altering one factor separately. Lastly, Yin (2014) argues that case studies are suitable while

the event of interest is contemporary, not historical. That does, once again, speak for the choice of using a case study design in this thesis.

Moreover, Yin (2014) states that it is desirable to do a case study when the specific real-world conditions are thought to be of significant importance for the topic. As (Ruppel and Howard, 1998) argues, factors influencing the rate of adoption differ between different kinds of innovations, which in turn motivates a case study on the adoption of AVs.

## 4.2 Data Sampling and Acquisition

Four types of primary data sources have been used for the empirical study:

- Formal in-depth interviews with adopters.
- Observations from workshops arranged by RISE for authorities and adopters.
- Informal conversations with RISE, Autonomous Mobility and Bestmile.
- Formal in-depth interviews with RISE and Bestmile.

### 4.2.1 Formal In-depth Interviews with Adopters

Since the study aims to answer how adopters perceive the factors, primary data was collected through interviews with potential adopters. The sample of interviewees was worked out as a combination of what Easterby-Smith et al. (2012) refer to as convenience sampling and snowball sampling. Convenience sampling is a design principle that is based on ease of access to the sample. Snowball sampling, on the other hand, is a continuation of another sample, in which for example interviewees in the first sample refer to other relevant interviewees.

The major part of the interviews was conducted with contacts and partners to RISE, and can, therefore, be considered as convenience sampling. There have been two kinds of convenience sampling. Firstly, the team working with AVs at RISE helped us through reaching out to potential interviewees, and secondly, we have talked to relevant people on workshops and meetings. This was a suitable sample method because RISE had contacts that had relatively good knowledge about the innovation in question. Therefore, these interviewees could provide insight to the study. Simultaneously, snowball sampling was used. Since the individuals who were interviewed knew other people within their respective organizations that were knowledgeable in the area, we got the chance to meet them as well.

The kind of organizations that were interviewed were potential adopters of the technology. As indicated by Löfgren and his team at RISE, there are several roles that are needed, and sometimes several organizations collaborate by taking one role each, in order for an adoption to take place. As a consequence, representatives from different kinds of organizations were interviewed.

The interviews were conducted with one to three respondents at the time, depending on the availability of the persons at the company of interest. Meanwhile one of us was asking the main part of the questions, the other author was taking notes and helping to ensure that the areas of questions in the interview guide had been answered. Since the study intends both to evaluate the factors affecting adoption in the theoretical framework, and to explore eventual new factors, a semi-structured interview design was chosen. An interview guide was elaborated from the theoretical framework, but the jargon of diffusion theory was translated

for making it easier to understand for non-experts. The interview guide functioned as a starting point for the interview with specified topics of interest, but many times the interview deviated with numerous follow-up questions in order to get clarifying answers. We also allowed the interviews to drift slightly, which gave the interviewees the chance to bring up the topics that they found most interesting and relevant, which, in turn, gave us the possibility to explore new factors influencing diffusion.

### 4.2.2 Observations from Workshops

RISE arranged four workshops for participants from adopting organizations, potentially adopting organizations and authorities. During the workshops, we participated actively in discussions and took notes of what participants said and how they behaved and reacted during the discussions. During one of the workshops, participants were invited to walk along the route at the campus of Chalmers at Johanneberg, as part of the S3-project. The content of the discussions and reactions from participants were observed in order to understand the viewpoints of the participating organizations.

### 4.2.3 Informal Conversations with RISE and Autonomous Mobility

In order to make the questions in the interview guide more precise and concrete, we had informal conversations and discussions with employees at RISE and the Danish AV operator Autonomous Mobility. Thereby we got a deeper understanding of the technology and potentially important issues. As a part of these discussions, we held a three hours long workshop with employees at RISE to discuss what factors have already been observed or were likely to have importance for adoption.

### 4.2.4 Formal In-depth Interviews with RISE and Bestmile

One interview of one hour was conducted with Kent-Eric Lång, former project manager of S3 at RISE. The purpose of this interview was to get an understanding of how the project started, which actors have hesitated to adopt the AVs, and what the reasons for their hesitancy have been.

One telephone interview was held for about 90 minutes with Maud Simon, business developer at Bestmile in Switzerland. This provided insight into what factors have had importance for adopters in Switzerland and in France. Bestmile produces a software platform that is used for monitoring and controlling AVs similar to the ones in the Swedish demonstration projects. For instance, Simon explained how private and public organizations think differently in regards to demonstration projects of AVs. This guided the further sampling of new interviews and led to adjustments of questions in the interview guide.

## 4.3 Overview of Cases

In this section, eight organizations presented that are on different stages of the continuum of adoption of AVs. All of them are in contact with RISE due to that they are interested in adopting the technology, and they have all been identified by RISE as relevant potential adopters. One to three people from each organization have been interviewed and within their respective organizations, they are typically responsible for sustainability they typically hold positions as responsible for sustainability and development areas. An overview of the interviewees is found at the end of this section.

Several of the interviewed organizations are partners of the demonstration project S3 (Shared Shuttle Service) is a demonstration project which is lead by Löfgren and his team at RISE. In the project, the plan is to run an AV on the campus of Chalmers at Johanneberg and two AVs running at Lindholmen during a few weeks of time. Due to the current regulatory situation in Sweden, all AVs need to be conveyed by a certified bus driver. The AVs used during the S3 project will run autonomously, but a bus driver will always be on board, ready to take control of the vehicle when needed.

The endeavor that RISE is doing for accelerating the adoption of the AVs incorporates a model for financing the vehicles. Due to its graphical shape of a heart, they call this financial model for "the heart model". The model builds on the idea that real estate developers would be able to exploit their property to a larger degree, given that they are not required to build as many parking lots. In exchange for the relieved parking requirement, they would need to deposit a predefined amount of financial value to a mobility fund. In turn, the mobility fund helps financing other kinds of mobility solutions than car parking, for instance, AVs. In its communication with potential adopters, RISE does to a large extent, bundle the idea of introducing the AVs with the heart model, although not excluding the possibility to work with different financial models.

| **Name of organization** | **Type of organization** | **Public or Private** | **Stage of adoption** | **Name of interviewee(s)** | **Interviewees' function** | **Length of interview(s)** |
|---|---|---|---|---|---|---|
| Härryda Municipality | Municipality | Public | The current commitment is working time for a pre-study plus one demonstration day. Is part of S3. | Frida Barrett | International Coordinator | 1,5 h + 0,5 h (follow-up interview with Barrett) |
| | | | | Fredrik Olsson | Industry and commerce manager (manager to Barrett) | |
| Förvaltnings AB Framtiden | Housing company, by the municipality of Gothenburg | Public | Establishing the topic in the organization. Is part of S3. | Ulf Östermark | Head of Research and Development | 1,5 h |
| Chalmers University of Technology | University in Gothenburg | Private | Has committed to a test of AVs running for several weeks on campus. Is part of S3. | Alf-Erik Almstedt | Professor of multiphase flow and program director of Five Star Campus | 1,5 h |
| Chalmersfastigheter AB | Real estate company, subsidiary to Chalmers University of Technology | Private | Has committed to a test of AVs running for several weeks on campus. Is part of S3. | Adam Vernhamn | Account manager | 1h |
| | | | | Charlotte Stening | Business and sustainability manager | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Åsa Östlund | Strategic real estate developer | |
| Umeå Parkerings AB | Parking company, subsidiary to Umeå Municipality | Public | Establishing the topic in the organization | Curt Jonsson | Business developer | 2 h |
| Varberg Municipality | Municipality | Public | Establishing the topic in the organization. Pre-study has started. | Jonas da Silva | Head of strategic development | 1,5 h + 0,5 h (follow-up interview) |
| Älvstranden Utveckling AB | Real estate developer, subsidiary to the municipality of Gothenburg | Public | Have made a commitment for the campus Lindholmen demonstration project. Is part of S3. | Åsa Svensson | Sustainability strategist | 1 h |
| | | | | Christine Olofsson | Sustainability manager | 1 h |
| The Furniture Company | Retail | Private | Prestudy for demonstration project | Anonymous | Sustainable transports manager | 0,5 h |

*Table 2. Overview of cases*

### 4.3.1 Chalmers University of Technology

Chalmers University of Technology hereinafter referred to as Chalmers, is one of the major technical universities in Sweden with two campuses located in Gothenburg. The interviewee from Chalmers was Alf-Erik Almstedt, professor of multiphase flow. Among other involvements, he is the strategic program leader of the Five Star Campus Program, which is an ongoing campus developing program aiming to demonstrate research and technology at the campus areas. The projects in the program should meet the following five criteria; openness, fun, ecologically sustainable, experimental and attractive. An exciting and attractive campus, Almstedt argues, may raise the recognition of Chalmers, which helps to climb in the university rankings, as well as to attract future talented students and employees. Participating in the S3 project by running AVs at the campus is one project that is intended to make the campus more attractive.

The AVs will also fill an intracampus transportation need, especially on rainy days, Almstedt suggests. Another motive for using the vehicle at Chalmers is to access data generated for the vehicle that can be used for research motives. It is, however, not yet clear what data will be accessed or what kind of research that will be performed related to the vehicle, but this is something that is currently investigated. Chalmers has allocated in-kind for working with a work package with open innovation in the S3 project as a way to conduct research using the data.

### 4.3.2 Chalmersfastigheter AB

Chalmersfastigheter is a subsidiary to Chalmers, which owns and develops real estates in connection to the university. The customer to Chalmersfastigheter is mainly its owner Chalmers and thereafter University of Gothenburg, but there are also a few other customers, such private and municipal companies that in some way are connected to the Chalmers. One interview was conducted together with three employees from Chalmersfastigheter. There were Adam Vernhamn (account manager), Charlotte Stening (business and sustainability manager) and Åsa Östlund (strategic real estate developer). Among the interviewees, only Vernhamn is directly involved in the S3 project.

Chalmersfastigheter is facing some challenges related to mobility and parking in the future. At Lindholmen, a district in Gothenburg where one of the Chalmers campuses is located, Chalmersfastigheter owns a multistory car park. There is currently enough parking so that new buildings can be built without the need for extending the number of parking. However, the municipality will tear down the multistory car park. Due to this situation, Chalmersfastigheter wants to work proactively with the mobility issue, and they want to find out how AVs can be a part of this solution.

It is not considered by Chalmersfastigheter to be their responsibility to manage the long-term management of the public infrastructure, including the AVs, neither are they convinced that this technology is a suitable solution. Instead, they think that they should have the role to help to push the technology forward. Since the main customer and majority owner is a university organization, they think that they should support the research by providing a test arena for new technology.

### 4.3.3 Älvstranden Utveckling AB

Älvstranden Utveckling AB, hereinafter referred to as Älvstranden, is a real estate owner and developer, owned by the municipality of Gothenburg, whose mission is to develop the city around the river shore of Göta älv, which floats through the city. Two interviews were held with two different representatives from Älvstranden. The first interview was held with Åsa Svensson who works as a sustainability strategist, and the second was conducted with the sustainability manager Christine Olofsson.

Älvstranden builds neighborhoods in the city of Gothenburg that supposedly are aimed to be more friendly to humans. In such neighborhoods, Olofsson thinks that large conventional vehicles should be restricted because they pollute the air and cause much noise. Instead, she thinks that smaller electrified vehicles are the future, and perhaps AVs could then be a viable alternative. As the city gets denser and Älvstranden builds develops neighborhoods with fewer parking than traditionally, they think that mobility can become an important challenge to work with.

As a partner in the S3 project, Älvstranden hopes to learn about how the AVs function in an urban environment. They would, for instance, like to know how the vehicle interacts with other traffic and how people would use the vehicle. They also perceive that it is important to create opportunities for people to meet, for example potentially at bus stops and on AVs. Moreover, they are interested to explore what the challenges are with the technology.

### 4.3.4 Härryda Municipality

Härryda Municipality, hereinafter referred to as Härryda, is a municipality that is located close to Gothenburg. The interviewees from Härryda were Frida Barrett, working as an international coordinator, and Fredrik Olsson, who is an industry and commerce manager at the municipality.

Barrett and Olsson presented a few different potential use cases for the AVs in Härryda. There are plans to radically densify Mölnlycke, the center of the municipality, with much more residential houses. Olsson described that it would be very difficult maintaining the parking ratio, given that the plans for Mölnlycke get materialized. Therefore, the interviewees consider it as necessary for strengthening complementary mobility solutions to personal cars and parking, such as AVs.

There are also other large plans for expansion within the municipality. An entire new town called Landvetter Södra is planned to be built. The vision for the new town is that it will be sustainable, interesting and exciting with new technology and innovation. The interviewees think that the AVs could serve the coming residents of Landvetter södra as a first and last mile solution.

Finally, another user case was pointed out by Barrett and Olsson, which is not related to urban expansion. Close to the center of Mölnlycke, there is a neighborhood called Säteriet that has poor public transportation. The reason is, according to Barrett and Olsson, that the residents of a residential neighborhood located between Säteriet and Mölnlycke have opposed the implementation of bus routes that run through the area. However, the interviewees think that AVs would be received differently and better accepted than conventional buses, which would open up possibilities for an eventual AV bus line to Säteriet.

Currently, Härryda is engaged in the S3 project and they are planning for a demonstration day of the vehicle in an enclosed area during the upcoming year in Mölnlycke. The function of the demonstration day in Mölnlycke will be to showcase the technology for the inhabitants of Härryda and also to test passengers' reactions and acceptance before applying for financing from the municipality for a bigger demonstration project, according to Barrett. An eventual bigger demonstration project would then test the benefits of the AVs when operating in real circumstances.

### 4.3.5 Förvaltnings AB Framtiden

Förvaltnings AB Framtiden, hereinafter referred to as Framtiden, is the largest residential group in Sweden, a subsidiary to the municipality of Gothenburg. The group owns three separate residential companies, all of which are public housing actors. We interviewed Ulf Östermark, who works as Head of Research and Development. Regarding AVs, Östermark has initiated discussions with RISE and has started to talk about it with people within his own organization. Framtiden has three strategic goals; build volumes; build more housing, recondition cheaply, and invest in neighborhoods that are perceived as insecure.

Hjällbo is a suburb in Gothenburg, where Framtiden's possess a large number of residential buildings. Östermark calls the suburb "a development area", which is due to the social problems that are widespread in Hjällbo. Östermark wishes to introduce the AVs in this suburb in order to raise its attraction and give the area a chance for positive publicity. The

vehicles may also fill a transportation need within the area, as well as giving the residents a chance to get a first low skill job as “safety hosts” at the vehicles.

As one of Framtiden’s strategic goals is to build more housing, it means that some neighborhoods are going to be denser than they are today. As a consequence, maintaining the current parking standard will be challenging. Östermark is therefore interested in how AVs can lessen the dependency on personal cars and parking lots, and exploit more land for housing.

### 4.3.6 Umeå Parkerings AB

Umeå Parkerings AB, hereinafter referred to as UPAB, is a public parking company, a subsidiary to the municipality of Umeå in Sweden. We got the chance to talk with Curt Jonsson, who holds the position as business developer at UPAB. As such, he is responsible for larger clients and prepares his organization for the changing future needs. Earlier, they could meet the increased demand for parking lots by simply building more parking lots and garages. However, since they are planning to build 15 000 apartments in Umeå, and the infrastructure of the city will be replanned accordingly. According to Jonsson, it is unlikely that the same number of parking lots will decrease in relation to the number of inhabitants. It is, therefore, essential to plan for how to solve the mobility issue in other ways than building parking lots. Then AVs, together with a multitude of other solutions, can play a role for maintained mobility opportunities in Umeå.

In the short term, Jonsson thinks that AVs can be useful for linking the different university buildings with the hospital and the surrounding neighborhoods. It is already a challenging situation due to a large number of people that are circulating in those areas, and it will be still more challenging in the future, due to exploitation in the area.

### 4.3.7 Varberg Municipality

Varberg Municipality, hereinafter referred to as Varberg, is a middle-sized Swedish town. The interview was held with Jonas da Silva, head of strategic development in Varberg. He has initiated discussions with RISE and affected parties from the municipality about setting up a demo. Though, these discussions have not come far, but a pre-study on AVs is planned to be performed in the near future.

There were a few different use cases that da Silva considers for the AVs. The town has a considerable amount of commuters working in nearby cities, but also commuters that come to Varberg, and there is potential for improving the transportation to and from the train station of the town.

Varberg has a low housing vacancy in the central parts of the town. Meanwhile, they have needed to arrange housing for recent immigrants, which is why they have been located in the outskirts of the town where the public transportation is poor. There, da Silva argues, the AVs may be useful.

There is a new major residential district that will be built in Varberg, in an area that currently is occupied by a harbor. The municipality expects that the area will be highly attractive since it is located by the sea, yet close to the central parts of the town. They are eager to increase the value area that will be built. Therefore, the municipality considers options for how to

increase the exploitation of the district, through a reduced number of parking lots, while maintaining a good mobility.

Lastly, Varberg is a popular summer destination, with beaches that attract many people. The nearly doubles its number of residents in the middle of the summer. However, there are a few kilometers of distance between the central parts of Varberg and its most popular beach, and da Silva suggests that AVs may diminish this threshold between the beach and the downtown.

### 4.3.8 The Furniture Company

The Furniture Company (an anonymized company) is a Swedish-founded retailer of furniture with large stores in the outskirts of cities all over the world. For the moment, the Furniture Company is considering to set up a demonstration project with AVs in connection to one of their stores, in Kållered, outside of Gothenburg. Therefore, they are in discussions with RISE, who perhaps will be a project partner with the Furniture Company. Much of the practical, project specific questions are dealt with by the local representatives in Kållered. People from the Furniture Company headquarters, with a rather global perspective on the business, are also involved in the project. One of them is a sustainable passenger transports manager who was interviewed for the purpose of this study.

Most of the Furniture Company stores are located outside of the city centers, close to larger roads. This makes the stores easily accessible by car, but sometimes more difficult to reach with public transportation. At some sites, the Furniture Company has arranged bus lines to improve the possibility to reach the stores without a car. Those bus lines are in some cases operated by the Furniture Company themselves, and in other cases, they have contracted an external operator. The buses that currently are in use are conventional diesel-engined vehicles that are manually maneuvered. The sustainable passenger transports manager and his colleagues look for alternatives to the conventional buses that they have today.

Today, there is no bus connecting the store in Kållered with the local train station, which is located approximately one kilometer away. They are doing a pre-study in order to understand whether AVs would constitute a viable solution for improving the mobility around the store. An important aspect of the pre-study is to assess the ratio between capacity and cost. Reduced costs are, moreover, a leading motivating factor for an eventual adoption of AVs. Another motivator is to get positive publicity and improved brand value if they are considered by the general public as being both an innovative and sustainable company.

## 4.4 Data Analysis

Content analysis is a qualitative data analysis approach that allows to both test hypotheses and for building theories (Easterby-Smith et al., 2012). Following this approach, data is analyzed with respect to factors derived from either pre-existing theory or other factors that are identified during the analysis itself. The approach of content analysis fits this study well since the aim is to evaluate a set of factors derived from the previous theory, as well as finding eventual new factors emerging in the data.

Immediately after the interviews had been conducted, we started to discuss how we had understood the answers that the respondent had given in order to identify any potential misunderstanding. When starting to analyze the data, coding was used. The first type of

coding being used was what Miles et al. (2014) refer to as provisional coding. The starting point of provisional coding is a list of codes generated from preparatory investigations, which in this case was the theoretical framework. However, as the analysis was conducted we got new insights, and as a consequence, new codes were created. The second type of coding that was used is called subcoding (Miles et al., 2014). When differences between the statements within the provisional codes were discovered, we started using subcoding in order to highlight the nuances in a better way.

## 4.5 Research Quality

Achieving high quality in qualitative research is according to Easterby-Smith et al. (2015) primarily a matter of transparency and rigor. First of all, the research should be understood in the context of previous studies conducted in the area, which is why Easterby-Smith et al. (2015) state that "a good literature review is the foundation of a good study". In this thesis, a literature review was conducted, and it turned into a theoretical framework that guided the direction of the interviews.

Moreover, Easterby-Smith et al. (2015) point out that qualitative studies may not live up to some strict quality standards that often are considered as requirements in quantitative studies. Such standards are objectivity, generalizability, and replicability. Instead, the value of qualitative studies lies primarily in their uniqueness. Whereas the amount of literature on adoption of innovations is extensive, the thesis contributes with a unique perspective on the AV industry by closely examining the factors influencing adoption, as perceived by the adopters.

Regarding the sampling, all the respondents had to be provided by RISE. There is a risk of missing out data about organizations that are potential adopters with no current contact with RISE because RISE may not be aware of some of the organizations that are potential adopters. However, the relatively low number of organizations that are currently considered to be adopters, is a consequence of the fact that the market is just emerging.

One could argue that the quality of this study would benefit by adding respondents that were more reluctant to adopting AVs. To some extent, such critique would be fair. That kind of respondents was initially thought to be interviewed, but there were practical problems in finding a well-informed actor that was reluctant to adopt. However, one should keep in mind that the organizations included in the study were at different stages of adoption and with different levels of enthusiasm. In addition, it is possible that some organizations, that currently are considered as partial adopters, eventually change their attitudes if a demonstration project turns out badly. The respondents should therefore not be seen as adopters in a static way. Hence, the range of respondents does, in fact, represent a multitude of perspectives.

## 4.6 Definitions

An important concept in this thesis is the adoption of an innovation. For the purpose of this study, adopters are defined as organizations that have invested or decided to invest any financial or in-kind resources in the technology of AVs, or invests working time to investigate the possibility further. Most of the above mentioned previous research on demonstration projects investigate their effect on further adoption but does not view the demonstration projects themselves as part of the adoption process. However, as pointed out,

Rogers (2003) describes an innovation process where the commitment of resources is part of the adoption of an innovation. Since different adopters may invest different amounts of resources, adoption is arguably defined on a continuum. An adopter that invests more resources into a project is considered as having a higher degree of adoption. Long-term adoption of AVs that are not on a project basis is referred to as full adoption, whereas all steps taken towards full adoption is called partial adoption.

Three other notions used in this thesis are “outcome of adoption”, “speed of adoption” and “rate of adoption”. With outcome of adoption, we denote the extent to which the AVs are adopted, because according to Rogers (2003) an adopter may start the process for adopting the innovation but then discontinues the adoption afterward. Damanpour and Gopalakrishnan (2001) define the speed of adoption as “the speed with which the organization adopts an innovation after its first introduction elsewhere, often in the industry”. Whereas the speed of adoption considers an individual organization, the rate of adoption looks at a group of individuals. It is defined by Rogers (2003) as “the relative speed with which an innovation is adopted by members of a social system”, and the rate is measured as the number of adoptions per time unit.

# 5. Results

This chapter will present the findings from the interviews and the workshops. All respondents consistently mentioned several reasons for being interested in adopting the AV technology. There was never one single motivating factor. There are five broad patterns that were distinguished, that represent areas of factors:

- Level of perceived utility
- Ambiguity in working process
- Dependency on other actors
- Delay of demand, and
- Potential of knowledge and networks built through demonstration projects

## 5.1 Level of Perceived Utility

The interviewed organizations motivate both their adoption so far, and their potential to pursue further adoption, with their perceived utility of the innovation. The utility is expressed in a variety of ways, which have been grouped as mobility, brand value, cost reduction, fit with values and goals, and vehicle and supplier characteristics.

### 5.1.1 Mobility

In all the cases that were studied, the respondents perceived a potential value in improving the mobility through using the AVs. Improved mobility is usually a top argument but the actual benefit is perceived as unclear among potential adopters. A typical mobility issue that adopters are keen to solve with the AVs is to replace the need for parking in city environments with a substitute, that becomes a natural part of how people move and access areas where they live or work. In several cases, the context in which the organizations want to incorporate the AVs is an expansion of residential or urban districts, which is expected to increase the demand for transportation. The expected improved mobility in such cases helps to motivate to adopt through participation in demonstration projects.

Jonsson from UPAB considers that there are mobility challenges related to the future expansion of the city of Umeå, and he describes that AVs could be part of the solution:

“We are facing a development of Umeå city with constructions of roughly 15000 apartments. As a consequence, we need to figure out how to handle the mobility. If we handle it in a traditional way, we get the kinds of neighborhoods that were built in the 60’s and 70’s in which everybody needed their own car. [...] I see that AVs would play a direct role in decreasing the need for cars.”

The way that Östlund describes the urgency for them to solve mobility issues at their land at Lindholmen indicates that the demonstration project there is interesting for them if it can lead to further adoption in a way that satisfies their need for mobility:

“We are forced to solve the mobility issue. We have a pistol to our heads - we have the pressure on us.”

Restrictions to build more parking, and commitment to using other solutions can motivate new mobility solutions such as AVs, which is described by Chalmersfastigheter. Several other mobility measures have already been adopted by Chalmersfastigheter together with other key stakeholders at campus Johanneberg in order to address the need for mobility, such as a new bus line with an electric bus between campus Lindholmen and campus Johanneberg. As they describe the situation, there are needs for mobility for each of the campuses because the parking opportunities will not be enough in the near future. At campus Johanneberg a decision by authorities to restrict the construction of any more parking in the vicinity of campus made decisions easier and more efficient when adopting mobility solutions, which is described by Östlund:

"I think we beat our chests and are proud of the "Grön Resplan". [...] It states that Chalmers and Akademiska Hus have committed not to build any more parking spaces. [...] This [Grön Resplan] has made it easier to make decisions. For example, the walk [and cycle path] would not have been agreed upon that efficiently and fast without the Grön Resplan. They had routines for making decisions in accordance with this decision."

Chalmersfastigheter thus has a commitment to help solve or to facilitate solutions to mobility issues and it is possible that it facilitated the decision to adopt AVs as well because AVs are possibly a part of the solution and in accordance with the decision. They think that in general, they need to have a mobility solution for Lindholmen that possibly includes AVs. In order to plan for the parking, they say that they need to take into account the development trajectory of AVs.

Organizations express different views depending on whether the demonstration project would be in a new district or an existing. Several of the potential demonstration projects concern areas where people will move in as new residential buildings will be built. It is noted that Jonsson has a belief that the difficulty of changing the behaviors of inhabitants in districts makes a difference in the mobility benefits between introducing AVs instead of providing parking spaces in a new district versus an existing district in Umeå:

"It [replacing the parking spaces with AVs] is quite a big change. It is about breaking and changing people's behaviors. If we would build a network of MaaS [mobility-as-a-service] where autonomous buses are a part of that traffic, we have the best opportunities in the new residential areas that are built. Because if you do that in the existing residential areas, it will not have an as significant penetrating effect. It is really difficult to break people's habits. Then it is easier to build where it's new [a new residential area] and say that these are the conditions to move in. Then people understand. And still, they have access to cars. That is one of the issues - to guarantee that there are vehicles when it's needed."

The quote represents similar views that for example interviewees representing Härryda and Varberg have. Also, some potential areas for AVs in the Älvstranden case are expanding as more residences are built and people are moving in during the next decades.

Jonsson from UPAB thinks that the mobility benefits of the AVs are best reaped together with other means of transportation that would complement each other:

"I believe that what will work in the future is some kind of mobility-as-a-service solution, where citizens subscribe to mobility. For example, if you take a bike or electric bike to IKEA, you should be able to take an AV home with your products."

Though, there is uncertainty about the actual value of increasing the mobility. For example, da Silva explains how he perceives this value:

“The value for accessibility as a consequence of better connections between the city center and the rural areas, and the interest for traveling with public transportation and autonomous buses needs to be quantified. It would be good to get help from somebody who has that competence, and therefore it is good if RISE investigates that for example.”

### 5.1.2 Brand Value

Almost all of the interviewed organizations have mentioned that they expect the AVs would have the potential to influence their brand image. The overwhelming majority of the interviewees reason that it would give positive publicity to their respective organizations. One interviewee, Svensson from Älvstranden, argues that participation in a demonstration project incurs a publicity risk:

“I think that it is important that the general public can see the benefits of the project and that it is perceived to be positive. At Lindholmen there are challenges with finding a route that is attracting many travellers. [...] The risk is that there will be negative media publicity, that people will say ‘now they are doing a fiasko project for car drivers, there are almost no passengers’. [...] I think it is important that the general public have a positive view when the city engages in innovation projects, and that money is not being wasted for nothing.”

Other interviewees have a more optimistic view of what the publicity may lead to. The sustainable passenger transports manager at the Furniture Company reasons that investing in AVs would strengthen their image as an innovative company, which in turn would improve their brand:

“Everything that is innovative is exciting. Tesla has a strong brand because they are innovative. There are not many retailers that have AVs. It is just like any other kind of marketing when building a brand, you want to be considered as innovative and forward.”

Both Östermark from Framtiden and Almstedt from Chalmers, share a common idea on how branding derived from an introduction of AVs could be important to their organizations. In the case of Framtiden, Östermark thinks that the publicity would not only give positive publicity to Framtiden and its subsidiary housing companies. He thinks that the publicity would also benefit the residents of the neighbourhoods that he call “development areas” if the AVs were introduced there, because the status of the neighbourhoods would be raised:

“We should build something hi-tech there, something that is shown on the news and that is written about in the local newspaper and gets attention in social media. [...] It [the AVs] could become a landmark. [...] It would get attention from people within the neighbourhood, but also something to tell about and to show people outside the neighbourhood, an attraction for visiting groups. [...] It would give the people in the neighbourhood pride if visitors are coming there to watch a new and modern solution [the AVs].”

Similarly, Almstedt reasons that the AVs would give positive publicity, that could contribute to raising the status and ranking of the university. A higher ranking does in turn favor the

students through a higher status, just as in the case of the residents of the development neighbourhoods that Framtiden cares about. Almstedt expresses it in the following way:

“It is a branding thing, it will strengthen the brand if it goes well. For ranking lists [for universities], reputation is one important thing and this can play a role here. [...] In the long term, it [a better reputation] can lead to more applications from prospective students. So it is important that projects like this one is publicly visible. [...] For the reputation, some attributes are important; that there are exciting things going on for example.”

Yet another perspective is brought in by Jonsson at UPAB. According to him, they would not care about the potential of getting positive publicity at his own organization, however, it would probably be very important for the municipal politicians to make an adoption decision:

“Politically it [PR as a motive] is very strong. It is super strong. And Umeå is a city that wants to be in the forefront. That is what most want, but we were for example the European Capital of Culture in 2014. There is a strong interest among the leading politicians to put Umeå on the map. [...] But it [PR] is not the reason that we [UPAB] are engaged, but in order to get acceptance [from the municipality] it is utterly important.”

da Silva shares the view with Jonsson, that the politicians of Varberg would care about the branding value. He explains that in order to make a decision whether to adopt the AVs, they need information about several parameters, whereof one is the potential brand value that the AVs may contribute to the municipality. The following quote from da Silva shows how he reasons that branding value also may be compared with other alternatives:

“An application is sent to the municipality. They [the municipal politicians] need information about for example the value that the buses may give for marketing. They would also like to know what it would cost otherwise to get comparable marketing effect with other kinds of marketing activities.”

Almstedt states that it is important that the campus is perceived to be good. He illustrates how an introduction of AVs could be used to raise the positive awareness of the campus:

“The visibility is important, also because it sets the entire campus project [Five Star Campus] on the map and it can contribute with possibilities to start a lot of other projects as well. So, I think that spin-off effects in that way are important for me.”

### 5.1.3 Cost Reduction

For some potential adopters, the cost is a crucial component for whether they will adopt or not. The interviewees provide three different perspectives on what their expectations are for the costs related to the AVs, and how it matters to them in different ways. Firstly, there is future direct costs, which are costs related to lower operational costs, that would be lower due to less personnel costs since AVs are driverless. Secondly, future indirect costs could be reduced if for example certain areas in a city can be exploited more, without having to build underground garages. Lastly, the interviewees discuss the short term costs that are related to set up a demonstration project. Yet others tell that costs are not currently concerned. How the adopters and potential adopters relate to these different perspectives on cost is explained below.

During one workshop, Münter from the AV operator Autonomous Mobility mentioned that 70 percent of the costs for a conventional bus are incurred by the driver. The same number was mentioned by Svensson from Älvstranden when talking about what the purpose is for them to invest in the AV technology:

"I do not know how large the cost of the driver is for the public transportation, but I heard a number of 70%. That is an enormous share. Then it is a discussion, maybe the first job for many, and integration. If we disregard that, it is a big economic gain, and the possibility for higher frequency on the bus lines."

Both Svensson and Münter arguably speak about costs from a future direct cost perspective, as they are expecting to reduce the operational costs when a driver not is needed. Similarly, da Silva from Varberg hopes to reduce the operational costs as a driver not is needed, but at the same time he hopes that the AVs in an initial phase will get opportunities for low skill jobs as hosts.

Several respondents do not talk about the AVs as a way for reducing the costs in the public transportation system. However, they view the technology as a tool to lessen other indirect costs. That can be expressed in terms of better mobility for more effectively exploiting a new residential area, as is the case for da Silva in Varberg:

"There are going to be 2500 new residences in that area. It is exclusive ground, and that is why we have prioritized to build as many residences as possible. Small autonomous shuttle buses may contribute through giving mobility to the residents, meanwhile the parking norm can be lowered in the area. With fewer parking lots, more residences can be built."

The quote above shows that da Silva considers a business case, weighing costs with potential revenues. When comparing the AVs with conventional buses he emphasizes the advantage of its small size, which in turn would be cheaper in terms of alternative costs when more area can be exploited for housing:

"A performance advantage that is expected of the AVs is that they are smaller, and can therefore run in conditions that larger buses not could handle. That reduces the limitations when building the new district. For example, one can expect a smaller turning radius, which lessens the need of large turnbacks."

Like da Silva, Östermark from Framtiden reasons that there are economic gains to be made through planning parking houses differently in connection with residential areas:

"In order to illustrate my reasoning, let us assume that we could build a parking house with six stories instead of two with three stories. That would be an enormous difference economically. Foundation and planning etcetera. It would be much cheaper with six [stories]. If you then would transport people so that it is acceptable living 700 meters form the parking instead of 400 meters, you would have saved a lot of money."

Moreover, Östermark stresses the importance of getting economic returns from investments in AVs. That could be done by indirect cost reductions through more effective parking solutions, as shown above, or through not needing to pay for safety arrangements:

“Most importantly, there must be a business case. It [the AVs] must save us money through not needing to build other expensive communication solutions. Alternatively, we must believe that the venture with these vehicles can handle more adults in movement, which raises the perception of safety enough so that other more costly measures are not needed. [...] There must be a business case, thereafter comes other values. [...] We are not the social service. We we need five percent return over time in our business.”

The third type of cost perspective is short term costs related to a demonstration project. This is brought up by Almstedt from Chalmers:

“They [the directors of the university] wanted to know about the cost [...] that is required. [...] There are three things that are important for Five Star Campus: To test new solutions, to provide a demonstration arena, and that there are fun things going on at campus. This project [S3] has a cost but it has been assessed to be important enough.”

In the case of Chalmers, although the cost was taken into account, it was apparently not an obstacle for the demonstration project. Similarly, Östermark brings up that it might be costly to in the short term when the vehicle is introduced. He argues that it would be alright, as long as it is fruitful in the long term:

“In an initial phase, it would be alright if it is just a cost. [...] Sure, we can do investments, but in the end, they need to pay off.”

Ultimately, Olsson and Barrett from Härryda describe how they relate to costs and other values:

“I do not think that the cost aspect has been touched upon at all in any discussion. It is not really a matter for the municipality to work with the issue from a standpoint in existing public transportation. I would say that the major parts [advantages of the AVs] is its size. To get frequency. Silence. That it is flexible and not needs to run on normal roads. One can plan in different ways. It reaches places that other buses do not reach.”

Apparently, Olsson and Barrett explicitly say that costs are not considered in the discussions, at least in the phase that they currently are in. This contrasts sharply from what is described above about future reduction in both direct and indirect costs.

The quotes above indicate that both reduced future direct and indirect costs are used as arguments for why AV technology may be viable. Although some say that no costs are considered, it appears to be an explanatory factor for adoption since for example Östermark says that the business case derived from lower indirect costs is the primary reason for adopting the technology. Also short term costs related to a demonstration project are discussed and could deter taking on a demonstration project if they are too high. However, that has not been the case in these interviews.

### 5.1.4 Fit with Values and Goals

Among the interviewed organizations, there has been a tendency that they motivate an eventual adoption with how it would make sense to their organization from the perspective of the organization’s values and goals. These goals are often derived from formal and official

descriptions of what the organization should aim for. Svensson shows an example of this by arguing that the AVs fit the vision of her organization Älvstranden:

"Vision Älvstaden [Vision River City - Älvstranden's vision for the development of Gothenburg] points out what we want to accomplish. There are three natural strategies: embrace the water, connect the city, and reinforce the centre. [...] We want to contribute with a development that is aligned with our vision and strategies. We think that these solutions [AVs and electric buses] can contribute to our districts, but also to the entire city and the region. [...] Small autonomous vehicles can increase the accessibility to good public transport which we consider very positive because the city works for a reduction of the dependence on cars."

As a part of Vision Älvstaden, Olofsson points out some additional aspects that she perceives that the AVs can contribute with:

"Is it possible to create added value for such a bus? [...] We refer to bus stops as meeting points. Is it possible to create some social interaction? [...] What kind of human meetings are created on a bus? Would people talk to the one sitting next to them because it actually is a new bus that they have never ridden before, because it is an experience in itself?"

Next, Östermark gives another example of how Framtiden's goals could be met by investing in the AV technology. In this case, not all goals are met perfectly. However, due to the potentially large gains in relation to some of the goals, and that the size of investment would be relatively small for Framtiden, Östermark thinks it is interesting:

"We have a very clear mission right now. It is to build volume, recondition cheaply, and to do social investments in the outskirts of the city where the insecurity is high. [...] This investment [AVs] would be so small, yet long-term for us, so that I have sneaked it in to our portfolio although it is not obviously within our scope. Is it a social investment in the outskirts of the city? - Well, no, but it could meet such values. Is it a cheap reconditioning? - Definitely not. Is it important for being able to build 1400 residences per year? - That could be important."

Östermark expects the vehicles to contribute to integration in two ways. In segregated neighbourhoods, the vehicles can contribute to give jobs and to get positive publicity to the neighbourhoods, which in turn would be appreciated by the residents:

"Meanwhile the vehicle is driverless, there can be a 'safety host' onboard. It could contribute with a meaningful job. [...] It would get attention from people within the neighbourhood, but also something to tell about and to show people outside the neighbourhood, an attraction for visiting groups. [...] It would give the people in the neighbourhood pride if visitors are coming there to watch a new and modern solution [the AVs]."

The interviewees are reasoning in two distinct ways about the AV technology in relation to their organizational values and goals, which could be referred to as technology push and technology pull. While Östermark's view is an example of what can be considered a solution oriented reasoning, or technology pull, as there are certain challenges that are addressed, there are other interviews, where the alternative way of reasoning has been identified. The interviewees at Chalmersfastigheter express that AVs might be interesting in the future for strengthening the mobility around their campuses. Gradually there will be fewer parking lots

per person close to campus. Therefore they think that they need to drive their own strategy when the municipality is not providing much help, and the AVs could be a part of it. However, they do not think that it solves much of their problems. They are somewhat skeptical to the setup of the S3 project as it would not solve much problems, but they are overall enthusiastic to help pushing the technology forward, as Östlund describes:

"I am somewhat skeptic in the sense that I think that it is good for your health to walk five minutes. [...] I am also questioning whether the buses will be utilized in the S3 project.[...] What drives us is the new technology and the opportunities that it can give in other areas in the future. You contribute through testing and evaluating. Through experiences, you can participate in pushing the technology forward."

The approach that Chalmersfastigheter has to AVs, of pushing the technology forward, is arguably in line with their strategy. In the interview, they told that they should work with innovation and provide opportunities for Chalmers to carry on its research activities, but it is not specified what problems those innovations should address:

"In our strategic business plan, we have a clear goal to work with, and enable, collaboration and innovation. The way we approach that is to see the campus as a testbed environment. [...] Our mission is to enable Chalmers' mission. Chalmers needs to research, and the campus is a research arena. Then it is up to us as real estate owners to enable that."

### 5.1.5 Vehicle and Supplier Characteristics

There are a number of factors that the potential adopters have brought up in the discussions that do not necessarily reflect the AV technology as such, but that may characterize the currently available models. Some of these factors have anyway been expressed to be important in order for adoption to occur. Some frequently mentioned vehicle characteristics are operating speed, safety and security, noise levels, and environmental impact.

The above mentioned characteristics may, of course, vary between different vehicle models. The vehicle that will be used in the S3 project comes from the manufacturer Navya with the model Arma. However, those characteristics do not vary greatly between the vehicles of what Löfgren classifies as the leading manufacturers in the segment.

Several respondents have raised the concern that the operating speed of the AVs will be too slow. One of them is Svensson at Älvstranden who expressed two worries in relation to this problem. Firstly, she doubts that the vehicles will be widely used due to that the time gains of using them will be very limited on the short distances that they will run in the upcoming demonstration projects:

"Will there be many passengers on the routes? [...] The reason is that the distances are small, and we do not know about the frequency. Now, it is going to drive faster, but initially they talked about 12 km/h. It would almost be faster to walk."

Secondly, Svensson thinks that, as mentioned in above section about brand value for adopters, that the low speed may cause trouble for car drivers if they disturb the flow of traffic.

Another issue concerning the vehicle itself is its safety. In regards to safety, there are also two kinds of concerns that are expressed by the potential adopters: actual safety and passengers' perceived safety and security. Actual safety refers to the vehicle's ability to avoid accidents. Stening at Chalmersfastigheter emphasizes the importance of taking the safety seriously, and she notes the difficulties:

"Safety is very very important, that it actually works when it is driving on campus. There are both pedestrians, cyclists, trucks and buses. There are many obstacles on the streets that you need to make sure that the vehicle can handle. [...] What could stop it [continued adoption] is if an accident occurs."

Not everybody viewed safety as primarily a risk. Almstedt, for example, explained that he expects the safety of the AVs to be even better than the safety of conventional vehicles, although there may occur initial problems:

"I have almost the feeling that this [AVs] on average is safer than having human drivers. Because it does not come up with stupidities and does not break the rules. But there could always be growing pains."

In addition to actual safety performance of the vehicle, some of the interviewees also brought up the issue of passengers' perceived safety. A first type of perceived safety was noted by da Silva at Varberg, who thinks that a major concern among the citizens and eventual passengers would be the safety of the vehicle when running on public roads with other traffic. Barrett highlights another perspective of the passengers' perceived safety, namely the perception of safety inside the vehicle, in relation to other passengers inside the vehicle. Although she personally would not be worried riding a bus that does not have a driver controlling the fellow passengers, she thinks that others would be worried:

"What people talk about as a worry, which does not worry me personally, is that people would feel insecure because they are trapped somewhere [in the AV] where nobody has control of what is happening. On the other hand, there are cameras in these buses that monitor what is going on. However, it might not hinder things from happening. [...] That could be something that people worry about."

Although it may not be unique for AVs, there are a number of respondents that raise a couple of the physical characteristics of the vehicle as attractive. In particular it is the vehicle's small size and low noise level that is regarded as interesting. Olsson from Härryda explains why he thinks that an AV may be accepted in a neighbourhood where other buses are not:

"People do not want bus traffic in this dense residential neighbourhood. However, an autonomous electric bus, that is smaller, could be an alternative to try. [...] I think that the size and the noise level makes the difference. Firstly, it would be difficult driving a larger bus in the current infrastructure. It is, of course, also a difference on a small electric silent bus, and large diesel bus."

The matter of electric propulsion is not only seen as an advantage in terms of noise level. It is also stressed as advantageous in the context of environmental impact. When asked about what the aim of investing in AVs would be, Jonsson at UPAB answers among other things that it is to improve the environment. Jonsson argues that the AVs would do so, not only

through reducing the traffic intensity, but also because of their electric driveline would be better for the air quality than conventional diesel engine buses:

“Since it is an electric vehicle that replaces fossil fueled vehicles, it is very positive from an environmental standpoint. It is actually something that Umeå works hard with. The city center is located a bit low, and periodically the air quality is not good.”

The existing suppliers of AVs during the time of this thesis are relatively new and can not be considered as incumbents. Neither is the operator Autonomous Mobility that is contracted for the S3 project an incumbent since S3 is planned to be their first project. Questions were asked about the potential adopters’ eventual concerns, but they didn’t show much worries in regards to the service or vehicle suppliers. Almstedt from Chalmers did, for instance, put it that dealing with new technology implies that one always needs to take into account, and he is experienced in doing that. However, he is not particularly worried about it:

“If you want to do something that is in the forefront, then there are many green actors [inexperienced and new] in all areas, so then you would need to have some sort of mix of intuition and common sense to find out if they [the suppliers] seem serious. [...] We do very thorough assessments before starting a project like this so it is not simple to just start something like this. Trafikverket has been here for example to make sure that everything works correctly. [...] I think that they [Autonomous Mobility, the operator in S3] seem very serious.”

A shortage of suppliers is according to the sustainable passenger transports manager at the Furniture Company primarily a potential cost issue because of less competition, but quality-wise it is not considered an issue:

“If you have got hundreds of companies that can supply a bus, then the price certainly becomes cheaper. But no, I do not see any major problems with it [that the suppliers are new]. It is from case to case. No matter what you do, one need to find a partner that can cooperate.”

## 5.2 Ambiguity in Working Process

Several potential adopters express uncertainty about how to work with AVs and how to work in collaboration with other actors. Despite an interest in participation in demonstration projects, this uncertainty experienced by some adopters seems to hinder or delay adoption. None of the interviewed organizations operate public transportation as a part of their current business, and AVs in particular is something that they lack experience of. Each of the interviewed organizations perceived AVs to be potentially valuable for them, but organizing for usage of AVs requires new collaboration between adopting organizations.

It was apparent during a workshop held by RISE with both partners of the S3 project, as well as Transportstyrelsen [Swedish Transport Agency] and Stadsbyggnadskontoret [the City Planning Office], that they all had different views and perceived uncertainty about how to set the time frame for the S3 demonstration project and which month to launch the demonstration project. The uncertainty consisted of several components. The first part of the workshop revealed that few of the participants were sure about how the financial model would work. Later, during an exercise in which the participants were mapping the actions required for launching the demonstration project of the S3 project, it was clearly difficult for the

participating actors to understand how to coordinate the actions and decisions. They did not completely agree upon in which order different parts of the pre-studies and assessments should take place and what information would be required for making the assessments. The uncertainty also regarded what responsibility each of the authorities would have in the approval process for the details of the project.

Some of the respondents are uncertain about how to finance the operation of the AVs, and whether they would become fully adopted in the long term. Svensson expresses that there are several possible ways to finance the AVs but the solution must be long-term:

"I do not believe in several separate ticket systems, it must be a general solution. On the other hand, if someone wants to finance it so that it is free for the passengers, it might be possible. [...] If the autonomous bus would go from a distant parking it would be possible to include the bus trip in the parking ticket. [...] Of course it [AVs] could be a part, but the public transportation must be long-term. We should not assume that real estate companies want to pay for public transportation. [...]

Härryda is open for several alternative ways of financing the operation, as Barrett describes:

"Payment method [how passengers pay for riding the AVs] is something that we have not thought about yet. We would like to hear from RISE about that. But there are many different alternatives. Maybe it can be included in the tenant fee. Or we could start a business, the housing firm and the municipality, or Västtrafik [the public transport authority] could be involved…"

da Silva at Varberg municipality, who regard the role of the municipality as finding partners and coordinating the demonstration project with them, does not think that their way of working will change much. However, he describes that in their pre-study they try to understand the way of working and find out what other actors can be involved in a demonstration project:

"We would like to understand how to work with it. The actors that would need to collaborate probably include the municipal executive board, the city development office, several entities of the municipality administration, and companies within the EMC [the Center for Energy and Environment] network. On the other hand, it is difficult to say exactly what actors these are going to be. It is very early yet and this is something that we will find out."

A similar description was given by Framtiden, who describe that several questions remain to be answered about how to work with AVs:

"What does it cost? What suppliers are there? Is it a service that should be purchased, or should it be operated in-house? Is it naturally associated with real estate maintenance, or is it purchased? Is it even we that should drive the question, or should an external actor [the local public transport authority] own the question? [...] If there is another actor [operating AVs on their ground], then an easement may be needed. How long should the contract be for such things? [...] Where should the charging stations be located and how are they supplied with electricity? [...] What frequency [on the bus line] is needed?"

This shows that there is an information need regarding how to work with AVs that must be satisfied before organizations can decide to adopt and start working with the AVs. Much of

the information that Varberg and Framtiden need concerns how the practical issues will be handled in the particular case or project.

## 5.3 Dependency on Other Actors

When an organization has the intent to adopt AVs, several external influences are able to negatively affect adoption. Also when an organization makes a decision to adopt, the decision is influenced by the opinion of citizens in the area. For a given organization, other organizations that are needed for a collective adoption, may reject the AVs and thus stop the adoption. Institutions can delay adoption through regulations that constrain the scope for demonstration projects. However, not all external influencers are considered important by adopters, because in some cases adopters only need to have a dialogue with actors. In other words, adopters are depending on other actors to different degrees.

### 5.3.1 Dependency on Other Adopters

The adoption of AVs, even in demonstration projects, is typically not a decision that is made by one adopting organization alone. Instead, several adopters make a collective decision, so the decision by one adopting organization depends on the decision by other adopters. For example, in the S3 project, all participating organizations agreed to invest some amount of money or in-kind resources each, and the actors have different roles and work packages that they are responsible for. In addition, part of the work that adopters perceive that they must do even before initiating a demonstration project is to find out which other actors will support and participate in the demonstration project, which is exemplified by both Varberg and Härryda. Varberg, which is in an early stage of its pre-study that is conducted before making any investments, is lacking insight about which actors they need to collaborate with, but da Silva thinks that needed competence could be acquired through cooperating with other companies:

“I believe that it is important to work together with EMC where there are companies that can contribute with valuable knowledge. [...] It is too early to know if any actors or competencies are lacking, I do not know that. The pre-study will show.”

There are several actors that da Silva consider as useful to cooperate with for Varberg, but he is not sure about what actors are needed or how they could contribute:

“We want to test the way of working. I think we will need to collaborate with the municipal executive board, the urban development office, the municipal administrations and companies in EMC and others. Still, it is difficult to say exactly what actors it will be.”

Similarly, Härryda municipality is also trying to find actors who can be involved and have dialogues with them. Recently, they had their first meeting with Wallenstam that is a real estate company that potentially could have a role as financier. Engaging the real estate companies is not the only way to finance the demonstration project but Härryda sees an opportunity for financing the project and also considers them as some of the most important stakeholders to have a dialogue with. Also for the demonstration day, Härryda thinks it is important to include those stakeholders. They want to involve such companies in an early phase and hope that they will remain in further adoption. Barrett expresses it in the following way:

“This day when we will show this bus [AV], test it, we also want to involve the real estate companies. For example Wallenstam [a real estate company] who constructs a lot here in Mölnlycke, because they are also interested in this, and in finding new solutions, and as a complement to future constructions. [...] They [Wallenstam] have just been asked, so this is new, but if we will have these tests for real and perhaps even test something more in later projects, it must be financed. And then you must have a financial model and then the real estate companies are among the important actors that we must have with us.”

There are also other kinds of actors that would be important to Härryda. Besides real estate companies, Olsson also mentions that they in the future would need to involve the local public transport authority:

“Primarily Wallenstam, but also Västtrafik [the local public transport authority]. Keolis [a public transport operator] also want to test [the AVs] but they become competitors to the current companies working with RISE - Autonomous Mobility, but they [Autonomous Mobility] might not be the only ones in the future for us.”

The quote shows that Härryda are considering what actor will be the operator, because both Autonomous Mobility and Keolis are operators in different business areas today. Härryda, and also Chalmersfastigheter, consider Västtrafik as an important actor to involve because Västtrafik is the local public transport authority, which they both think needs to handle the question in the long run. As a way of describing obstacles for adopting the AVs, Olsson mentions the role of Västtrafik:

“It is actually Västtrafik who works with such issues [public transport], not the municipality. The collaboration must be closer with them as well as with the real estate companies.”

Chalmersfastigheter does not have a plan to continue with adoption of AVs after the initial demonstration projects. It is not within Chalmersfastigheter’s scope to become involved in the operations of public transports in the long-term. Östlund describes that Chalmersfastigheter together with Chalmers are meaningful for the development of the technology in an early phase, whereas Västtrafik, as public transport authority, would be better apt to take over the operations and continue into full scale adoption:

“Then it is probably Västtrafik who has a role. Until the standard exists, though, we and Chalmers probably have a role to show the way.”

In contrast to the above presented view among adopters, that Västtrafik must be involved because they have a role, Lång at RISE, who has been leading S3 from the beginning, explains that Västtrafik has not responded with a lot of interest, and neither are the AVs thought to be integrated into the public transportation system in the future. In contrast to a similar project involving AVs in Stockholm earlier, he claims that:

“In this case we [the team at RISE] regard it to be something that is driven by the real estate companies.”

However, he also mentions that the intention of the team at RISE was to still keep Västtrafik involved because, as he puts it:

“We don’t want Västtrafik to feel that we have gone below their radar.”

Indeed, participants from Västtrafik have been part of the S3 project and made an in-kind investment in it.

### 5.3.2 Dependency on Other Stakeholders

Another kind of preparation that da Silva mentions is needed in terms of interaction with other stakeholders, is to discuss the demonstration project with the local public transport authority and taxi company:

“Perhaps the local public transport authority and the taxi company will consider the autonomous buses as competition. [...] We just need to have a dialogue with them and update them about what happens. It shouldn’t be too much of a problem as long as we clarify that the autonomous buses fill another purpose than the taxi. [...] On the other hand, it would be easier for us to handle it through receiving information from RISE about their [eventual] experiences of having dialogues with actors who have resisted in other projects with the AVs.”

The last sentence indicates that da Silva perceives the dialogues important enough to improve the way to handle the dialogue. However, da Silva describes the role of the taxi company as less influential for the adoption decision by Varberg.

Härryda has adapted their way of demonstrating the AVs because they believe that it would be troublesome getting approval from authorities to test the vehicles in a real traffic situation. Barrett says that it is why they initially will demonstrate the vehicle in an enclosed area:

“It [the demonstration] is not going to be the same as on Lindholmen and Chalmers, that they run in traffic with other vehicles. Instead we are going to close. It is because the approval process is so incredibly demanding and takes long time, so we will probably demonstrate with cordon a few hundred meters back and forth so that people can get a ride.”

The effect was in this case that the scope of the initial test was changed. Barrett and Olsson actually want to test what people’s reactions are and how they would use AVs. These aspects will instead be tested in an eventual second demonstration project at a later occasion. As Vernhamn notes, it is currently required to have an approval from Transportstyrelsen for each new demonstration project.

## 5.4 Delay of Demand

Organizations experience that full-scale adoption is only possible after certain requirements have been met. Since adoption requires the concerned urban areas to be ready for using AVs, small-scale demonstration projects are seen by some adopters as the only available adoption in the short term.

In order for adoption to be continued after the demonstration projects, it may take a long time according to Östermark and Barrett. Östermark exemplifies how long time it can take while also mentioning that there is a difference between the initial project and the future application:

“The next step after that [the demonstration projects] would be to make it a real tool. It’s not only a demonstration project - it might become reality in ten years from now. In our planning, that is a short time.”

With the long planning, it is necessary to start the adoption process early in order to avoid being too late with adopting.

It may take several years for Härryda before AVs can be introduced in a demonstration project in a new district around Mölnlycke Fabriker, except for a demonstration day between May and August 2018 when some tests will be conducted. Barrett describes some reasons for this:

“It would be good to test the buses soon, but it depends on when the construction starts. [...] Perhaps not so much will be finished in one year from now. First there are 600 residences that will be built [out of 2500 in total] in Mölnlycke. I do not think it is so interesting to test anything before people have moved in there. But we could possibly try [run a demonstration project in] another area instead.”

Therefore, it is likely that it will take time even before proper tests can be conducted in a demonstration project and then even longer time before a full-scale investment can be made. Otherwise, another area needs to be assigned for the demonstration project.

## 5.5 Potential of Knowledge and Networks Built through Demonstration Projects

The outcome of the demonstration projects can determine further adoption for many adopters. The Furniture Company, Varberg, Härryda and Älvstranden all shared the view that the outcome of the demonstration projects can to a large extent be determinant of whether commercial projects of a larger scale are justified after the demonstration project. Especially if they are participating in the demonstration project themselves, they feel more confident that the learnings from the project can be useful for the decision whether to continue with further adoption or not. On the other hand, learnings from demonstration projects where they are not participating are regarded to be useful complementary input to some extent.

The outcome of demonstration projects is considered as a determinant for future adoption, because the viability of AVs as a solution to the organizations’ needs is not yet verified in their specific context so that the participating organizations can gain knowledge before scaling up. This is exemplified by how Barrett and Olsson from Härryda describe what the most important outcome of a demonstration project would be:

“One of the most important aspects is the opportunity to gain new knowledge.”

One possible outcome of the demonstration projects is also that the adopters end their adoption, if they learn that there is not fit between what they need and what the AVs can provide. Barrett describes that several different outcomes of the tests might cancel intended continued adoption of the AVs:

“I hope that it [demonstration day and the potential demonstration project] can lead to a wider usage of the buses [AVs]. Otherwise it wouldn’t look so good if we are wasting the tax income, but it can turn out to be too expensive, or that the technology needs to be improved,

or that we need to select another route. We want to test usage related aspects as well, to see how the buses [AVs] are used and what people think about them. If they think that it wasn't a good idea at all and that it doesn't add anything [valuable], perhaps we shouldn't proceed with it [investing more in the AVs]."

The demonstration projects play the following three roles for enabling continued adoption of AVs:

- Generate new knowledge exploratively, which then will be used for the decision to adopt AVs further.
- Generate new knowledge that gives answers to specific questions that form a basis for the decision of further adoption.
- Open up opportunities to build a network of actors related to AVs, which in turn may be used in further adoption.

### 5.5.1 Explorative Learning

Several adopters are unsure what tests are needed in the demonstration projects. Still, an interest is expressed by the same adopters for testing the AVs in order to gain new knowledge. For instance, Älvstranden considers the demonstration project at Lindholmen as necessary for them to start with because they are currently not sure about how to assess the technology and what they would need to test in a project. Olofsson suggests that there might be challenges that Älvstranden should be aware of before investing more in the AVs, but she is uncertain about what kinds of challenges there could be:

"The test is the most important thing, and to figure out which challenges exist. What do we as urban developers need to think about in order to make it [the AVs] work if we run them in a real-life situation?"

Olofsson further describes that they are unsure about what exactly to test:

"The most important thing is what we can learn [in a demonstration project]. [...] Not everyone from the municipality knows what questions to ask. We do not know at the moment [what needs to be tested]"

Andersson who represented Älvstranden at a workshop organized by RISE to discuss the roadmap for the development of the technology, believed that Älvstranden as a city developer and potential participant in demonstration projects for AVs needs to understand what to test in demonstration projects, as shown by the quote below:

"It would be useful to have a framework for assessing what we could get out of the demonstration projects and how successful they have been. We do not have that today."

### 5.5.2 Required New Knowledge

The interviews reveal that most adopters, in addition to exploring the technology, have an intention to use demonstration projects to run tests that provide answers to specific questions in order to determine whether or not it is appropriate to adopt further after the demonstration projects. For example, Älvstranden would like to test acceptance and how people are using the AVs, as Andersson puts it:

“People do probably have different views and needs so it would probably be useful to have many short demonstration projects to test many different user preferences and features.”

Most adopters mention that they would like to use the demonstration projects as a way of learning about how people use the AVs, to what degree they accept the AVs, how they perceive safety and security, and how the AVs function from a technical point of view in their environment. Typically, the reason to do the tests is to generate basis for a decision whether to adopt further or not after the demonstration project, in similarity with explorative learning. Olofsson expressed clearly that the required knowledge is important for the further adoption decisions:

“We need to know in what kind of city environment it worked and how people interact [with the AVs]. [...] We would take that into account in an assessment before investing more.”

Before scaling up to a large operation of AVs, there are multiple aspects that Östermark would like to learn about through a demonstration project. Here, he lists a number of aspects that he would like to learn if Framtiden had their own project:

“What does it cost to operate such a system [AVs]? What suppliers are there? Is it a service that should be purchased, or should it be managed in-house? Is it a natural task for a janitor? [...] How long should the contract periods be? There are thousands of practical questions that I would like to be tested before starting to scale up.”

Moreover, da Silva says that the reliability over time needs to be tested in an eventual demonstration project, which indicates that he perceives it useful to have relatively long projects:

“We need to test the reliability of the buses over time. I believe that the tests in general need to be relatively long in order for us to see how weather and other factors affect how well the buses work. For example the horizontal rain that we have pretty often in Varberg…”

Barrett said that it would be possible for Härryda to include a test of either the payment system, integrated to the AVs, or an entire new business model, as part of the demonstration project.

### 5.5.3 Lack of Substitutes to Demonstration Projects

Regarding learnings from demonstration projects, there are alternative ways to gain learnings, but adopters see these rather as complementary to the demonstration projects than substitutable. An alternative source of learnings that is mentioned, is to study outcomes of previous demonstration projects, in which the adopter in question is not participating. Another is participation in workshops and discussions with other actors who are involved in AV projects. In addition, these two alternative approaches for attaining knowledge are also used in order to assess whether it is worth investing in a demonstration project.

Potential adopters frequently mentioned that running a demonstration project in their geographical area is a way for them to gain knowledge, that is not completely substitutable with learnings produced somewhere else. da Silva speculates that only some kinds of knowledge could be attained through looking at tests somewhere else than in Varberg:

“The perceived safety [of the AVs] can be tested in Varberg. That can be compared to how the safety is perceived in Paris as an important input. The will to use the buses, though, is a local issue that probably needs to be tested locally.”

The sustainable transports manager motivates why he thinks that the Furniture Company needs to run their own tests instead of studying the outcome from other previous tests. He thinks that the perception among their shopping passengers could differ from people in other studies:

“If we would introduce it [the AVs] we would like to know what our customers think about it. [...] There are more shopping passengers then, it might differ a bit. If you are commuting to work you have one travelling behavior, if you travel to go shopping at ICA [a grocery store] you have another behavior, and if you travel to a department store you have another[…]. So it is more or less that we want to be sure that the passengers who are going to our department store think that it is a good idea.”

As an example of how organizations learn from other tests than their own tests, is given by Andersson, who explains during a workshop that Älvstranden is both interested in conducting demonstration projects and following other demonstration projects as a complement. Not only do adopters usually prefer to learn from demonstration projects where they are participating rather than learning from other demonstration projects - there is even unawareness of the ongoing demonstration projects in France and in Switzerland, as explained by Simon at Bestmile. Most interviewees tell that they are not particularly influenced by the fact that there are other similar organizations considering adopting the technology. An example is Almstedt:

“I had seen that tests had been done, but I did not really know where they took place. Mostly, I wanted to know about the safety conditions here, and about the responsibility issue. [...] It does feel good that there are some [other adopters], but it has not influenced me much. [...] There have been a lot of safety assessments here before initiating S3.”

### 5.5.4 Opportunities to Build a Network

Several potential adopters express how the network gained through participating in a demonstration project can help them to continue with adoption of AVs. Framtiden emphasized the opportunity to create a network of actors related to the AVs. As Östermark at Framtiden describes the rationale behind being part of the demonstration project at Campus Johanneberg, there is a will to be proactive by connecting with a network and learn before the potential adoption through a demonstration project in Hjällbo:

“This industry will become bigger. We want to learn about it now. Then we need to get into the network. We can’t wait two years - we want to be in the game. For example, we are participating in some workshops. ”

Östermark thereby suggests that taking part of a network with actors in the field helps them to get on track in an initial phase in order to get an opportunity to adopt later. Similarly, Barrett hopes that participation in the S3 project will lead to access to more contacts that eventually enables her organization, Härryda to take on significantly larger projects. In that sense, the network that the S3 project constitutes is valuable, particularly in a second step:

“Birger [project manager, S3] and I have talked about sending in an application for Horizon 2020 [a research and innovation funding program]. [...] This would require new contacts, and RISE has in its turn contacts with research clusters in all over Europe. That enables this kind of projects. [...] I do not know where to start or who to contact, but RISE could help out with such contacts and cooperations.”

When asked about whether it is important that there are other similar organizations are starting to look at AVs as a mobility solution, Jonsson at UPAB answers that it is not. However, he thinks that is an advantage that there are other organizations that can cooperate:

“To me personally, it [that similar organizations are progressing with AVs] is not important, but it could be important to others. [...] The more they cooperate with the development, the better it is. There is no question about it.”

## 5.6 Main Results

A number of factors related to the utility of the AVs were identified to impact a decision to proceed with adoption. That is how the vehicles could contribute to improve mobility in urban environments, how the adopters could benefit from a strengthened brand and how they may reduce costs in different ways through the usage of AVs. An eventual adoption was also discussed in relation to the respective organizations’ values and goals, and to what extent an adoption would align to the values and goals. The vehicle and its specifications was evaluated by considering a number of different factors, which in turn, compared it to conventional buses.

The AV is widely perceived as a new kind of vehicle. As a consequence, it is believed that new ways of organizing around the vehicle is needed, such as new business models. Most potential adopters are planning to implement the AVs in collaboration with a number of other actors that in most cases not are mapped out. The adoption of the AVs by one actor is thereby perceived to be dependent upon the adoption of other actors.

Before proceeding with a full adoption, the adopters express a need for learning more. There are specific aspects that they want to get answered, but there is also a perceived need to learn through own exploration. In order to get specific answers, as well as to explore, the adopters suggest to conduct demonstration projects.

# 6. Discussion

This thesis aims to give an understanding of the factors influencing the adoption of AVs in Sweden. Since the study has taken place at an early stage of the diffusion of this innovation, these may not be the last words being written on the topic, and the view of what actually affected adoption may change when seen in retrospect. Due to the early phase, the best source of data about what will influence adoption is the potential adopters themselves and their thoughts on what matters to their respective organizations.

The study provides insight into what the motives are for potential adopters to adopt AVs, as well as what they consider to be the difficulties in doing so and what needs to be investigated before proceeding. These insights provide managerial implications that are elaborated below in this chapter.

In this section, we discuss empirical findings in relation to the factors in the theoretical framework that has been provided above, see Figure 1. The results reveal that factors perceived by adopters to influence their adoption, in this study are related to either the perception of the innovation, collective adoption, facilitation by demonstration projects, barriers in the environment, or the length of the adoption process. We, therefore, regard these to be the main areas of factors revealed by the study to influence adoption, and thus the structure of the discussion section below will be based on these areas. Thereafter we summarize the effects of the factors in a table showing which areas of factors are related to the outcome of adoption, rate of adoption, and speed of adoption, respectively. Ultimately, we discuss the implications of the factors for change agents that strive to increase the adoption of AVs in Sweden.

## 6.1 Perception of the Innovation

Several aspects of how the AVs are perceived influence whether, and when, they are being adopted according to the results. The perceived characteristics, as described by Rogers (2003), and the process-characteristics, as described by Dimanpour (2001), give a certain effect on the speed of adoption. The relation between the perceived nature of the innovation and the adoption is summarized below under the three concepts called *Level of Perceived Utility*, *Delay of Demand* and *High Process-Orientation of Innovation.*

### 6.1.1 Perceived Utility

The level of perceived utility consists of several aspects that can be related to what was described as *Factors Related to the Innovation* in the theoretical framework. For example, mobility, brand value, cost reduction, and vehicle and supplier characteristics, can be described as aspects of the relative advantage as described by Rogers (2003). The aspect of utility that we label as *Fit with Values and Goals* is closely related to compatibility as described by Rogers (2003).

### *Mobility*

Improving mobility is described in several ways to be beneficial for adopters, and can be regarded as a relative advantage. It appears to be uncertain how big the benefit of mobility is, for example when connecting rural areas with the city, and therefore it is seen to be needed that RISE or some other actor with the competence can reduce that uncertainty. This reflects what Kristian Häggman (2009) describes - the direct interaction between technology provider has been essential for identifying applications of the innovation.
Adopters perceive that there are two kinds of challenges for achieving improved mobility in an area using AVs, either because of the inhabitants in the area or because of dependence on other mobility solutions. Firstly, when introducing AVs in already existing areas, adopters believe that inhabitants will find it hard to change their habits in order to start using the AVs. If few or no people are willing to change their way of traveling, there are no gains in regards to mobility to be made. This could be regarded as a compatibility issue. Secondly, it is challenging to get the mobility benefits from the AVs, given that their benefits only can be reaped to their full potential when combined with several other new means of transportation, as it is claimed by some adopters. Assuming that this is the case, the innovation is rather radical, which implies a slow rate of adoption.

### *Brand Value*

The numerous quotes about how AVs may matter for the branding shows how important this value is for the adopters and it can be described as a relative advantage. For the most part, the potential value of the branding is expected to be positive, although Älvstranden is an exception. Some of the interviewees explained how the branding not only provides value to the organization but also to important stakeholders, such as Chalmers' students and Framtiden's residents. It was also illustrated by Almstedt how the vehicle could provide branding value in order to promote his Five Star Campus program internally. Some interviewees expect that the politicians, that in some cases are important decision makers, care about the brand values. That indicates that a high perceived brand value is a factor that motivates the adoption of AVs. Vice versa, a perceived risk for negative effects on the brand leads to hesitation to adopt.

### *Cost Reduction*

Three types of costs were mentioned in the interviews: future direct costs as the autonomy of AVs lower driver costs, future indirect costs when areas in a city can be exploited more, and short-term costs of demonstration projects. Saving costs can be seen as a relative advantage compared to the alternative ways of implementing ways for inhabitants in a residential area to travel or reach their cars, for instance. The expected costs are important for determining the outcome of the adoption since it is part of the decision ground. The expectations are positive for future direct and indirect cost reductions, and the short-term costs for demonstration projects are not regarded to be too high. However, the costs have not been completely sorted out at an early stage of the pre-studies and there are uncertainties about the costs.

### *Fit with Values and Goals*

The interviewed adopters articulated how the AVs fit with the values and goals of their respective organizations. This indicates that they consider a good fit as highly important. The fit with values and goals relates closely to what Rogers (2003) call compatibility of the

innovation. Whereas Rogers (2003) focuses on the eventual compatibility of an innovation with the values and beliefs that groups of individuals hold, this study reveals that organizations reason in similar terms. However, a major difference is that the organizations refer to formal documents in which their values and goals are defined.

The interviewees do, however, not only take their own organization into account in the discussion of compatibility. For example, since the adopters worry that it would be challenging introducing AVs in existing areas, in which the residents would need to change their habits, shows that the interviewees also care about the eventual compatibility with groups of individuals.

#### *Vehicle and Supplier Characteristics*

The potential adopters have brought up a multitude of aspects that not necessarily are directly related to the AVs in general, but instead to specific vehicle models, as well as to specific service or vehicle suppliers. Numerous vehicle characteristics were repeatedly brought by several adopters that are not unique to AVs, both advantages and disadvantages. Although there are rather conventional buses with electrical propulsion and possibly autonomous buses with combustion engines, the adopters were assuming the AVs to have electrical propulsion. The vehicle and supplier characteristics are clear examples of relative advantages, although the characteristics many times instead were considered disadvantages. The adopters did in some cases have different standpoints to whether one characteristic was considered an advantage or disadvantage, for example, safety and security.

### 6.1.2 Delay of Demand

The results suggest that the interviewed organizations attach high priority to that the innovation is compatible with their respective values and goals. There is a great diversity of ways in which the respondents motivate how the AVs fit the formalized values and goals, and all of them considered the AVs to fit their organizations well. However, there seem to be some degrees of freedom on how to accomplish their organizational goals.

The literature suggests that the organizational structure, including values and goals, may constitute barriers to adoption if they are not well aligned with the innovation. Although good fit with values and goals was perceived as important by the respondents, the results do not support that it impedes the initial stages of adoption. Though, the goals of the respective organizations give a direction of when adoption will occur.

The demand for AVs appears at different times for adopters, depending on what kind of utility is considered to be important to the adopter, and the point of time when it is possible for the adopter to exploit such utility. Adopters who prioritize the mobility and cost utility, and perceive that utility is only possible to exploit after several years, currently have low incentives to adopt. Though, adopters who require a long time for planning for full-scale adoption, intend to start the initial adoption early, with for example pre-studies or demonstration projects. Adopters who prioritize other utilities, such as branding, have higher incentives to adopt early and have a higher speed of adoption.

Among the many different kinds of factors presented above, that are perceived by adopters to bring utility, mobility benefits were frequently perceived as the main motivating factors. In particular, the opportunities to exploit mobility benefits with AVs are perceived to be good in

newly built areas. When adopters wait for the opportunity the speed of adoption is reduced. Respondents from Framtiden, Härryda, Chalmersfastigheter, and Varberg exemplified that such opportunities exist a couple of years ahead. In the case of Framtiden, opportunities exist around ten years ahead for a full-scale implementation because of their long-term planning, but Östermark mentions that a demonstration project may occur earlier. In the case of Härryda and Varberg, it would take several years before new residential areas are constructed and tests can be meaningful, but on the other hand, there are other routes that could be used for demonstration projects in a near future.

An improved mobility, which numerous respondents apparently hope to achieve through the introduction of AVs, is arguably heavily dependent upon operational cost reductions that the technology may incur if a driver not is required. Since the regulations in Sweden currently do not allow to run the vehicles without a bus driver, a scenario of reduced operational costs pertains to the future. Today, the same level of mobility could be achieved by conventional mini-buses. The expectations of improved mobility are thereby, assumingly, based on the idea that better mobility will be provided to the same costs, or lower, in the future.

Chalmers perceives the values of research opportunities and branding of AVs as relatively higher compared to the mobility benefits and is not considering the AVs as a way to meet increased mobility needs as a consequence of constructions. Therefore, Chalmers does not consider it necessary to wait with the adoption. Instead, it is likely that Chalmers manages to get more publicity if they adopt at an early phase. Likewise, Östermark at Framtiden explained that the AVs possibly can come into play in ten years, which supposedly is a short period of time in the real estate industry. In order to make all the plannings needed for future constructions, Östermark thinks that they need to start early to understand the technology and what its implications may be. In both of these cases, there are clear reasons for starting the adoption early, and neither of them is dependent on reducing costs or improving mobility today.

### 6.1.3 High Process-Orientation of Innovation

Because of the perceived high degree of process-orientation, the rate of adoption is negatively affected. It has been concluded in previous research that process innovations usually show a lower speed and rate of adoption compared to product innovations (Damanpour, 2001). In the case of AVs, the innovation is obviously partially a product since it is a piece of hardware, and partially as a process, in the sense that the adopting organizations perceive that they need to work in a new way when adopting the AVs. The perceived ambiguity about how to work with several aspects of the AVs, such as how to work with financing the AVs together with partners, and how to set up and test a ticket and payment system, is a typical trait of a process innovation. The observability is typically lower for process innovations than for product innovations (Damanpour and Gopalakrishnan, 2001), which is consistent with Rogers (2003) if a product innovation can be considered to have a higher ratio of hardware content and process innovation a higher ratio of software content. Traits of process innovation should, according to Damanpour and Gopalakrishnan, (2001), reduce the rate of adoption because replication of the innovation becomes more difficult.
Organizations must see a fit between the innovation and their needs in the matching stage in order to make a decision to adopt (Rogers, 2003). Given that the AVs are perceived to be organization-specific to some extent, the role of testing the innovation and making an effort to adapt the innovation to the culture and structure should be important to organizations (Damanpour, 1996), and be required as a part of the matching stage. Therefore,

demonstration projects are critical. This is expressed by some adopters as a need to learn how to work with the AVs. The need for demonstration projects and extensive adaptations in the matching stage, in turn, affects the speed of adoption negatively.

Given that the adopters find it necessary to run demonstration projects prior to continuing adoption does not only suggest that the innovation is process-oriented, but also that it is perceived as relatively complex, which requires considerable learning efforts by the adopter. As is also noted by Rogers (2003), a perceived high complexity of the innovation is expected to give a low rate of adoption because of the supposed large efforts needed by the adopter.

## 6.2 Collective Adoption

The results indicate that in the adoption of AVs, the involvement of several organizations is usually needed. In accordance with previous theory, the results reveal that the rate of adoption for a given organization is reduced if there are dependencies on numerous other adopting organizations because a positive adoption decision is less likely. On the other hand, a contagion effect may be caused by the need to involve more adopters, which increases the rate of adoption. These two effects work in opposite direction on adoption, where the former reduces the rate of adoption and the latter increases it. In addition, resistance to adoption may be reduced through the interaction that occurs when one organization needs to convince other adopters whom the adoption depends on.

### 6.2.1 Many Decision-Makers

Rogers (2003) suggests that the rate of adoption is lower in situations with a high number of decision-makers, as well as in situations with collective adoption decisions. In this study, the decision to adopt was in many cases supposed to be made collectively by several different organizations, who in turn may have multiple decision-makers. Consequently, the complexity of an adoption decision is high. For example, each organization in S3 is in charge of the resources that are needed in order to conduct the demonstrations. Thereby the organizations are dependent on each other's involvement. Without consensus, the adoption does not occur. For example, if Chalmersfastigheter would not decide to adopt through S3, the other partners would not be able to use the land for the route of the AV, because there was no consensus, and thus there would be no adoption in that case.

However, the results indicate that there is uncertainty about which role public transport authorities have in relation to the adoption decisions and whether that increases the number of decision-makers. For instance, some adopters in the S3 project perceive that they are dependent on Västtrafik, while Lång at RISE considers the role of Västtrafik to be less central in the demonstration projects compared to the role of real estate companies. Thus, the actors have different views on which organizations are important adopters of the technology. If a larger number of actors are considered to be important, it increases the number of decision-makers involved in the collective the adoption. Then, according to Rogers (2003), the rate of adoption is expected to be lower. Therefore, given that certain actors only need to be informed instead of being active decision-makers, the rate of adoption could be higher.

### 6.2.2 Contagion to New Organizations

The fact that numerous actors typically are needed in order to adopt collectively due to dependencies on each other have yet another effect. An organization that intends to adopt is

urged to spread the idea to other organizations that are needed in order for an adoption to take place. Thereby, contagion is caused, which stimulates other organizations to adopt. Social learning is also prevalent, with some degree of imitation of other adopters in the surroundings. The adopters also look for networks in which they can exchange knowledge and learnings. For example, Härryda spread the idea of AVs to the real estate companies and Varberg spread the idea to companies within the EMC network. Thus, given that there must be numerous involved actors in one single project, the rate of adoption may increase because the organizations spread the idea to others.

### 6.2.3 Interaction between Collectively Adopting Organizations

Seen from the perspective of Kristian Häggman (2009), the adoption process is complex because many actors are involved. Since there may be resistance to the innovation, it is important that there is a direct interaction between those actors who benefit the most from the adoption of AVs, in order to ensure that there are incentives enough for the other actors involved in adoption. In the case of Framtiden, it is possible that they have stronger incentives than other actors that would be involved. One argument for that is that Framtiden expects to save costs through reduced need for building several parking houses. The example of Härryda, who has initiated dialogues with other actors in order to convince about the potential gains of adoption, is showing that an actor with incentives has direct interaction with other actors in the complex adoption process in order for the adoption to occur. A quote by Barrett highlights that: “They [Wallenstam] have just been asked, so this is new but if we will have these tests for real and perhaps even test something more in later projects, it must be financed. And then you must have a financial model and then the real estate companies are among the important actors that we must have with us.” Since many of the organizations perceive that they are dependent on other adopters, their direct interaction with those may therefore not only lead to contagion but also remove resistance to adoption among the already involved organizations in the same AV project, as described by Kristian Häggman (2009).

## 6.3 Facilitation by Demonstration Projects

The fact that AVs are being adopted through demonstration projects has primarily a facilitating effect on outcome and rate of adoption. In addition, the participation in demonstration projects implies adoption because of the resource commitment. In our view, the demonstration projects where potential adopters participate are important parts of the process of adoption because decisions are made to adopt the AVs as it is agreed to launch a project and resources are committed to AVs to the extent of the project scope.

In accordance with previous research by Lefevre (1984), the demonstration projects for AVs seem to play a role in bringing the AVs from prototype to a marketable product. The demonstration projects are used to gain learnings and to build a network according to the participants, who also typically regard their own participation in demonstration projects to be the only viable way for them to start the adoption. The possibility of participating in a demonstration project is in previous research usually not compared to alternatives from the adopters’ point of view, such as learning from other demonstration projects without participation or participating in other kinds of learning contexts. However, this study shows that the demonstration projects are not perceived to be substitutable.

Followingly, it is possible to argue that the demonstration projects are both in an experimental phase where learning is maximized, and in a diffusion phase at the same time,

where gaining public acceptance and credibility among customers is the primary focus, according to the description by Karlström and Sandén (2004). Similarly, Zhou et al. (2015) suggest that demonstration projects can have testing and showing functions, and both these functions are perceived important in the case of S3 for example. This is supported by the fact that adopters express a will to test AVs to learn, while also gaining public acceptance by showing the AVs to the general public, and achieving a positive brand value.

The display function can, therefore, be regarded as a way to reduce the barriers in the environment that could otherwise hinder adoption (see *Barriers in the Environment* which is described below). The potential brand value can also be seen as a relative advantage, while the ability to run tests of AVs in demonstration projects, creates a trialability and thus has a positive impact on the rate of adoption according to Rogers (2003). Further, the factors belonging to *Perceived Utility*, such as brand value, can be improved through *Facilitation of Demonstration Projects*.

In line with the reasoning above, adopters appear to have expectations on the innovation already, especially on gaining utility, such as the brand value of innovativeness and fit with values and goals, despite the fact that AVs are being tested at an early stage. The consequence is that the role of the demonstration projects is both testing and showing the innovation at the same time, in a risk-taking manner. However, running demonstration projects also reduces uncertainties through the learnings achieved in the various tests.

## 6.4 Barriers in the Environment

Potential barriers have been identified, although of a seemingly lower perceived importance in comparison to other factors. The literature suggests that there may be groups, such as NGOs (Walker et al., 2008) or corporations forming lobby organizations (Kemp et al. 1998), that oppose the development of an innovation. In this thesis, a couple of groups were identified that potentially would oppose an initiative to adopt AVs. The threat from these organizations was, though, not seen as a major problem. It was assumed to be solved through mere informing the groups about the situation.

Neither was the newness of the suppliers perceived as a major inhibiting factor for adoption. For instance, the sustainable passenger transports manager at the Furniture Company thought that it did not matter much that the suppliers are new with no or very scarce previous track record. According to him, it was primarily a matter of price, because collaboration is always an issue to be solved.

Two groups that indeed have proved to be concerns to the respondents are institutions and the general public. Firstly, the adopting organizations express an uncertainty about the regulations imposed by institutions. In order not to have to deal with the regulations, Härryda plans to have a demonstration project, that is limited to one day on an enclosed area. Hence, this confirms what Kemp et al. (1998) writes, that the organizations become hesitant to adopt due to regulatory uncertainties.

Secondly, there was an uncertainty in regards to how the AVs would be received by the general public. Portouli et al. (2017) assert that in the Greek demonstration project of AVs that they studied, the technology was overall well-received by citizens of the town where the technology was tested. Nevertheless, the organizations interviewed for this thesis worry that the general public will react differently to the geographical area where the AVs would be

introduced. They emphasize the importance of finding out their attitudes, as well as how the users would utilize the vehicles because the outcome of the further adoption depends on it.

## 6.5 Length of Adoption Process

As described above, previous research has shown that the length of the innovation process is important for the speed of adoption (Rogers, 2003). Also, the empirical findings in this study show that there appear to be several stages that each organization needs to go through when adopting AVs, which can be related to the theoretical innovation process. Different factors increase, or reduce, respectively, the length of the stages in the process as described in this section.

For the AVs, the process is more accurately described if some adjustments are made to the adoption process suggested by Rogers (2003). Instead of one adoption decision, there are typically three times when an adoption decision is made in organizations: First the decision to initiate a pre-study, then the decision to invest in a demonstration project, and finally the decision to continue the adoption of AVs after the demonstration project. Hence, the initiation phase and the implementation phase are not completely separated from each other by a single adoption decision, like in the adoption process suggested by Rogers (2003). We select the decision to invest in a demonstration project as the main adoption decision. Thus, major amounts of resources are invested in adoption with that decision. The corresponding initiation phase then covers the pre-study and the implementation phase covers demonstration projects and continued adoption. The selection of what to call adoption decision is motivated by for example the similarity between the theoretical redefining stage and the how adopters from the starting point of demonstration projects are involved in actions that put the innovation to use in their organizations.

The length of the adoption process is affected by some factors found empirically that are described below in relation to some of the stages:

1. **Agenda-setting stage**: Many adopters see that the AV is a solution that meets their needs already. That indicates that either the agenda was set before they became aware of the opportunity with AVs, or the awareness of the AVs made them think of a potential need. Either way, the agenda-setting was not found to reduce the speed of adoption in the cases that were studied, except for in the case of Älvstranden. Olofsson perceives that there is a need for an agenda-setting for Älvstranden before investing in a large implementation of the AVs.

2. **Matching stage**: As mentioned above, the organizations express a need for pre-studies and workshops in order to make a decision to continue adoption. The purpose of these activities is to assess the benefits of the innovation and evaluate an eventual fit with the culture and structure of the organization. It was unclear to the organizations what pre-studies were needed, and in which order they should be conducted in the S3 project.

3. **Redefining stage**: A known trade-off is that either the redefining stage must take time, or adoption becomes less likely. There is a need for adaptations because the

innovation is to some extent process-oriented, which means that the redefining stage needs to be relatively long as stated above in *High Process-Orientation of Innovation*. The redefining stage includes mutual adaptations between the innovation and the adopting organization (Rogers, 2003), and in the case of AVs, the ambiguity in the ways of working with the AVs makes it necessary that the adopting organizations adapt practical aspects, which was described by Framtiden and Varberg for example. Redefining is done partially through demonstration projects since there is a decision to adopt before a demonstration project takes place. With adaptations of the AVs to the individual organization, the organizations will be more likely to make the decision to adopt. According to Rogers (2003), the more the adopting organization is participating and spending time in the redefining and implementation activities, the more likely it is that the organization will regard the innovation as their own and therefore the higher the likelihood that the innovation will be sustained, in other words, become incorporated in the daily activities in the long term. Both Älvstranden and Varberg have indicated that they perceive that the tests in demonstration projects need to be rather extensive in order to really learn enough from them, which can arguably be regarded as redefining. If a lot of time is spent on adaptations of the process part of the innovation, the speed with which the adoption occurs for the organization is reduced. Hence there is a trade-off between the likelihood of an outcome of further adoption and the speed of adoption in that sense.

4. **Routinization stage**: Among others, Chalmersfastigheter is not interested in operating AVs in the long term. Therefore it is necessary to let the local public transport administrator, Västtrafik, take over the next stages of the development, which means that another actor must first go through their adoption process before a full-scale adoption can occur.

Considering that the steps above are regarded as necessary and believed to consume time, it limits how fast the adoption can proceed towards full-scale adoption. We do not provide an adoption process for another similar innovation as a benchmark to compare the speed of adoption with. Instead, we state that the total length of the steps together constitutes the lower limit for the time required for adoption, which makes the process longer than adoption processes where for example pre-studies and workshops were not needed for adoption. The steps look a bit different from case to case, so the analysis above merely highlights that several empirical findings indicate obstacles to adoption, which are consistent with theory. In general, the adopters have not described any factors that can be related to the confirmation stage, which is probably because not any of the adopters have reached that far and they are concerned with the how the closest proceeding goes to get started with adoption in first place. Furthermore, discontinuance can occur after the pre-studies or after the demonstration projects for example if the public acceptance or the technical aspects are not convincing about the fit, according to many adopters who see this as critical for their decisions.

## 6.6 Effects on Adoption

The five areas of factors discussed above that impact the adoption are presented in the table below, see Table 3. In the table, the effects of each factor are marked when we argue that it affects the outcome of adoption (O), the rate of adoption (R), or the speed of adoption (S).

| Area of factors | Description | Sources |
|---|---|---|
| **Perception of the Innovation (O, S)** | Perceptions of utility motivating adoption of AVs are broadly divided into the five categories mobility, brand value, cost reduction, fit with values and goals, and vehicle and supplier characteristics. | Empirical results Supported by previous research (Rogers, 2003) |
| | The differences in what kind of utility is perceived by adopting organizations have an effect on whether there is a delay before the organizations demand the AVs. | Empirical results Supported by previous research (Rogers, 2003) |
| | AVs are perceived to include a high extent of process innovation, which leads to extensive adaptations, slowing down the adoption. | Theoretical explanation (Damanpour and Gopalakrishnan, 2001; Damanpour, 2001, Rogers, 2003) |
| **Collective Adoption (O, R, S)** | There are many decision makers, which slows down the adoption. | Empirical results Supported by previous research (Rogers, 2003; Kristian Häggman, 2009) |
| | Contagion from adopters to new potential adopters increases the rate of adoption. | Empirical results Supported by previous research (Bianchi et al., 2017; Frambach, 1993; Arthur and Lane, 1993) |
| | Interaction between actors who expect to benefit from adoption reduces potential resistance among other adopters whom the adoption depends on. | Some empirical results Supported by previous research (Kristian Häggman, 2009) |
| **Facilitation by Demonstration Projects (O, R)** | The demonstration projects are in an experimental phase and a diffusion phase at the same time and have both a testing and a showing function. | Empirical results Supported by previous research (Karlström and Sandén, 2004; Zhou et al., 2015) |
| | The testing function creates trialability, which has a positive impact on the rate of adoption. | Theoretical explanation (Rogers, 2003) |

| | | |
|---|---|---|
| | The showing function reduces a potential barrier of getting public acceptance, while giving positive brand value, which has a positive impact on the rate of adoption. | Empirical results Supported by previous research (Rogers, 2003; Kemp et al., 1998) |
| **Barriers in the Environment (O)** | While most external groups of stakeholders have a very limited impact on the decision to adopt AVs, two groups that matter are institutions and the general public. | Empirical results |
| | The perceived regulatory uncertainty related to institutions makes adopters limit and adapt their demonstration projects. | Empirical results Supported by previous research (Kemp et al., 1998) |
| | The outcome of the level of acceptance from the general public such as commuters using the AVs, determines the outcome of adoption. | Empirical results |
| **Length of Adoption Process (O, S)** | The speed of the adoption process depends on the total length of the stages of the adoption process, which for AVs has several obstacles. | Empirical results Supported by previous research (Rogers, 2003) |
| | The high perceived level of process-orientation and many perceived uncertainties create a perceived need for extensive testing. | Empirical results Supported by previous research (Damanpour and Gopalakrishnan, 2001; Damanpour, 2001, Rogers, 2003) |
| | If the length of the redefining stage is not long enough, it may negatively impact the outcome of the adoption, making organizations discontinue the adoption after the demonstration project has been conducted. | Theoretical explanation (Rogers, 2003) |

*Table 3.* Overview of effects on adoption

## 6.7 Implications for Theory and Practice

The results presented can give important insights for change agents that can guide how to manage the diffusion of AVs. The framework with five areas of factors presented above, allows change agents to direct their attention to selected factors in order to achieve results related to different effects on adoption among organizations; either the outcome, the rate, or the speed of adoption. Using this distinction of the primary effects of the factors on the adoption of AVs, the right factors can be addressed when trying to facilitate the diffusion. In particular, when there are trade-offs between the effects which is the case for *Length of Adoption Process*.

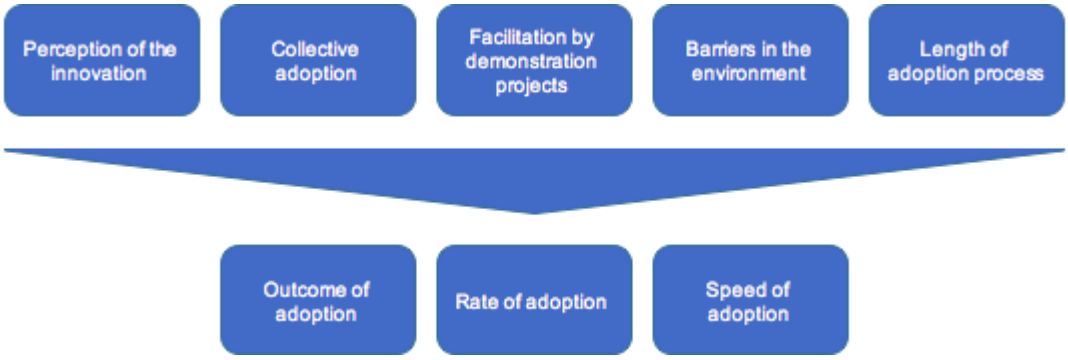


*Figure 2.* Framework of factors, perceived to influence adoption of AVs, and the resulting effect of the factors

While the framework developed does not assess the ability of change agents manipulating individual factors through actions, there have been presented in the results above a number of actions that the adopters either expect from the change agent RISE or actions that RISE is performing today in order to improve diffusion, such as initiating and conducting demonstration projects. In the emerging industry for AVs in Sweden, RISE has a central role in performing demonstration projects, which enables them to manage the factors related to *Facilitation by Demonstration Projects* to a higher degree.

### 6.7.1 Implications for Change Agents

Below are a number of aspects listed that change agents should consider when carrying their initiatives in order to drive diffusion.

#### *Delay of Demand*

It is important for the change agent to keep in mind that due to the relatively low maturity of the innovation, with for example the regulatory requirements having a bus driver onboard, only certain organizations are likely to have an interest in adopting on an early phase. A successful effort to choose potential adopters to focus on requires that the change agent takes into account that the time when the value can be exploited through adoption depends on what kind of value is important for the adopter. Given that the goal is to achieve an adoption soon, resources should be spent on convincing adopters that have incentives to become early adopters, such as those that value branding highly. However, also adopters that do not have a rationale for adopting at the moment may need to commit resources early on, given that they have a long planning cycles.

#### *Branding*

Most respondents considered an improved brand image to be an important objective for an eventual adoption of AVs. Therefore, it may be effective to attract adopters through suggesting ways to improve the brand image through adoption. However, the opportunity for strengthening the brand does, arguably, decrease over time when the AVs are more widely spread not perceived as an exciting innovation anymore. Hence, adoption would be negatively influenced by previous adopters. When change agents promote the innovation, it is worth remembering that the expectations that the adopter may hold of improving its brand, may not come true, since other adopters possibly come first and absorb the publicity.

### *Positioning*

It was seemingly very important to the respondents that the innovation was aligned with their respective organizational values and goals. Therefore, when communicating the innovation with potential adopters, it would be favorable to position the AVs in accordance with the formal goals of the organization in question.

### *Trade-off between Speed and Rate of Adoption*

The results suggest that there is a trade-off between speed of adoption and rate of adoption, since projects with a high number of involved organizations diffuse the innovation to more actors, though it becomes more difficult to complete the adoption. Change agents should be aware of this trade-off and choose wisely what initiatives to pursue. Finding a way to reduce the number of organizations involved should be prioritized if the speed of adoption is prioritized. If, on the contrary, a high rate of adoption is more important relatively, it is a preferable strategy to enable more organizations to engage in demonstration projects and become part of adoption.

### *Process-orientation*

Given that the AVs to some extent are perceived as a process innovation and not only a product innovation, the rate of adoption is impeded. A message from the change agents telling that the AVs would be more than a bus without a driver would possibly appeal to a wider group of adopters. However, it does also strengthen the process aspects of the innovation, thereby partly offsetting the positive effect on adoption stemming from appeal to some adopters. Change agents need to perform a balancing act so that AVs are not perceived too much as a process innovation, but that it still attracts needed actors.

### *Trialability*

Due to the high importance of trialability, there is an urge for change agents to create efficient ways of trying out the technology. Since larger demonstration projects are costly, it would be desirable to discover what kinds of learnings that an adopter accepts to learn from previous demonstration projects, and what learnings that they want to acquire through participation in a demonstration project. Alternatively, efforts would need to be made in order to change the perception held by potential adopters, that learnings must come from demonstration projects.

### *Length of Adoption Process*

The process for adopting an innovation tends to be slower because of the factors that make the stages longer in the process. The awareness of these factors can guide change agents in their attempts to increase the speed of adoption while letting the adopters spend enough time on the redefining stage because more time spent by the adopter increases the likelihood of adoption.

## 6.7.2 Suggestions for Further Research

This thesis contributes to theory by providing a framework adapted for a specific industry with a structure of five areas of factors that affect adoption. The framework has a different

structure compared to the three areas of factors that stem from previous research. However, the factors of the framework that we provide, are based on a search for the same factors in an empirical setting. Thus, the new structure is refined in order to explain both what generic and specific factors matter for adoption within the AV industry, and in which way the factors influence adoption.

The study has limitations related to how exhaustively the framework describes all the factors affecting the adoption of AVs in Sweden. Only organizations that have currently shown interest in adopting AVs were interviewed, and in addition, they were interviewed before full adoption had occurred. Organizations that could be potential adopters but have chosen not to proceed with adoption were not accessed so data is missing about what they perceive to be the main barrier that led to not adopting AVs. Therefore, the barriers described to influence the adoption decisions, are viewed from the perspective of organizations that still show interest in adoption. However, the study is meant to create a framework of areas of factors that are important according to the best accessible data as of today rather than making an exhaustive list of all factors that matter for adoption, which allows for further improvement as the development of the industry evolves and more data gradually becomes available about actual adoption as it unfolds. Therefore, further research may contribute at a later stage to improve the framework based on studies of organizations that continued to full adoption and organizations that discontinued adoption.

# 7. Conclusions

This thesis aims to answer what factors that existing and potential adopters perceive to influence an eventual adoption of AVs in Sweden, and how those factors make an impact. Based on the results of interviews with adopters, five areas of factors emerged, namely *Perception of the Innovation*, *Collective Adoption*, *Facilitation by Demonstration Projects*, *Barriers in the Environment*, and *Length of Adoption Process*.

The first factor stands for the importance that the innovation is perceived to give the adopter some value in terms of for example reduced costs, improved brand or increased mobility. Secondly, the adopters of AVs are adopting the AVs in collaboration with each other, which may result in reduced speed of adoption but an increased rate of adoption. Next, the adopters perceive that demonstration projects are needed in order to proceed in their adoption process. Change agents may either provide such demonstrations or comfort by referring to sufficiently similar previous demonstration projects. The fourth factor is barriers in the environment, in form of for example regulation or public debate, that impedes adoption. Lastly, the speed of adoption by is affected by the number of steps in the adoption process and a trade-off between the speed of adoption and outcome of the adoption was identified.

Change agents who aim to increase the diffusion of AVs in Sweden may use the framework resulting from the study as a new tool to structure areas of factors affecting the diffusion, which helps in the efforts to either improve affects the outcome of one individual adoption by an organization, the rate of adoption, or the speed of adoption. Thereby, the framework takes into account what makes the diffusion of the AVs behave differently from the innovations in much of the previous research and enables change agents to improve the diffusion in the way that best fits their abilities and goals.

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