SUCCESS FACTORS FOR ACCELERATING THE INNOVATION PROCESS AND INCREASING THE USER ACCEPTANCE OF PUBLIC CHARGING INFRASTRUCTURE IN THE CONTEXT OF ELECTRIC MOBILITY

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Abstract: *The German mobility industry has been in a strong transformation process since the beginning of the energy transition. Electric mobility is one of the transport policy measures that allows climate-neutral mobility. In order to achieve user acceptance of electric vehicles and their charging infrastructure, the technologies must be highly attractive to potential users. This research approach focuses on accelerating the innovation process and increasing the user acceptance of public charging infrastructure within the early majority of Roger's adoption segments. Therefore, a new model will be developed which identifies processual and contentual success factors. As a basis, a phase model of the innovation process and acceptance theories will be used.*

Keywords: *Electric Mobility, Public Charging Infrastructure, Innovation Process, User Acceptance, Early Majority, Success Factors*

Introduction

Since the beginning of the energy transition, the German mobility industry has been strongly influenced by change. The transport sector emits a high proportion of CO2, which must be reduced against the background of the climate protection goals (cf. Geschäftsführende Vorstände der Fraktion im Deutschen Bundestag, 2016, p. 1).

Electric mobility is a central element of transport policy to achieve the climate protection goals. It enables CO2-neutral locomotion if the electricity for charging is generated using regenerative energy sources (cf. BMWi et al., 2011, p. 5).

As early as 2009, the Federal Government introduced the 'National Electric Mobility Development Plan', which aims to force research and development as well as the preparation and introduction of electric vehicles in Germany (cf. Bundesregierung, 2009, p. 2).

As a result, the responsible ministries provide support for a large number of measures (cf. BMWi et al., 2011, p. 6). Among others, the Federal Ministry of Transport and Digital Infrastructure provides subsidies for research and development in the electric mobility sector, the procurement of electric vehicles and the deployment of charging infrastructure. Within the 'Funding Guideline Charging Infrastructure for Electric Vehicles in Germany' they provided subsidies in the amount of 300 million euros from 2017 to 2021. Moreover, in the context of their newly launched funding programme 'Publicly accessible charging infrastructure for electric vehicles in Germany', they are providing another 500 million euros from 2021 to 2025 (cf. BMVI, 2022).

Additionally, in order to meet demand in fast-charging infrastructure on medium- and long-distance routes, the Federal Ministry of Transport and Digital Infrastructure is calling for tenders for the deployment and operation of 1,000 fast-charging locations, each with several charging points with up to 300 kW power (cf. BMVI, 2021).

In recent years, the creation of political, regulatory, technical and infrastructural conditions had clear priority. As a result, specific user needs have not yet been investigated thoroughly (cf. Bundesregierung, 2009, pp. 2f.).

However, in order to successfully position electric mobility in the market in the future, it must be highly attractive to users (cf. Höfler/Neumann, 2016, p. 14). Attractiveness refers on the one hand to the electric vehicle itself and on the other hand to the associated charging infrastructure.

The use of electric vehicles and the associated charging infrastructure is dependent on the acceptance of potential users (cf. Dallinger et al., 2011, p. 22). The extent of acceptance of a technology depends on the extent to which a technology is beneficial for potential users (cf. Pflaumer, 1984, p. 185).

In 2021 in Germany 13,6% (October 1, 2021) of new registered vehicles were pure electric ones (fc. Statista, 2022). This proportion almost exactly matches the segments of innovators and early adopters according to Roger's diffusion theory.

Roger's diffusion theory deals with the diffusion and the adoption of innovations within society over time. It can be derived which segments of a society implement an innovation in the early phase of diffusion and thus serve as an example for the rest. For this purpose, Rogers creates segments based on the first use of an innovation which depends on the innovativeness of a person.

Regarding electric mobility and the associated charging infrastructure we are soon entering the third segment – the early majority. People from the early majority are described as less favorable toward change and less able to cope with uncertainty and risk (cf. Rogers, 1983, pp. 257f.).

However, the temporal dimension of the diffusion process of electric mobility is influenced by a decisive factor. The new government defined even higher goals for the diffusion process of electric mobility than the old one did. It is aiming for at least 15 million electric vehicles (cf. Elektroauto-News.net, 2021) and one million charging points by 2030 in Germany (cf. Bundesregierung, 2022). This target is very ambitious when you consider that today there are only 517,000 (October 1, 2021) electric vehicles in Germany (cf. Statista, 2022).

Achieving these goals and ensuring the economic performance of electric mobility requires a high degree of acceptance in society (cf. Dallinger et al., 2011, p. 22).

Against this background, this research approach will focus on public charging infrastructure in the context of electric mobility. A highly attractive public charging infrastructure that is accepted by the early majority can have a positive effect on the diffusion of electric mobility and helps to achieve market penetration. Market penetration is again necessary in order to achieve the political goals as well as its long-term economic performance. In doing so, this research approach takes on the perspective of the user.

Research Gap & Research Questions

Innovations spread relatively fast within the first two segments of Roger's diffusion theory. This can be ascribed to two facts. On the one hand, innovators and early adopters have certain characteristics that make them implement innovations earlier than other members of the society. On the other hand, there are a variety of instruments for involving them into the innovation process. Participating in the innovation process enables them to place their requirements concerning the innovation from the beginning of the development process (cf. Knöchel/North, 2018, p. 8).

Beside instruments that involve innovators and early adopters, there are also instruments that involve regular customers into the innovation process. One of these instruments are focus groups. Their main objective is to boost constructive discussions by bringing together participants with different opinions and attitudes from different point of views (cf. Knöchel/North, 2018, p. 26). Even if the focus group concept focuses on regular customers as participants, it can be assumed that innovators and early adopters still dominate among the participants. Background to this assumption are the characteristics of people within these segments. Only when there is intrinsic motivation, people are motivated and do participate in an innovation process.

This assumption is also supported by von Hippel. He introduced the term "lead user" which can be characterized as people who have new product or service expectations long time before the majority of society has. They also expect a great benefit for themselves as part of an innovation. The expected benefit can be so great that they become innovative themselves and develop products or services (cf. Churchill et al., 2009, p. 7). According to the definition of lead users, they can be classified into the segments of innovators and early adopters according to Roger's adoption segments. Results of a study by von Hippel (2005, pp. 19ff.) show that product and service development is focused on lead users only.

With regards to public charging infrastructure, there are many studies involving lead users. For example, Sucietto (2019, pp. 29ff.) conducted a lead user workshop that aimed at finding possible innovations in the context of the charging experience. In another example Anderson et al. (2018, pp. 2ff.) focus on user preferences for public charging infrastructure and give insights from a survey of 843 early adopter electric vehicle users in Germany.

However, the early majority differs significantly in its characteristics and thus in the decision-making process. Nevertheless, the early majority is the first sizable segment of a population – with a share of 34% of the society – to adopt an innovation. They are an important link in the diffusion process because they interconnect the very early and the relatively late segments. Once this segment has been reached, the diffusion process is a fast-selling item (cf. Rogers, 1983, p. 249).

According to Lucas (2020, p. 76) there is a weakness in research regarding electric mobility in general. Research only deals with innovators and early adopters. However, a potential sale of this technology to the more pragmatic early majority can only be assumed after further technical development or after targeted market influence through suitable marketing concepts. This requires research to focus, among others things, on a segmentation of the market according to Roger's adoption segments.

Lucas' recommendation will be adjusted for this research approach to the area of public charging infrastructure in the context of electric mobility. Today there has not been sufficient research in how the innovation process can be accelerated and how the user acceptance can be increased within the early majority.

Derived from the above mentioned state of the art in literature, this research approach shall give an answer to the following research questions:

1. With regards to public charging infrastructure, how can the innovation process be accelerated?
2. How can the user acceptance of public charging infrastructure be increased within the early majority according to Roger's adoption segments (cf. chapter 3.3.3)?
3. Which past innovations in tech and mobility are suitable for a case study to derive success factors for the innovation process and the user acceptance of public charging infrastructure?

4. Which corporate objectives can be identified in the case studies for the respective innovations in tech and mobility?
5. Which success factors can be derived from these objectives in the case studies?

In order to close the research gap, success factors for the innovation process and the user acceptance will be examined from past innovations in tech and mobility.

Theoretical Background

In this chapter, the theoretical background for processing the research questions will be presented. For this purpose, electric mobility and the role of public charging infrastructure in its context will be explained. Afterwards, the theoretical approach of innovation processes as well as acceptance models will be thematized.

1.1. Electric Mobility

First, an introduction to the term 'electric mobility' will be given. This is followed by an explanation of the charging infrastructure in the context of electric mobility.

Definition of Electric Mobility

Electric mobility is the part of mobility in which vehicles are driven electrically or partially electrically (cf. Yay, 2010, p. 41). According to § 2 EmoG, a distinction is made between three types of electric vehicles: pure battery vehicles, hybrid electric vehicles that can be charged from the outside and fuel cell vehicles. Pure battery vehicles and externally chargeable hybrid electric vehicles are relevant for this work, since these can be charged from the outside via the power grid. Pure battery vehicles only have an electric drive, while hybrid electric vehicles have a combustion engine in addition to the electric drive (cf. § 2 Para. 1-3 EmoG).

Charging Infrastructure in the Context of Electric Mobility

Electric vehicles can be charged via the power grid at private, semi-public or public charging stations. Private charging stations are located on an area that is privately owned and only has access to a limited group of users. This includes, for example, garages and private parking spaces. Company parking spaces can also be assigned to this category if they are only accessible to employees. Semi-public charging stations are located on publicly accessible areas that are privately owned. Charging stations in parking garages owned by private operators, in shopping centres or in leisure facilities can be assigned to this category. Public charging stations are also located on publicly accessible areas. In comparison to semi-public stations, however, these areas are owned by the public sector (cf. Reinke, 2014, pp. 38f.).

For the further course of this research approach, public charging infrastructure will be described in more detail. There are two main roles in the public charging business model: The Charge Point Operator (CPO) and the Electric Mobility Provider (EMP). The CPO is responsible for the installation, operation and service of public charging stations. In addition, the CPO evaluates the charging processes and transmits the billing-relevant data. The EMP, on the other hand, is responsible for the contractual relationship with users of the charging station. He also sets the pricing of customer tariffs and provides access and payment systems (cf. Heiß, 2014, p. 9).

However, since the customer does not actively perceive the roles while using the infrastructure, this research approach will detach from the roles.

Electric Mobility as Innovation

With regards to the mobility industry, a paradigm shift is taking place. Compared to conventional vehicles, electric vehicles require a new business model. While conventional

vehicles are stand-alone products and only need a filling station and a repair station, electric vehicles are much more complex. The value proposition of electric vehicles consists of six key values: The electric vehicle itself, the traction battery, the electricity, the information and communication technology (ICT), the charging infrastructure as well as the parking space (Laurischkat/Viertelhausen, 2017, p. 115). Figure 1 summarizes the values graphically.

Products and services must be developed for all of these values. Due to that, electric vehicles are an integrated solution for customers, since the vehicle itself is part of a product-service system. In addition, the trend is shifting more and more from owning to using. This trend makes such integrated systems increasingly important (Laurischkat/ Viertelhausen, 2017, p. 115).

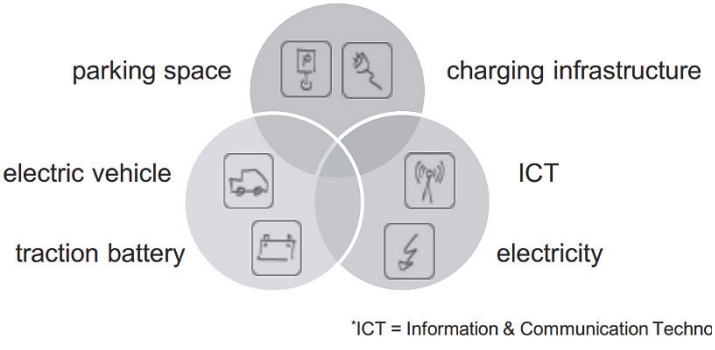

Figure 1: Key values for an electric mobility specific value proposition (Laurischkat/Viertelhausen, 2017, p. 115)

1.2. The theoretical Approach of Innovation Processes

As a framework for identifying success factors for the innovation process, the theoretical approach of innovation processes will be described. First, an introduction to the concept of innovation will be given. Subsequently, the phase model according to Herstatt/Verworn will be presented.

Innovation

With regards to the innovation process, an innovation is understood to be a new feature introduced on the market or in the company. The focus is on changing the type of product or process that is intended to improve the economic success of a company. A novel combination of ends and means is a prerequisite for an innovation. Hauschildt/Gemünden (2011, pp. 5ff.) describe five dimensions according to which innovations can be characterized:

1. Content dimension: A basic distinction is made between product and process innovations. Product innovations describe changes in the range of services, while process innovations describe improvements in the creation process of the range of services.

Electric mobility and the associated charging infrastructure is a product as well as a service innovation since it is a product-service system (cf. Laurischkat/Viertelhausen, 2017, p. 115).

2. Intensity dimension: Innovations can be differentiated according to fact and degree of innovation. In fact, innovation means the uniqueness of a product. This is to be assessed by experts. The degree of innovation describes the difference compared to the previous

situation. As a rule, a distinction is made between 'incremental' and 'radical' innovations. Incremental innovations mean the continuous modification of existing products or services. They bring changes in small steps. Incremental innovations are of great importance for companies. They strengthen the competitive situation, for example through increases in quality or productivity. Radical innovations, on the other hand, are based on scientific knowledge and occur irregularly. They enable the development of new markets and form the starting point for further innovations (cf. Freeman/Perez, 1988, pp. 45f.). Radical innovations are also referred to disruptive innovations (cf. Christensen/Bower, 1996, p. 202).

Electric mobility and the associated charging infrastructure can be characterized as a disruptive innovation (cf. Stephan/Mooser, 2017, pp. 30ff.) because there is a paradigm shift (cf. Laurischkat/Viertelhausen, 2017, p. 115).

3. Subjective dimension: The difference to the previous situation realized through an innovation is always based on a subjective perception. Although this can be objectified, the innovation must always be viewed from the perspective of the respective subject.

4. Normative dimension: Innovations must assert themselves in the company or in the market. This means that a benchmark for innovations is, among other things, the profits made as a result.

5. Process dimension: The development of innovations usually follows a process that is divided into different phases. In general, these phases are the initiative, research, development, market launch and serial production.

Phase Model according to Herstatt/Verworn

Innovation processes describe the course of development of an initial idea into a marketable product or service. Due to the complexity of the process, individual process steps are divided into different phases (cf. Blohm, 2013, p. 14). Phase models are a prerequisite for recognizing decision-making mechanisms and causal relationships in an innovation process (cf. Thom, 1980, p. 51).

In the literature there is a large number of phase models, each of which has its advantages and disadvantages for individual process steps. They differ in their focus, questioning and level of detail (cf. Verworn/Herstatt, 2000, p. 2).

Popular models are the three-phase model by Thom, the stage-gate model by Cooper, the phase model by Brockhoff and the phase model by Herstatt/Verworn.

The phase model by Herstatt/Verworn focuses in particular on the early phase of the innovation process and thus the generation of ideas (cf. Lehnen, 2017, p. 16). Focusing the early phase of the innovation process offers a promising approach for the innovation success (cf. Verworn/Herstatt, 2005, pp. 17ff.). Therefore, the phase model by Herstatt/ Verworn will be used in this research approach.

The phase model by Herstatt/Verworn puts the focus on product development and the diffusion of the product to ensure a greater reference to reality (cf. Lehnen, 2017, p. 16). Figure 2 shows the model which is divided into five phases.

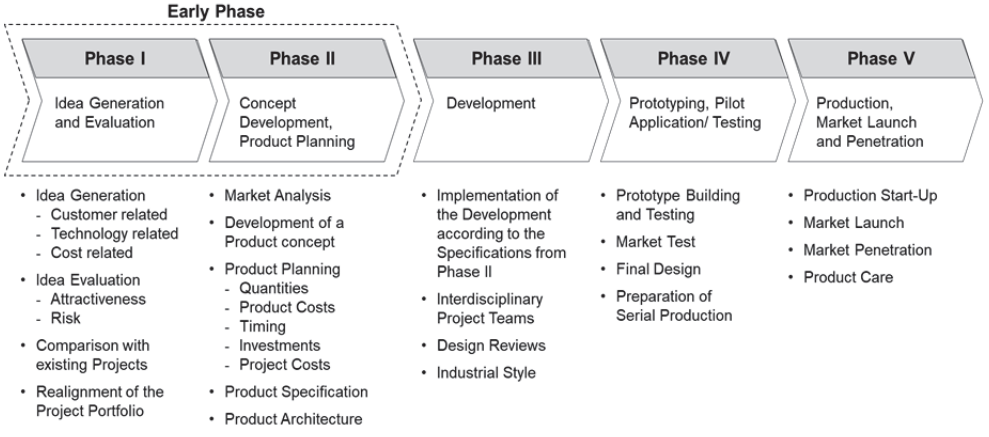

Figure 2: Phase model according to Herstatt/Verworn (own illustration according to Herstatt/Verworn, 2005, p. 17)

The first phase serves to generate and evaluate ideas. A comparison with existing projects takes place and the project portfolio is realigned. The second phase includes concept development and product planning. In this phase, market analyses are carried out first. Based on them, the product architecture with product specifications is developed. In addition, this phase involves concrete product planning with regards to quantities, costs, time, etc. The third phase is for development. In this phase, the products are developed in interdisciplinary teams according to the specifications from phase two. If necessary, a design review will be carried out. Then, in the fourth phase, a prototype is built and market tests are carried out. In this phase, the final design is determined and preparations for the series production are made. Finally, in the fifth phase, production as well as market launch and penetration follow. The last phase also includes product maintenance (cf. Lehnen, 2017, p. 16).

Regarding the phase model by Herstatt/Verworn, the early phase of the innovation process is focused. This includes all activities from the first impulse of an idea to the decision or rejection of the implementation of the concept (cf. Verworn/Herstatt, 2007, p. 8).

1.3. Acceptance Models

As a framework for identifying success factors for the user acceptance, the theoretical approach of acceptance models will be explained. First, an introduction to the concept of acceptance will be given. Subsequently, the technology acceptance model 3 and the diffusion theory will be introduced.

Acceptance

In theory, there is no general, uniform meaning about the concept of acceptance. Rather, there are different definitions, depending on the context (cf. Arnold/Klee, 2016, p. 9). According to Kollmann (1998, pp. 2f.) acceptance, in a business context, is associated with the introduction of an innovation. Acceptance is of particular importance when measuring and forecasting the success of technological innovations, since the introduction of an innovation is not synonymous with acceptance by society. Because not everything that is technically possible brings economic success.

Technology Acceptance Model 3

Originally the technology acceptance model (TAM) was developed by Davis for predicting the individual adoption and use of new information technologies (ITs). It assumes that individuals‘ behavioral intention to use new ITs depends on the perceived usefulness and the perceived ease of use. Perceived usefulness describes the degree to which a user believes that using an IT will improve performance. Perceived ease of use describes the degree to which a user believes that using an IT is effortless (cf. Venkatesh/Bala, 2008, pp. 275f.).

In 2000, Venkatesh and Davis have extended the original TAM by the general determinants of the perceived usefulness. Determinants are the subjective norm, the image, the job relevance, the output quality, the result demonstrability and the perceived ease of use. The extended model is called TAM 2. It aims at explaining the influence of social and cognitive-instrumental process variables on the perceived usefulness. Social process variables mean the subjective norm and the image. Cognitive instrumental process variables mean the job relevance, the output quality, the result demonstrability and the perceived ease of use (cf. Venkatesh/Bala, 2008, pp. 276ff.). Figure 3 explains the determinants.

Determinants	Definitions
Perceived Ease of Use	The degree to which a person believes that using an IT will be free of effort (Davis et al., 1989).
Subjective Norm	The degree to which an individual perceives that most people who are important to him think he should or should not use the system (Fishbein & Ajzen, 1975; Venkatesh & Davis, 2000).
Image	The degree to which an individual perceives that use of an innovation will enhance his or her status in his or her social system (Moore & Benbasat, 1991).
Job Relevance	The degree to which an individual believes that the target system is applicable to his or her job (Venkatesh & Davis, 2000).
Output Quality	The degree to which an individual believes that the system performs his or her job tasks well (Venkatesh & Davis, 2000).
Result Demonstrability	The degree to which an individual believes that the results of using a system are tangible, observable, and communicable (Moore & Benbasat, 1991).

Figure 3: Determinants of perceived usefulness (Venkatesh/Bala, 2008, p. 277)

Moreover, Venkatesh developed a model focusing the determinants of the perceived ease of use. Determinants of the perceived ease of use are the computer self-efficacy, the perception of external control, the computer anxiety, the computer playfulness, the perceived enjoyment and the objective usability. Figure 4 explains the determinants (cf. Venkatesh/Bala, 2008, p. 278).

Determinants	Definitions
Computer Self-Efficacy	The degree to which an individual believes that he or she has the ability to perform a specific task/job using the computer (Compeau & Higgins, 1995a, 1995b).
Perception of External Control	The degree to which an individual believes that organizational and technical resources exist to support the use of the system (Venkatesh et al., 2003).
Computer Anxiety	The degree of "an individual's apprehension, or even fear, when she/he is faced with the possibility of using computers" (Venkatesh, 2000, p. 349).
Computer Playfulness	". . .the degree of cognitive spontaneity in microcomputer interactions" (Webster & Martocchio, 1992, p. 204).
Perceived Enjoyment	The extent to which "the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use" (Venkatesh, 2000, p. 351).
Objective Usability	A "comparison of systems based on the actual level (rather than perceptions) of effort required to completing specific tasks" (Venkatesh, 2000, pp. 350–351).

Figure 4: Determinants of perceived ease of use (Venkatesh/Bala, 2008, p. 279)

A combination of the TAM 2 and the model focusing the determinants of the perceived ease of use results in the TAM 3. Figure 5 visualizes the simplified TAM 3 according to Venkatesh/Bala.

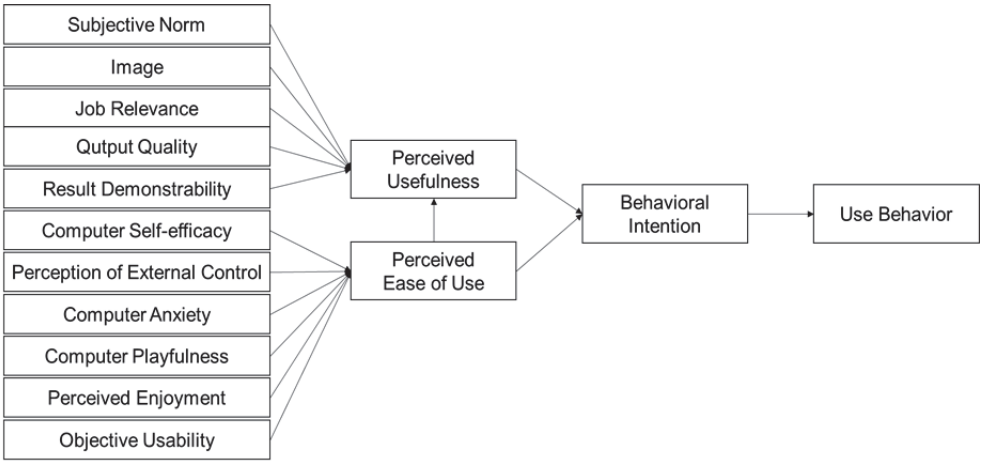

Figure 5: Simplified TAM 3 (own illustration according to Venktesh/Bala, 2008, p. 280)

For this research approach, the TAM 3 will be transferred from ITs to the area of public charging infrastructure in the context of electric mobility. With regards to the acceptance and use of public charging infrastructure, it is therefore assumed that the behavioral intention of individuals to use it depends, among other things, on the perceived usefulness and the perceived ease of use.

Diffusion of Innovations

Roger's diffusion theory deals with the diffusion and the adoption of innovations within society over time. Diffusion is the communication of an innovation over time to all members of a society through various channels and adoption is the decision to implement an innovation. It can be derived which segments of a society implement an innovation in the early phase of diffusion and thus serve as an example for the rest. For this purpose, Rogers creates segments based on the first use of an innovation which depends on the innovativeness of a person. The innovativeness describes the extent to which a person is more willing to implement an innovation than other members in society. The innovation to be communicated always contains something new, something previously unknown to society. This unknown in turn brings with it uncertainty, because neither the structure is known nor there is sufficient information about the functionality of the innovation (cf. Rogers, 1983, pp. 163f.).

There is a so-called innovation decision-making process from getting to know an innovation to confirming the decision.

Since the innovation decision-making process is carried out individually, so-called adoption segments can be formed based on the first use of an innovation. The diffusion of innovations is dependent on four main dimensions: The innovation itself, communication channels, time and the social system (cf. Rogers, 1983, pp. 10ff.).

Figure 6 shows the adoption curve according to Rogers (1983). The x-axis indicates the duration, the y-axis indicates the percentage of willingness to innovate in society. The normal distribution of the curve results from the diffusion effect (cf. Rogers, 1983, p. 247).

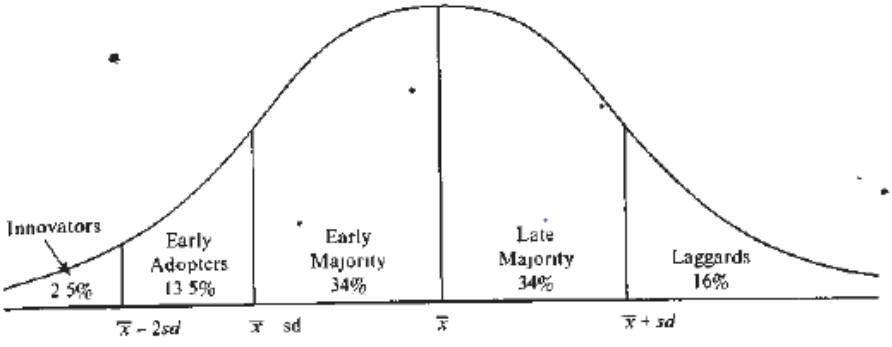

Figure 6: Adopter categorization on the basis of innovativeness (Rogers, 1983, p. 247)

The adoption curve is made up of five segments.

The first segment is formed by the „Innovators“ with a share of 2,5%. Innovators are the venturesome and the ones eager to try innovations. Therefore, they often leave local peer networks. The geographical distance within a clique of innovators can be considerable. They are very cosmopolitan and often live among themselves, cut off from the majority of

society. In order to belong to the group of innovators, some basic requirements must be met. Innovators need to be financially well off to be able to absorb the possible financial losses that the introduction of an innovation can entail. In addition, they must be able to deal with uncertainties and be willing to take risks. Furthermore, it is important for them to be able to cope with setbacks in the event of failure. Innovators play a significant role in the diffusion process because they bring innovation into the social system from outside of the system's boundaries.

The second segment is called „Early Adopters". With a share of 13,5% they are the respectable. In contrast to the innovators, early adopters are more integrated into the social system and have the greatest degree of opinion leadership. They serve as a role model for potential users because they orientate themselves on them, get advice and information. Early adopters are generally sought by change agents because they can speed up the diffusion process. Due to their central role in the communication system, they succeed in reducing uncertainties in the subsequent segments.

With a share of 34% the third segment is formed by the "Early Majority". They are the deliberate and implement innovations before the average member of a social system does. The early majority interacts in local peers on a frequent basis. They are an important link in the diffusion process between the very early adopters and the relatively late ones. This group takes time to think before deciding to implement. Consequently, the usage decision process is, relatively speaking, longer than in the previous segments.

The „Late Majority" forms the fourth segment with a share of 34% as well. They are the sceptical and only implement an innovation when the average member of a social system has already done. Possible motives for an implementation are economic necessity or social pressure. The late majority is very sceptical and cautious when it comes to innovation. Since this group has relatively few resources available in comparison, almost all uncertainties must be eliminated prior to the implementation.

The "Laggards" are the last group to implement an innovation. With a share of 16% they are the traditional. They are based on traditional values and almost resistant to innovation. They are the laggards and almost excluded from society because they don't keep up with the times. Innovations are usually only implemented when the innovators are already using new technologies again. The traditional orientation of this group delays the diffusion process immensely (cf. Rogers, 1983, pp. 248ff.).

The figure of the adopter segments shows that innovations spread relatively fast within the first two segments. People within these two segments are open minded toward change and good in coping with uncertainty and risk (cf. Rogers, 1983, pp. 257f.).

This research approach focuses on the early majority as electric mobility and the associated charging infrastructure are soon entering this segment. The early majority differs significantly in its characteristics from the first two segments. In this research approach the characteristics that Rogers names for earlier adopters will be transferred to the early majority. Consequently, the following characteristics will be derived for people who belong to the early majority (cf. Rogers, 1983, pp. 251ff.):

Socioeconomic Status	Personality Variables	Communication Behavior
- medium educated - medium literated - medium Social Status - medium Degree of upward Social Mobility - medium-sized Units - Subsistence Orientation - deliberate Attitude toward Credit - not that specialized Operations	- mediocre Ability to deal with Abstractions - mediocre Rationality - mediocre Intelligence - mediocre favorable Attitude toward Change - mediocre Ability to cope with Uncertainty and Risk - mediocre favorable Attitude toward Education - mediocre favorable Attitude toward Science - fatalistic to some Extent - medium Levels of Achievement Motivation - medium Aspirations (Education, etc.)	- mediocre Social Participation - mediocre interconnected in the Social System - network mostly within their Social System - moderate Change Agent Contact - less Exposure to Mass Media Communication Channels - less Exposure to interpersonal Communication Channels - basic Knowledge of Innovations - medium Degree of Opinion Leadership - do not belong to highly interconnected Systems

Table 1: Characteristics of the early majority according to Rogers (own illustration according to Rogers, 1983, pp. 251ff.)

1.4. Success Factors for Innovation Success

For the evaluation of innovation success, objectives must be set prior to the innovation process. They serve as reference level by which an innovation will be evaluated (cf. Hauschild, 1990, pp. 14f.).

In order to increase the probability of success, “Critical Success Factors […] are used to support and evaluate the success of a strategic and tactical approach in project implementation […] “ (Asgari et al., 2018, p. 228).

Critical success factors are defined as a few key areas of activity where organisation performance is ensured by satisfactory results (cf. Bullen and Rockart, 1981, p. 3). According to Leidecker/Bruno (1984, pp. 27ff.) these can be characteristics, conditions and variables that are mainly responsible for the organisational success.

Electric mobility and the associated charging infrastructure can be seen as an innovation project (cf. chapter 3.1.3). For this reason, a new model will be developed in this research approach. It aims to identify success factors for accelerating the innovation process and increasing the user acceptance of public charging infrastructure within the early majority of Rogers diffusion theory. The success factors will be based on two pillars: The innovation process and the user acceptance.

Figure 7 visualizes the proprietary development of the new model.

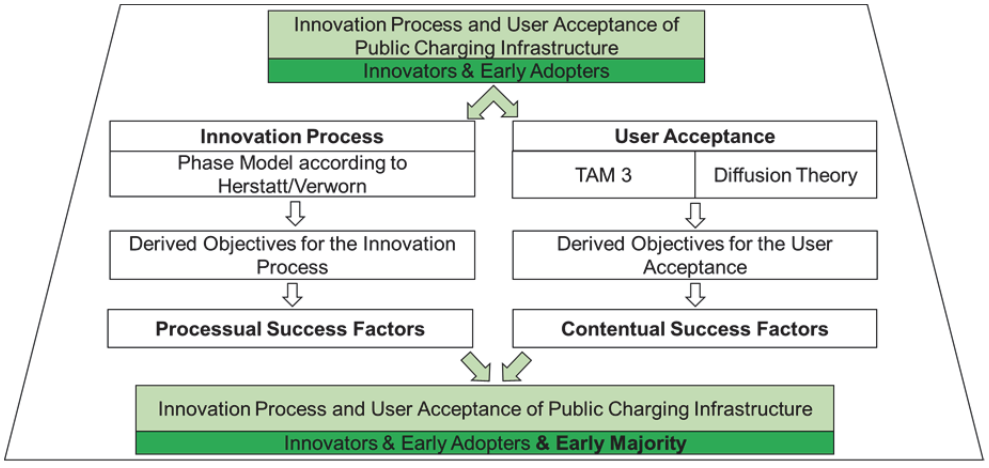

Figure 7: Model for deriving success factors for the innovation process and the user acceptance (proprietary development)

In a first step, objectives will be defined. Regarding the innovation process, objectives will be based on the phase model according to Herstatt/Verworn. It focuses on the early phase of innovation in which success factors are crucial (cf. chapter 3.2.2). With regards to the user acceptance, the TAM 3 and the diffusion theory will be consulted for defining objectives. The TAM 3 focuses on technologies (cf. chapter 3.3.2) whereas the diffusion theory deals with the diffusion of innovations within society over time (cf. chapter 3.3.3).

In a second step, the defined objectives serve as a basis for deriving processual success factors for accelerating the innovation process and contentual success factors for increasing the user acceptance.

Objectives derived from the Phase Model according to Herstatt/Verworn

In the following, objectives for the innovation process will be derived from the phase model according to Herstatt/Verworn (cf. chapter 3.2.2.). Figure 8 visualizes the derivation of the objectives.

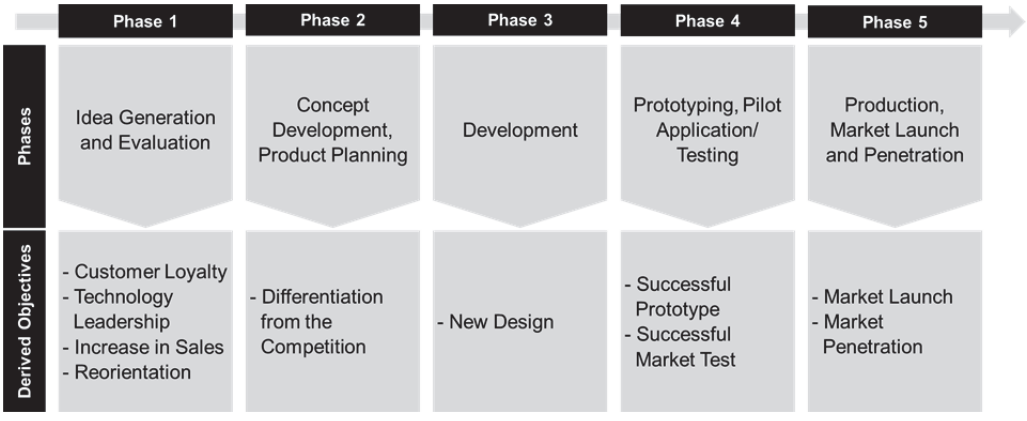

Figure 8: Derived objectives from the phase model according to Herstatt/Verworn (proprietary development)

According to Herstatt/Verworn, phase 1 focuses on generating new ideas. These ideas have to be customer-, technology- and cost-oriented. From these specifications it can be derived that an innovation should lead to customer loyalty, technology leadership as well as an increase in sales. The idea must be attractive and low risk. In addition, it must differ from existing projects. Due to that, reorientation will be important.

In the second phase, the focus is on developing an innovation concept. Market analyses play an important role. With regards to the product specification and architecture, differentiation from the competition is crucial.

Phase 3 deals with the development of the previous defined concept. Based on the previously defined specifications of the innovation, the development should have a new design.

After the development, a prototype will be built and the innovation will be tested. This is subject of phase 4. A functioning prototype and a successful market test are objectives to strive for.

The last phase is focusing the market launch as well as the market penetration. Successfully completing both must be the top priority to accelerate the innovation process.

Success Factors for the Innovation Process

Based on the above mentioned objectives from the phase model according to Herstatt/Verworn, success factors for their achievement will be derived. In turn, the success factors contribute to accelerate the innovation process.

Figure 9 visualizes the success factors according to the respective objectives within the phases. One success factor to retain customers is the embedding of the innovation into an ecosystem. A holistic system creates a bigger barrier to change and customers are more likely to stay. In order to become technology leader, investments in research are required whereas reorientation can only succeed with an innovation mindset. Furthermore, the subscription business model can be a success factor to increase sales since customers pay regularly.

Differentiation from the competition requires knowledge about their activities. Environmental and competitor analyses are essential to position an innovation competitive in the market.

The intended objective of a new design requires following trends as well as new perspectives. Therefore, investments in development teams are absolutely necessary.

Furthermore, proper preparation is required to successfully build a prototype. Once a prototype is built, a structured test management is required for an innovation to successfully pass the market test. It allows the systematic identification of possible gaps.

After an innovation has been successfully developed and tested, the use of marketing measures is essential with regards to the market launch. Potential users must be informed about the existence of the innovation as well as its advantages.

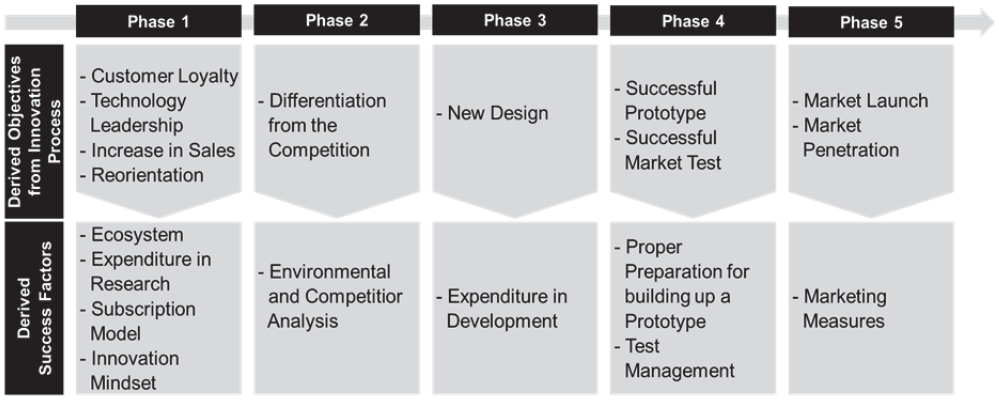

Figure 9: Derived success factors from the phase model according to Herstatt/Verworn (proprietary development)

Objectives derived from the TAM 3 & Diffusion Theory

In the following, objectives for the user acceptance of innovations will be derived from the TAM 3 (cf. chapter 3.3.2) and the diffusion theory (cf. chapter 3.3.3).

First, the TAM 3 will be considered. The determinants of the perceived usefulness and the perceived ease of use will be used as a basis for defining possible objectives. In doing so, the perceived ease of use as a determinant of the perceived usefulness will be left out, since other determinants affect it. Figure 10 visualizes the derivation of the objectives.

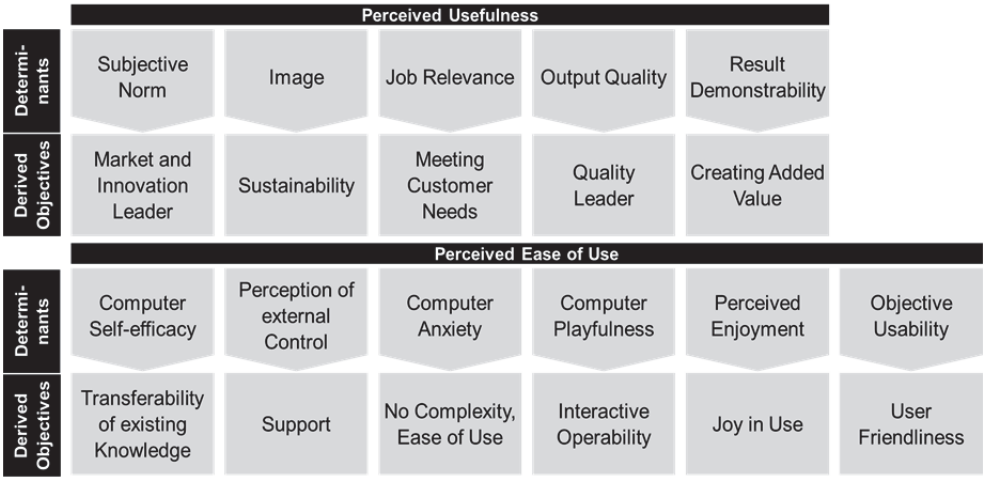

Figure 10: Derived objectives from the TAM 3 (proprietary development)

The subjective norm is the first determinant of the perceived usefulness. Since it describes the perception of the innovation by third parties, achieving market and innovation leadership is an objective to strive for.

Furthermore, the perceived usefulness is determined by the image which has an effect on the social status. Nowadays sustainability is becoming more and more important and the

use of sustainable products confers social status. Due to that, sustainability should be on the agenda.

The job relevance is the third determinant of the perceived usefulness. The focus here is on applicability to one's own use case. This can only be achieved by meeting customer needs.

Moreover, the perceived usefulness is determined by the output quality. In order to ensure good quality, quality leadership should be striven for.

The result demonstrability is the last determinant of the perceived usefulness. With regards to the result, the creation of added value is essential.

The perceived ease of use is, among other things, determined by the computer self-efficacy. Since it deals with the ability one has to perform a specific task using the innovation, transferability of existing knowledge should be an objective. Transferring existing knowledge is easier than learning new one.

The perception of external control, as second determinant of the perceived ease of use, deals with resources to support the use of an innovation. This is why support measures should be offered by the company.

The computer anxiety is the third determinant of the perceived ease of use. In order to not make the application difficult for the customer, no complexities should be included. Rather, ease of use is important.

Due to the fact that the perceived ease of use is also determined by the computer playfulness, interactive operability should be aimed for.

Furthermore, the perceived ease of use is determined by the perceived enjoyment. The higher the level of enjoyment when using an innovation, the more likely it will be bought. Therefore, the joy in use should come first.

The last determinant of the perceived ease of use is the objective usability. Here, user friendliness is very important. The innovation has to be easy in use and assert itself against the competition.

In a second step, the diffusion theory will be considered. Here, the characteristics of the early majority will be used as a basis for deriving possible objectives. Figure 11 visualizes the derivation of the objectives.

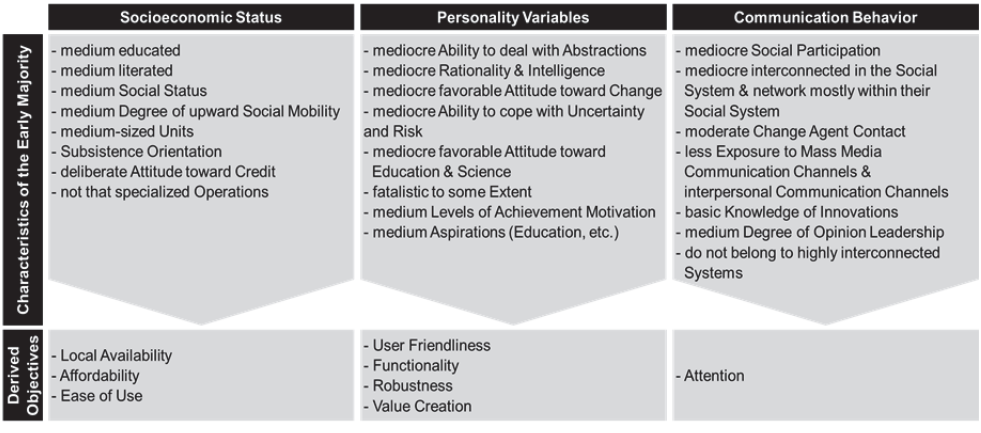

Figure 11: Derived objectives from the diffusion theory (proprietary development)

The socioeconomic status of the early majority is mediocre. Since they have a medium social status, the affordability of an innovation is an important objective. From their subsistence orientation, it can be deduced that innovations must be available locally. Furthermore, the early majority is medium educated as well as medium literated. Due to that, the ease of use is crucial.

With regards to the personality variables, it can be said that they have medium aspirations, for example regarding education. They are mediocre intelligent and do not have a favorable attitude toward science or change. Their rationality and ability to deal with abstractions is mediocre as well. For them, functionality and robustness are crucial. Since they have a mediocre favorable attitude toward change, the user friendliness of innovations is beneficial. The easier the use of an innovation is, the more likely it will be used. Moreover, value creation is beneficial as well.

The communication behavior of the early majority is mediocre, too. They network mostly within their social system and do not belong to highly interconnected systems. Their knowledge of innovations is basic. With regards to objectives, creating attention to innovations is a basic requirement.

Success Factors for the User Acceptance

Based on the above mentioned objectives from the TAM 3 and the diffusion theory, success factors for their achievement will be derived. In turn, the success factors contribute to increase the user acceptance.

Figure 12 visualizes the success factors derived from the TAM 3.

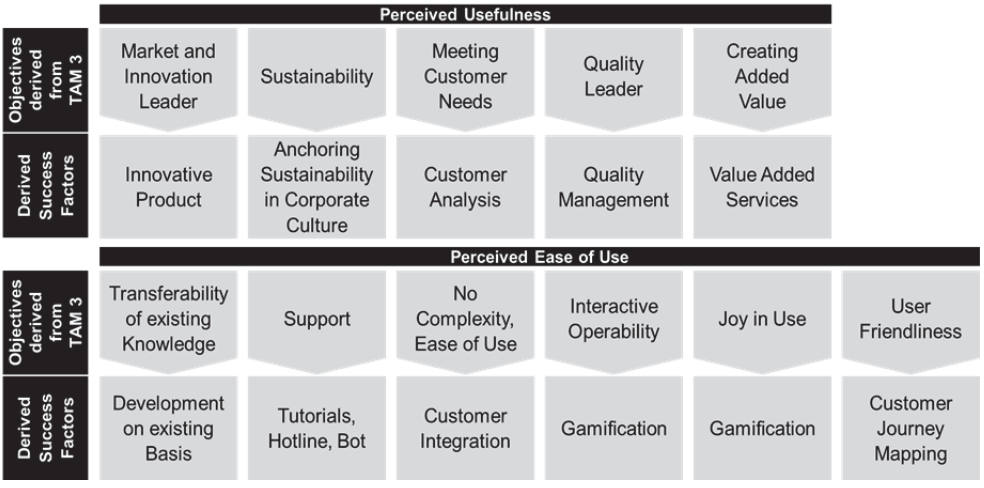

Figure 12: Derived success factors from the TAM 3 (proprietary development)

In order to prevail against the competition and to become market and innovation leader, innovative products are absolutely necessary. They help to stand out from the competition and offer customers something new.

Furthermore, sustainability plays an important role with regards to user acceptance. In order to achieve this objective, sustainability must be anchored in the corporate culture. Additionally, a promotional image will be achieved as a side effect.

However, one of the most important objectives is meeting customer needs. Therefore, a detailed customer analysis is required at the beginning of the innovation process.

Another intended objective is quality leadership. This can only be achieved with the help of strategic quality management. Strategic quality management allows a systematic approach and thus the identification of weak spots.

Adding value to the actual product is important with regards to user acceptance as well. Offering additional services will be a promising success factor for that.

To simplify the handling of an innovation, transferability of existing knowledge is a key to success. It can be guaranteed when the development of the innovation takes place on an already existing basis.

Support is one of the most important services when it comes to innovation. It helps to solve problems and to minimize uncertainties. Support can be provided through various channels, e.g., a hotline, a bot or tutorials.

So that the support does not have to be called upon in the first place, the innovation should not be very complex, rather easy to use. Customer integration into the innovation process allows to experience first-hand what ease of use means.

With regards to the interaction between the system and the customer as well as the joy in use, gamification will be a key to success. The playful operation guides the customer individually and brings joy at the same time.

Moreover, user friendliness is very important when it comes to innovations. Therefor customer journey mapping is a valuable tool. It helps to understand customers' needs and provides them with a value-added experience.

Figure 13 visualizes the success factors derived from the diffusion theory.

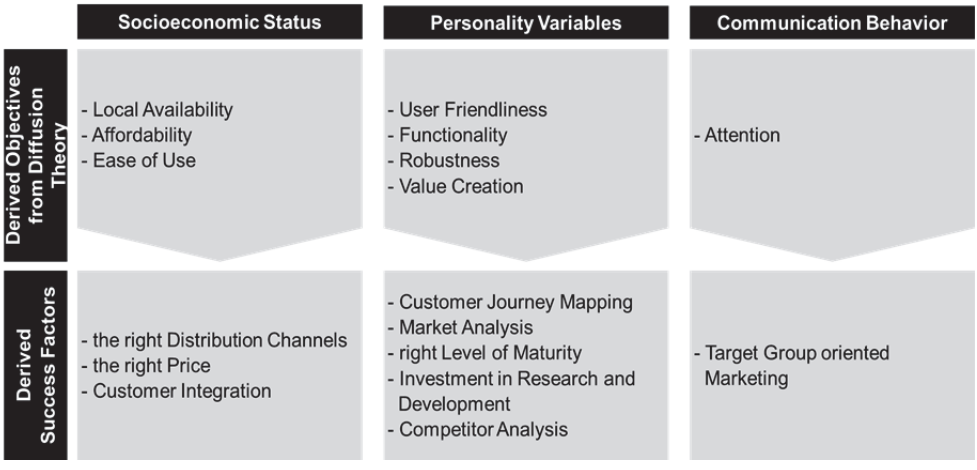

Figure 13: Derived success factors from the diffusion theory (proprietary development)

Local availability and affordability of an innovation are crucial to achieve user acceptance within the early majority. Choosing the right distribution channel and the right price are appropriate success factors.

Moreover, the ease of use is an important objective as well. As already mentioned, customer integration into the innovation process allows to experience first-hand what ease of use means.

Additionally, user friendliness is a prerequisite when it comes to acceptance. As already said, customer journey mapping is a valuable tool for offering user friendliness since it helps to understand customers' needs.

In order to guarantee the functionality and robustness of an innovation, market analyses carried out in advance and the right degree of maturity are two success factors.

Value creation is beneficial with regards to user acceptance. Competitor analyses as well as sufficient investments in research and development contribute to that.

The early majority networks mostly within their social system. Target group oriented marketing is the appropriate success factor to get their attention.

In summary, the following processual and contentual success factors can be identified for accelerating the innovation process and increasing the user acceptance of public charging infrastructure:

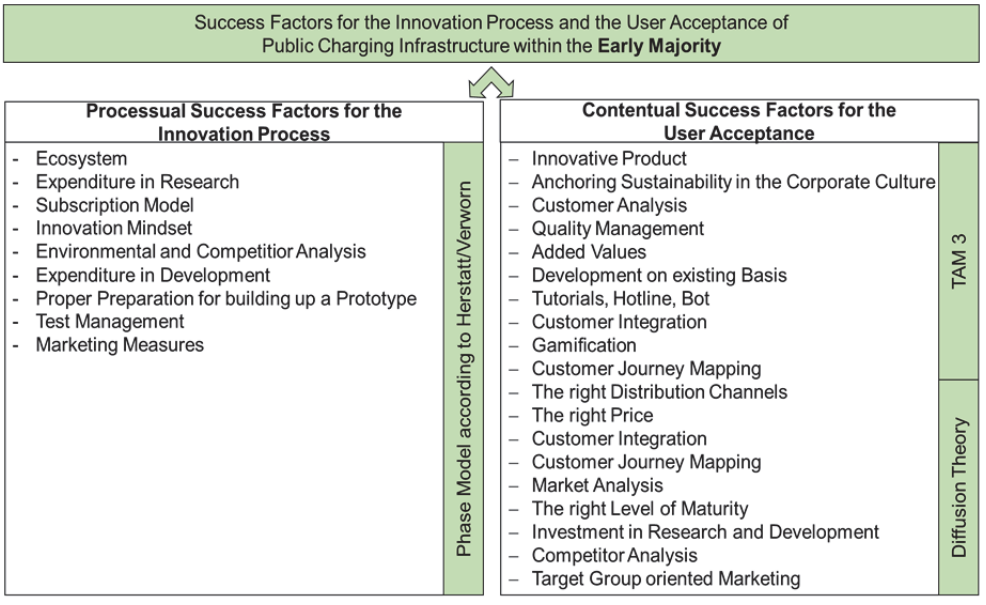

Figure 14: Success factors for the innovation process and the user acceptance (proprietary development)

Research Design and Methodological Approach

In order to answer the research questions mentioned in chapter 2, success factors for the innovation process and the user acceptance of public charging infrastructure will be examined in case studies from past innovations in tech and mobility.

According to Bauer/Schimpf (2018, p. 23) a look into the past is worthwhile in the field of industrial innovation. It helps to better understand the present and to shape the future successfully. This procedure will be transferred into the field of tech and mobility. Therefore, past innovations and their diffusion into the early majority will be examined using the methodology of case study analysis. The case study method is characterized by its flexibility in relation to the object of investigation. It is particularly suitable for research questions that focus on new phenomena or phenomena that have only been recorded in rudimentary approaches (cf. Bonoma, 1985, p. 204).

Beside successful innovations, failed innovations will also be taken into account. These are suitable for deriving learnings and consequently making recommendations for future innovations. Regarding each case, two data collection methods will be used for answering the research questions: A structured literature review and expert interviews.

Discussion

After completing the empirical research, a discussion will follow. With regards to the research questions mentioned in chapter 2, a comparison will be made between the state of the literature and the results of the empirical research. Furthermore, the advancement of knowledge will be described in further research.

Conclusion

This research approach focuses on accelerating the innovation process and increasing the user acceptance of public charging infrastructure in the context of electric mobility.

For this purpose, a model was developed which identifies success factors specifically for the early majority of Roger's adoption segments.

On the one hand, there are processual success factors for the innovation process and on the other hand, contentual success factors for the user acceptance. Examples for processual success factors are building an ecosystem and conducting environmental as well as competitor analyses. Value added services and gamification are examples for contentual success factors.

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