

AI for Future Mobility: What Amount of Willingness to Change Does a Society Need?

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Abstract: In addition to demographic changes in society, the success of modern forms of mobility such as automated vehicles and new mobility models is increasingly contingent on the acceptance by users from the local community. Various factors influence acceptance and the related concepts of willingness or resistance to change. A distinction can be made between general and specific willingness to change. General willingness to change is an attitude of users towards innovations, whereas specific willingness to change is situation-specific and relates solely to a specific change and its process. In the project *Rethinking Mobility* at the University of Wuppertal (Bergische Universität Wuppertal), the question is investigated of how to overcome resistance, enhance acceptance towards new mobility concepts and how the best basis can be created for users to form individual's opinion on future mobility concepts. In addition, users should be enabled to perceive the advantages of new solutions and to compare them with their own values and standards. From the project's point of view, a holistic view of the complex topic of technically assisted forms of mobility is crucial for the implementation of new mobility concepts. In particular, the advantages of the integration of artificial intelligence (AI) will be examined in the project.

1 INTRODUCTION

The cities of Wuppertal, Solingen and Remscheid form the Bergisch City Triangle (Bergisches Städtedreieck) and are faced with large altitude differences within and between the three urban areas. Between the lowest and the highest area in the Bergisch City Triangle there are 325 meters of altitude difference. All three urban areas differ in altitude more than 200 m. Within the city limits of Remscheid, the difference is even more than 280 m (bgmr, 2020). This results in many meters in altitude that citizens and visitors of the Bergisch City Triangle have to cover on their way through the region. Almost 200,000 people commute to or from one of the three cities every day (IT.NRW, 2017). Combined with the 85% of the citizens of the Bergisch City Triangle that use mobility solutions on a daily basis, a huge number of people move within the region every day (Nobis, Kuhnimhof, Follmer, & Bäumer, 2019). These people need mobility possibilities that meet their needs under the given circumstances and make their journey as pleasant as possible. In addition to the special features of the Bergisch City Triangle mentioned, megatrends

such as demographic change and urbanization occur as well. For the cities of the Bergisch City Triangle, as for Germany as a whole, it is predicted that the average age of the population will increasingly rise in the coming years. This will change the needs and requirements for mobility solutions in the future. Next to this, many cities in Germany are faced with an increasing number of mobility users. Based on this, a mobility concept that adapts the needs of all user is becoming increasingly necessary. Successful mobility concepts of other major German cities such as Cologne or Munich cannot be transferred to the Bergisch City Triangle without further ado. The spatial and socio-spatial conditions of a city have a direct influence on the acceptance or rejection of new mobility options by its citizens. Similar to companies, culture and history have a considerable influence on the reaction of citizens. As an example, offers like bike sharing, which are highly accepted in cities with a long-standing cycling culture such as Münster, Bremen or Karlsruhe, cannot be transferred to cities with a different cycling culture. In future mobility concepts, the region of the Bergisch City Triangle must be considered as a whole and yet in its

uniqueness in order to find ideal solutions for existing challenges and circumstances. Furthermore, for a successful introduction of new mobility concepts it is crucial to satisfy the users' needs of mobility. It is important to detect and define specific factors that influence someone's willingness to change to enable the modernization of the mobility concept of the Bergisch City Triangle. The willingness to change is one of the crucial factors to increase the acceptance for innovations within the whole society of the region. The connection between acceptance and willingness to change as well as the importance of both concepts for the success of future mobility in the Bergisch City Triangle is explained in the following. Next to this the reasons why the citizens' acceptance and the early involvement of society are decisive criteria for a successful introduction and conversion of new mobility concepts will be discussed. To understand the challenge for a change on short notice insights in the environmental key characteristics in times of digital transformation and industry 4.0 are given next.

2 ENVIRONMENTAL CONTEXT

People tend to assume that people know how other people will behave in a given situation. The assumption that people's behavior is that easy to understand leads to the persuasion that technical systems and machines can easily replicate human behavior. This hypothesis is not tenable, since human behavior is only rarely that unambiguous that it can be predicted correctly. With regard to the needs of potential users, it is often concluded that some people can formulate their own needs and generalized the results to the entire urban population. This presumption implies the risk that core needs of potential users will not be considered and that new mobility concepts will not be adopted because they miss out on the users' needs. Especially in technical areas, it is frequently expected that innovations which can objectively be perceived as useful and technically well implemented will be accepted by users as soon as the technical improvement over existing offers is recognized and the advantages are properly explained. The reasons why this approach is not sufficient to explain human behavior in its entirety are discussed in the following subchapter.

2.1 Human Behavior

In order to understand how people deal with innovations and environmental changes, it is important to understand what constitutes and affects

human behavior. The unique aspect of humans compared to existing robots and machines is that humans can behave differently under similar conditions. Machines and robots have an inhuman and sometimes frightening effect on humans due to their "perfect" reactions. Human behavior is diverse and has complex causes that can be traced back to the interaction of various factors. Therefore, it is difficult to predict human behavior with any certainty. Human behavior is not driven by reflexes and drives and can rarely be replicated. Reactions to the same environmental conditions can be completely different from one time to another, since human behavior is the result of the interaction of numerous internal and external factors. Factors such as previous experiences and mood affect type and extent of behavior. In addition, factors such as group dynamics, environmental factors and individual personality traits have a considerable influence on human behavior (Freyth, 2017). Events that appear to be unrelated to the actual situation can fundamentally influence a person's judgement and consequently their reaction (Williams & Bargh, 2008).

A characteristic that builds the foundation for acceptance of environmental changes, such as the preferred type of mobility, is willingness to change. Willingness to change is, next to competence to change and possibility to change, an element of the individual intelligence to change. Intelligence to change refers to the ability of a person to adapt to changing circumstances. Among intelligence to change, willingness to change defines, the individual's readiness to accept change and to embrace innovations (Baltes & Freyth, 2017). This does not mean that a person unconditionally accepts and integrates innovative alternatives into his or her everyday life but rather that the person is generally convinced that using the new alternatives is a possibility (Baltes & Freyth, 2017). The degree and access to one's personal willingness to change depends on the situation and can vary significantly according to environmental conditions.

Direct and moderating factors of willingness to change can be distinguished in risk and protective factors. On one hand, risk factors are factors that potentially weaken the willingness to change. Protective factors, on the other hand, are factors that enhance willingness to change and create ideal circumstances for a person to be open to change and new experiences. Risk and protective factors can further be divided into biological, psychological and social factors. All relevant factors are directly or indirectly related to the shown behavior and influence its occurrence either positively or negatively. In

addition to risk and protective factors, there are also neutral factors that have no influence on willingness to change or situation-related behavior (Figure 1).

Within the context of mobility, risk and protective factors of potential users' willingness to change can be defined. Risk factors are the factors that hinder or negatively influence openness towards new mobility concepts. Protective factors favor and promote acceptance in mobility context. Freyth (2017) identifies several factors that generally foster openness to new ideas regardless of the current situation, namely the general willingness to change. These factors include traits such as curiosity, optimism, frustration tolerance and risk affinity. Willingness to change is a trait that is rather consistent over time due to its connection to the Big Five personality traits and can be trained or encouraged within a biologically predetermined extent (Freyth (2017)).

It is a time-consuming and divided process to define which factors are crucial to encourage both general and specific willingness to change. Specific willingness to change is situation-related. This type of willingness to change is connected but does not depend on one's general willingness to change. In order to increase the specific willingness to change, it is important that the need for change is transparent and plausible for the individual. Unless the reasons for the present situation cannot be maintained are communicated sufficiently, it is difficult even for people with a strong general willingness to change to be open to change. The advancement of willingness to change is an interaction of general and specific willingness to change (Freyth, 2017).

At present no studies on a universal understanding of acceptance factors for future mobility innovations have been published. Particular applications have been examined and the acceptance of these technologies have been surveyed. A comprehensive presentation regarding the acceptance of entire mobility concepts including hard and soft facts has not yet been established. One reason for this shortage might be the fact that very few cities began to implement a fully integrated smart mobility concept yet. With regard to the improvement of acceptance, willingness to change is mentioned as a fundamental criterion in the organizational field. In the organizational context a high willingness to change among employees is a key factor for the company's success, as willingness to change is closely linked to innovation orientation (Franklin & Krüger, 2017). For a continuous competitiveness it is essential for companies to manage change and to explore innovations. In order for this to work successfully at

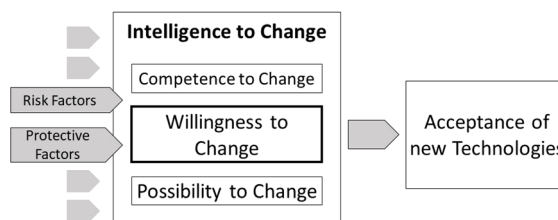


Figure 1: Factors of Willingness to Change

an increasingly rapid pace, an early and long-term review of the risk and protective factors of willingness to change is essential for the success of a change process.

Since there are no studies on willingness to change in the mobility sector yet, it is questionable to what extent connections can be transferred from an organizational context to a mobility context. Studies on acceptance of mobility concepts can be built upon findings from organizational research and evolve from there. Specific conditions that have to be considered for research on acceptance and willingness to change in the mobility sector of the Bergisch City Triangle will be explained in the following.

2.2 Mobility Revolution

For a revolution of current mobility systems, a holistically designed model that is available at short notice is crucial in order to keep track of and act to global technology development, to achieve climate goals and at the same time to meet the citizens' needs. Cities and city councils have a major advantage in achieving their set goals if citizens are open to new forms of mobility and are keen to explore new offers. This is the only way to counteract the trend of rising car numbers and the resulting increase in traffic jams in most city centers. Openness to mobility changes can be optimized and supported by targeting the greatest possible willingness to change of citizens when implementing new mobility offers and formulating them accordingly.

Based on the assumption that the distribution of willingness to change among mobility users shows a similar distribution as innovation projects it can be assumed that 1/3 of all users show a high willingness to change and are very curious about new possibilities (Rogers, 1962). According to Rogers' diffusion theory (1962) it can be assumed that 1/3 of potential users will seldom or even never interact with new possibilities as long as the innovation is new and unfamiliar. They start to use an innovation if the product or process is fully integrated into the everyday life. On the remaining 66 % risk and

protective factors have a crucial impact. In addition to previous personal experience and the general willingness to change, the way to address innovations and convey information is critical to the acceptance of all kind of innovations (Freyth, 2017).

To increase willingness to change it is crucial to communicate the necessity of (behavioral) change in a comprehensible way. In mobility context concerns and fears of users need to be considered. In addition, disadvantages of the current mobility solutions should be communicated transparently. To actively shape the future of mobility in cooperation with potential users, a change of faith among potential users should be initiated, and a process of rethinking initiated. A project of the University of Wuppertal investigates how acceptance of new mobility concepts are distributed among citizens of the Bergisch City Triangle and which factors have a positive or a negative effect on the acceptance of a general and inclusive mobility solution.

3 RETHINKING MOBILITY

Defining the possibilities of artificial intelligence (AI) within the mobility revolution and a sustainable development of new forms of mobility is a major goal of modern mobility concepts of the Bergisch City Triangle for the next years. The cities of Wuppertal, Remscheid and Solingen are cooperating with local transport companies, an economic development agency, an automotive supplier and the University of Wuppertal on a certain real-life laboratory project called *Bergisch.Smart_Mobility*. Funded by the Ministry of Economic Affairs, Innovation, Digitalisation and Energy of NRW in Germany the project *Bergisch.Smart_Mobility* aims to implement AI as an enabler of future mobility until the end of 2021.

Four subprojects have been defined within the larger project *Bergisch.Smart_Mobility* that deal with different perspectives and methods on artificial intelligence as enabler for the future of mobility. The subprojects conduct on one hand insights in technical future topics such as Smart Vehicle Architecture, On-Demand Services and AI-based Traffic Management. On the other hand, in the project *Rethinking Mobility* an integrated approach to modernize forms of mobility in the Bergisch City Triangle in a sustainable manner and the development of holistic solutions is researched. The latter is the foundation of the planned research of users' acceptance and resistance. A more detailed insight into the objectives and methods of

Rethinking Mobility as well as the projects structure will be given in the following sections.

3.1 Project Objectives

The goal of artificial intelligence as an enabler for future mobility is closely linked to major social and economic challenges. The ideal transport system does not only need to be technically successful, but also have to meet the needs and requirements of citizens and providing companies. Furthermore, only a few ethically relevant challenges of new mobility forms and technologies can be solved without considered the larger context. Even though there is a great interest in smart mobility solutions on both sides, the provider and the potential user, prior to *Bergisch.Smart_Mobility* there were no successful and sustainable restructured concept of a connected mobility for the Bergisch City Triangle that combine the various needs and interests within a holistic solution.

An investigation on general requirements and expectations of potential users of intelligent mobility systems illustrates the challenge: Many citizens are convinced that modern mobility systems are mainly relevant for the industry and they do not see any need for personal action. Accordingly, the willingness to actively engage in the mobility revolution is not very pronounced. In shaping future networked communities and regions, the involvement and commitment of citizens and civil society as well as companies is particularly important. The Bergisch City Triangle offers good structural conditions for a joint and cooperative path into the future of mobility. Within the framework of *Rethinking Mobility*, an innovation ecosystem will be established for AI-based mobility in the Bergisch City Triangle which empowers citizens, qualifies skilled workers, encourages entrepreneurs and refreshes established educational structures.

3.2 Solution Strategy

In the context of the entire research project *Bergisch.Smart_Mobility*, the subproject *Rethinking Mobility* serves as a source for comprehensive information about developments in the larger project in a broad dialogue all significant stakeholders. Furthermore, requirements for AI-based mobility systems and user needs are identified as well as economic and ecological potentials and challenges are analyzed. In order to promote acceptance and the implementation of new mobility concepts, factors for the acceptance of future mobility concepts are

identified and interpreted in the further course of the project to generally foster acceptance. To achieve these goals, it is important to consider the willingness to change and other influencing factors of acceptance. Within the subproject *Rethinking Mobility* two large scientific studies will be examined to fully explore the mechanisms underlying an increased or decreased acceptance. Firstly, interviews will be conducted with experts and key figures of mobility related topics. The aim of the interviews is to define potential needs and requirements of mobility user. Based on the results of the interviews a quantitative survey will be conducted to explore the actual acceptance of mobility concepts satisfying the former defined needs. By this survey a large number of participants will be asked to receive results that can be generalized for the Bergisch City Triangle. The factors that will be defined within the survey to enhance and defend the acceptance of smart mobility concepts will be examined in more detail. The role of willingness to change will be explored if necessary to answer questions regarding acceptance. Crucial for the entire subproject *Rethinking Mobility* is to involve civil society in the development of smart solutions in order to design effects sustainable. This interdisciplinary and integrated approach may offer potential for receiving new insights that has not been detected so far.

In addition to the focuses already mentioned, a dissertation is conducted within the context of *Rethinking Mobility*. The aim of the dissertation is to develop a model that encourages the willingness to change of the users of modern mobility solutions. The model is expected to provide general recommendations for introduction forms and methods to support willingness to change with regard to new mobility concepts. Subsequently, it should be investigated to what extent the model can be transferred to other regions and cities. In many modern mobility concepts cities intensively consider the integration of artificial intelligence. Several cities have started first pilot projects. Among implementations and offers of AI companies, it is important for cities and local authorities to consciously choose certain opportunities of artificial intelligence in relation to their goals. Technical solutions should not only be used because they are available but because they fulfil a need. Local authorities take their own decisions and accompany the resulting development and implementation. The first step towards intelligent mobility systems is learning about opportunities and needs. Local authorities, citizens and company representatives can analyze how artificial intelligence is integrated into other regions and the local effects of these initiatives.

At the same time, their own competences should be applied and integrated into social discussions. Finally, it is essential to raise awareness for the complex challenges and opportunities arising from the use of artificial intelligence for economy, society, politics and science, and to guide relevant stakeholders more closely to the subject.

By dealing with something new or unknown like AI, personal knowledge limitations are reached by individuals. When engaging in something unfamiliar, personal mental order structures, for example the degree of familiarity with a technology, are put into perspective. Once the technology is familiar and users trust it, users use it. In order to ensure curiosity and interest rather than a defensive reaction, understanding plays a special role (Schönefeld, 2016). For this reason, the main goal of the project *Rethinking Mobility* is to provide information about AI and new mobility technologies that will be available in the future (Schönefeld, 2016). The different participation and research formats of *Rethinking Mobility* are supported by an interdisciplinary team of experts. The project will make a significant contribution by integrating citizens as well as SMEs as designers and users in the innovation ecosystem and thus to use artificial intelligence comprehensively as an enabler for future mobility.

4 SUMMARY

The mobility revolution is inevitable and most cities and local authorities currently face the challenge to develop sustainable and green mobility solutions in the short term to fulfil the users' and providers' needs as well as the political requirements. A comprehensive reorientation of local authorities is required to inform citizens about new mobility concepts at an early stage and to involve the community within the development process. This is the sole way to enhance acceptance among citizens.

In order to improve the acceptance of modern mobility solutions in the Bergisch City Triangle of Wuppertal, Solingen and Remscheid, it is essential to take an interdisciplinary and integrated view of the subject area, as proposed by the project *Rethinking Mobility* at the University of Wuppertal. The substantial acceptance of innovative concepts is appropriate as a certain number of users has to be reached in order to sustainably implement an innovation. If a majority of citizens accept an innovation other people are also open to test or even use a new technology. A city needs a society that is

open to new ideas in order to remain agile and continuously improve the city. This can only be enhanced when providing the best environmental requirements for acceptance of unknown mobility solutions.

General and specific willingness to change among the inhabitants of the Bergisch City Triangle is one way of externally increasing acceptance for mobility concepts. Acceptance and willingness to change are closely connected. The willingness to change is a key factor in enabling prospective users to approach an innovation as openly as possible and potentially accept it. Mental access to the greatest possible openness for new processes and products is linked to the willingness to change. It is expected that willingness to change is strengthened or encouraged by so called protective factors and weakened by risk factors. If these protective and risk factors are considered during the implementation of new mobility concepts, it can be assumed that ideal frameworks can be defined to enable people to be as open as possible to new ideas. Therefore, besides increasing the awareness of the urban society and regional companies, an aim of the project under consideration is to identify influencing factors of acceptance and their provision for institutions that shape the mobility revolution for the Bergisch City Triangle.

5 CONCLUSION

Besides the objectives of *Rethinking Mobility* mentioned above, there is great potential to analyze the origins and effects of unsuccessful mobility concepts of recent times. Furthermore, it may complement the project results by comparing the recommended procedure following the *Rethinking Mobility* investigations of the project with successful mobility concepts of other cities and closely examining its transferability. Cultural and historical aspects may differ but the concepts could be transferable to a certain extent. Vice versa cultural aspect may be similar but aspects of the concepts cannot be shared between the cities. The assumptions of *Rethinking Mobility* are based on the premise that for connected future mobility concepts some general conclusions can be drawn about characteristics of successful mobility concepts in Germany regardless or with little regard to environmental factors. Although cities need to develop individualized approaches in order to reflect the culture and values of an urban society, it is necessary to determine whether certain aspects are transferable across cities

and to which extent this is feasible. Based on different mobility strategies, it could be possible to formulate generally valid protective and risk factors for the acceptance of new mobility concepts. It is feasible that factors have opposite effects in different cities. Here a distinction needs to be explored between stable protective and risk factors that have a general impact for several cities, factors that change their effects between cities and those that are neutral for every city investigated. Finally, the transferability of the concept developed for the Bergisch City Triangle onto other cities needs to be investigated and evaluated after designed within the context of *Rethinking Mobility* and *Bergisch.Smart_Mobility*.

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