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Exploring Various Dimensions of Perceived Usefulness on the Intention to Use Mobility-as-a-Service

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ABSTRACT

In response to society's volatile and changing mobility requirements, new mobility concepts and business models are currently developed and piloted. The Mobility-as-a-Service (MaaS) concept attempts to meet rising customer demands in a need-based and situational manner. For the success of innovative mobility, user acceptance and thus a user-centred business model and product development is crucial. The aim of this study is to provide deeper insights in the perception of society's usefulness in a potential MaaS use to derive recommendations for the design of MaaS business models from a user perspective. This is done under consideration of the Importance-Performance-Matrix. The question is investigated to what extent differentiated usefulness dimensions (functional, emotional, social, economic, and ecological) influence the intention to use Mobility-as-a-Service. By applying the Technology Acceptance Model in the context of an empirical study the relationships between perceived usefulness dimensions, attitude towards using MaaS and the intention to use MaaS were examined. The results show that the perceived emotional, functional, and economical usefulness dimensions significantly influence both the attitude towards and the intention to use MaaS in a positive direction. Especially the perception of emotionally increasing elements were identified as main drivers for an intensified MaaS use. No significant results could be found on the social dimension. Finally, the perception of ecological usefulness shows a significant negative impact on the intention to use on the one hand, and a significant positive influence on the attitude towards using MaaS on the other. The results provide impulses for a user-centred development of MaaS, enable an approach for a differentiated consideration of usefulness dimensions, and suggest a need for more in-depth research.

Keywords: Mobility-as-a-service, Mobility behaviour, Perceived usefulness dimensions, Technology acceptance model, User-centred business development

INTRODUCTION

Society is undergoing disruptive change, becoming increasingly mobile and connected (Gouthier and Nennstiel, 2018). Due to the ubiquitous availability of digital technologies, traditional economies are being disrupted. This is leading to the emergence of new business models and product innovations. Terms such as platformization, servitization, and everything-as-a-service (Lassnig et al., 2018) are shaping the shift from an ownership-oriented to a service-oriented approach to business models across industries (Caiati et al., 2020). In the mobility and transportation sector, too, the business models of established providers are adapting, innovative players are entering the markets, and new means of transportation are becoming available (Fridgen et al., 2019). In addition to political and economic factors, socio-cultural and technological factors have been identified as the main drivers of change (Gao et al., 2016).

Against this background, innovative and demand-oriented mobility systems are emerging under the term Mobility-as-a-Service (MaaS) (Kamargianni et al., 2019). These business models pursue the goal of intermodal integration of all available means of transportation (e.g., public transport, car sharing, bike sharing, ride hailing or pooling) and all services fundamental to their use (e.g., information, planning, ticketing, payment) to provide mobility-as-a-service (Sochor et al., 2018). Hereby, processing is centralized on a digital platform (Arias-Molinares and García-Palomares, 2020). By means of customized mobility packages, customer needs are to be met according to the situation and MaaS is to develop into an alternative to private vehicle ownership in the long term (Bundesverband Informationswirtschaft, 2018). MaaS is seen as an example of technology-driven innovation that creates a foundation for the vision of future mobility and leads to a "user-centered mobility paradigm" (Goodall et al., 2017). This paradigm shift is considered as the "[...] biggest paradigm change in transport since affordable cars came into the market" (MaaS-Alliance, 2016). Some examples of MaaS systems available today are Whim (a.o., Helsinki) and Jelbi (Berlin).

The concept of MaaS is a new and comparatively under-researched area. Studies on the usage behaviour of MaaS currently represent only a small proportion of scientific work (Mola et al., 2020). To date, only a few works exist that address the usefulness of MaaS from a user perspective. The impact of perceived usefulness, differentiated into sub-dimensions, on the intention to use has not been considered in previous studies in the context of MaaS. In the case of user-oriented business models, it is the perceived usefulness from the user's perspective that determines whether an offer is accepted and will be used (Haller and Wissing, 2020a).

Due to the relevance of the user perspective in the design of MaaS, the aim of this paper is to identify drivers for a MaaS use considering a behavioural science approach. Based on this, recommendations for the user-centred development of MaaS business models can be derived. To derive specific implications, this work deals with a subdivision of the perceived usefulness construct into differentiated dimensions and the analysis of their influences on the intention to use MaaS based on the Technology Acceptance Model (TAM).

BACKGROUND

As a complex construct, various differentiation approaches developed in utility research based on the concept of the utility ladder by Vershofen and

Proesler (1940), which are applied independently of the object of investigation. About perceived usefulness in consumption decisions, Sheth et al. (1991) established a differentiation into five dimensions (social, emotional, functional, epistemic, and conditional value). Their work provides an ideal basis for extending existing utility constructs, as it has already been validated in numerous interdisciplinary studies, also in the context of mobility. For example, Boenigk et al. (2019) investigated the impact of the dimensions of functional, social, hedonistic, and ecological usefulness in a study explaining the sharing behaviour, using eCargoBike-sharing as an example. Hartl et al. (2018) analysed drivers for a car-sharing use and considered economic, social, hedonistic, and ecological usefulness expectations. Further studies in the context of ride-hailing (Lee et al., 2018) and integrated mobility platforms (Scheuerle et al., 2017), identified hedonistic and economical usefulness dimensions as factors influencing the use of the mobility offers.

To ensure a holistic view of perceived usefulness of MaaS within acceptance research, this paper differentiates perceived usefulness into five dimensions based on approaches available in the literature. A distinction is made between functional, emotional, social, economic, and ecological dimensions.

One model that depicts the relationship between perceived usefulness and usage behaviour is Davis's Technology Acceptance Model (TAM) (Davis, 1985). It is a widely used instrument for measuring the acceptance and usage of information technologies and systems (King/He, 2006). As the core component of a MaaS system is information technology (MaaS app), the TAM is qualified for measuring technology acceptance (Mola et al., 2020). To examine the relationships between the dimensions of perceived usefulness, attitude towards using, and intention to use, Figure 1 illustrates the research model of this paper, based on the TAM.

As a core analysis of this work, the impact of usefulness dimensions on the intention to use is examined. The actual use and thus acceptance of MaaS follows from the intended use, which is why the intention to use is assigned

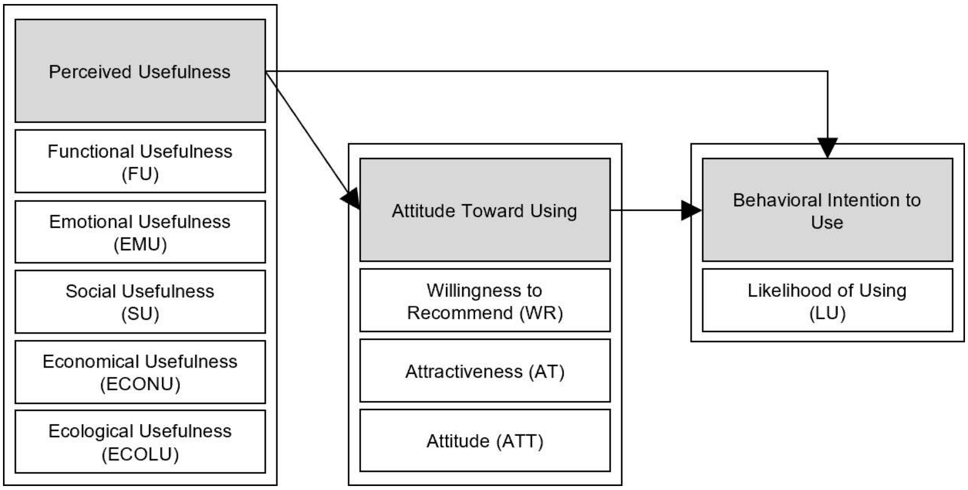

Figure 1: Research model.

special relevance in this study. Within the scope of the core analysis, the research question is examined to what extent the usefulness dimensions influence the intention to use MaaS. The positive impact of perceived usefulness on the intention to use (postulated in the TAM) indicates a positive relationship in the context of hypothesis formulation. The usefulness dimensions are each characterized as independent variables and the intention to use as dependent variable.

METHODOLOGY

Due to the context of the study and insufficient existing data to answer the research objective, an online survey was used within the framework of this research project to collect the required data. In the "MaaS together" project, a large-scale online survey (approx. 6400 participants) was facilitated in four countries: Germany, England, the Czech Republic, and Poland (Matowicki et al., 2022). The intended population includes commuters of full age living in urban regions of the mentioned countries, as this represents the potential target group for MaaS usage (Nikitas et al., 2017). These persons could be identified as commuters if they regularly travel by means of transport at least three days per week and thus have mobility needs suitable for MaaS use.

The survey was divided into five blocks (A-E) enclosed by an introduction and a conclusion. In addition, screening questions about participants' sociodemographics and commuting behaviour were collected at the beginning. In block A, latent variables of personality were included and divided into three blocks for the sake of variety. Block B, C and E included questions not relevant for this study. Block D included the main questions relevant for this work which focused on the perceived usefulness of MaaS, differentiated into the 5 sub-dimensions, as well as questions about the attitude towards using and intention to use MaaS. When operationalizing these constructs, we selected scales that have already been tested to ensure high reliability. To gain a uniform understanding of MaaS, a definition was included prior to block D.

There are various methods available in the existing literature for the analysis of direct and indirect effects of variables on the predicted outcome. During the end of 20th century, Structural Equation Modelling (SEM) emerged as a powerful multivariate data analysis tool in social science research, especially in the fields of psychology, sociology, and education (Mueller, 1999). Since it can handle numerous endogenous and unobserved variables, it allows to test more elaborate relationships among multiple explained and explanatory variables at the same time (Wang, 2013). Today, with the development and increasing availability of SEM computer programs, it has become a well-established and respected data analysis method utilizing many of existing analysis techniques. The ML approach for the estimation of structural equation models is a so-called covariance-based method. Often LISREL (Linear Structural Relationships) is used as a synonym, though LISREL is the name of a widespread statistical software used in SEM. All covariance-based methods work with the sample variance-covariance matrix and all its information. Therefore, the ML approach is a so-called "full information approach"

(Sarstedt et al., 2017). The ML estimation results are model parameter estimations. With these parameter estimates fitted values for the latent variables can be computed. This proceeding is reverse to Partial Least Squares (PLS) approach, where so-called scores for the latent variables get estimated first.

THE RESULTS

In the analyses regression coefficients for the model were established. The numerical output of our investigated model is presented in Table 1. The first important finding is that the Attitude Towards Using (ATT) has a dominant influence on the Behavioural Intention (BI) to use MaaS with estimated regression coefficient of $\eta 6 = .561$, and p - value <.001. Regarding the Perceived Usefulness, the influence degree of different latent variables on overall Behavioural Intention can be ranked as Emotional, Functional, Ecologic, Economic and Social in descending order.

The usefulness dimension with the greatest impact on BI is Emotional Usefulness ($\eta 2 = .322$), showing a significant causal relationship ($p < .001$). This result indicates that perceived usefulness of MaaS in relation to the intention to use MaaS is strongly connected with emotions of the potential user towards this service. Second to this, are the Economical and Functional usefulness dimensions with their moderately positive relationship with BI. The path coefficients for these latent variables are .146 and .135. On the other hand, quite surprising result is the negative relationship of perceived Ecological usefulness on BI among respondents. This relationship was not only adverse, but also relatively strong with $\eta 5$ of −.176. The only exogenous variable that was revealed as statistically insignificant was the social usefulness of MaaS with $p = .317$ (.05 was chosen as significance criterion).

Table 1. Regression coefficients.

						95% Confidence Interval	
Predictor	**Criterion**	**Estim. Beta**	**Std. Error**	**z-value**	***p***	**Lower**	**Upper**
Functional Usefulness	ATT	0.076	0.016	4.677	.000	0.044	0.107
Emotional Usefulness	ATT	0.419	0.017	24.360	.000	0.385	0.453
Social Usefulness	ATT	0.044	0.011	4.079	.000	0.023	0.066
Economical Usefulness	ATT	0.181	0.013	14.267	.000	0.156	0.206
Ecologic Usefulness	ATT	0.282	0.010	29.549	.000	0.263	0.301
Functional Usefulness	BI	0.135	0.021	6.527	.000	0.095	0.176
Emotional Usefulness	BI	0.322	0.026	12.611	.000	0.272	0.372
Social Usefulness	BI	−0.014	0.014	−1.002	.000	−0.042	0.013
Economical Usefulness	BI	0.146	0.017	8.545	.000	0.112	0.179
Ecologic Usefulness	BI	−0.176	0.014	−12.169	.000	−0.205	−0.148
ATT	BI	0.561	0.028	20.006	.000	0.506	0.616

DISCUSSION

Based on the results presented in the previous chapter, implications are given below. The following section classifies and interprets the results using the Importance Performance Matrix by Martilla and James (1977) as a basis. In

Figure 2, we address the usefulness dimensions results that have a positive impact on Behavioural Intention to use MaaS. Based on these, tendencies to drivers become clear that reinforce the use of MaaS and can be included accordingly in a user-centred business model development as well as in strategic decision-making.

To provide implications from the model results, the participants agreement, to what extend MaaS provides utility on specific usefulness dimensions (arithmetic means on x-axis) and their impact on the intention to use MaaS (betas from SEM on y-axis) are shown in a two-dimensional matrix. Due to the comparison of the (performance) level of the usefulness dimensions and their impact on the intention to use, this procedure is particularly suitable for the simple derivation of recommendations for action (Schimmelpfennig, 2016). Following the Importance-Performance Matrix, the classification of the usefulness dimensions into quadrants is used to identify drivers as well as strengths and weaknesses (Schimmelpfennig, 2016). Interpretation of the grid as well as marketing strategies are explained in the following (as in Martilla and James, 1977):

1) Keep Up The Good Work: People perceive a MaaS use as (emotionally) beneficial. Fulfilling these expectations is important, as the perception of emotional elements has a high impact on the intention to use MaaS. Thus, business development should focus on constantly meeting those expectations and further implementing emotional elements in MaaS.
2) Concentrate Here: In this quadrant, people perceive elements of MaaS as rather unimportant for usage, however fulfilling these elements has a high impact on the intention to use MaaS. Thus, business development should concentrate on creating awareness of those elements to make them visible.

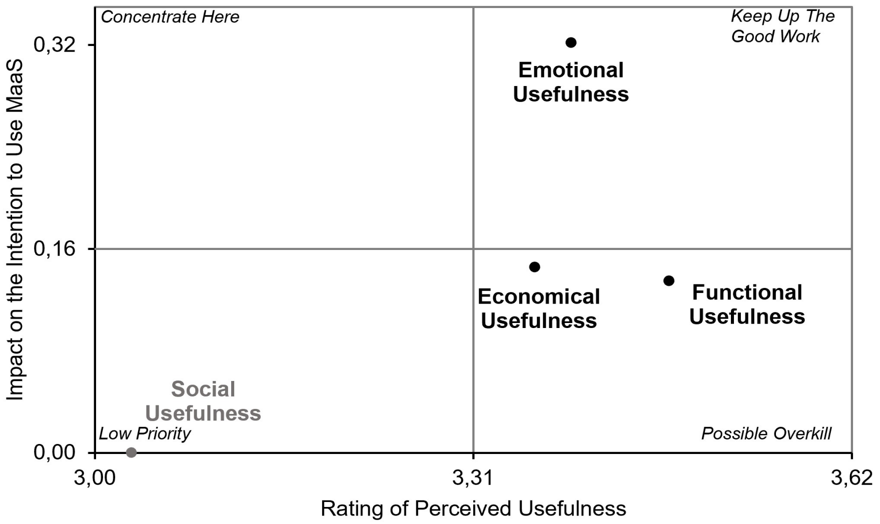

Figure 2: Importance performance matrix.

3) Possible Overkill: People perceive a MaaS use as (economically and functionally) beneficial. Fulfilling these expectations tends to be rather unimportant, as the perception of economical and functional elements has a rather low impact on the intention to use MaaS. Thus, business development should only put effort into avoiding dissatisfaction when not fulfilling (as basic factors) those elements.
4) Low Priority: People perceive MaaS use as (socially) less beneficial. Fulfilling these expectations is rather unimportant, as the perception of social elements has a rather low impact on the intention to use MaaS. Thus, business development should not focus working on those elements.

Since the ecological usefulness dimension has a negative impact on the BI, we have not included the dimension in the matrix due to the low-constructive contribution to MaaS business development. The SEM results for the relationship between social usefulness dimension and intention to use MaaS are not significant, no valid statements can be derived here. Accordingly, we have depicted the social usefulness dimension in greyed out form in the figure.

Perceived Emotional Usefulness

The matrix shows that the emotional usefulness dimension is located above the average usefulness rating and is based on a high impact factor. The emotional usefulness is the most important impact factor for an intended MaaS use. The more likely a MaaS use gives users pleasure or a good feeling, the more likely they are to use it. Currently, participants tend to perceive a higher emotional usefulness in a MaaS use, but its potential has not yet been fully exploited due to its great importance (high impact on BI). To increase the BI, MaaS should be designed so that fun and enjoyment (Georgi and Schaffner, 2017), pleasure (Hamari et al., 2016), or joy (Boenigk et al., 2019) are perceived by users. Due to the great importance of perceived emotional usefulness, the recommendation to "Keep Up The Good Work" (Martilla and James, 1977) from the Importance Performance Matrix should be followed. Although MaaS is seen as a mobility concept that already offers emotional added value, this must be established in the long term. Eliminating pain points (e.g., in transaction process) as well as considering elements that force a positive perception of MaaS on an emotional dimension (e.g., include e-kick-scooters) are just a few examples for optimization to exploit the potential on emotional dimension. An increase of emotional usefulness dimension is strongly reflected in an increasing intention to use and thus acceptance of MaaS.

Perceived Functional Usefulness

Further, the matrix shows that the functional usefulness of MaaS is perceived most strongly across all usefulness dimensions. In participants perception, MaaS provides a benefit through faster and easier transportation or efficiency improvement. Further, the functional dimension is found to be below the average impact level, indicating a tendency for lower impact on BI. The already strongly perceived functional elements in MaaS could be caused by the fact that innovative mobility generally entail the expectation of an increase in mobility performance. The basic usefulness in mobility, transportation from A to B (Klopp, 2014), remains the basis of new mobility and should naturally be improved (e.g., improve effectiveness and efficiency of physical transport) (Gouthier and Nennstiel, 2018). The most strongly perceived usefulness dimension is the functional one, which is one of the core elements perceived and expected in MaaS. Despite high expectations of MaaS as a value-generating mobility concept that makes transportation easier, faster, and more efficient, the impact on an intention to use through the fulfilment of requirements turns out to be rather moderate. The high expectation should be met moderately (avoid dissatisfaction), but due to the tendency of average impact on the BI, no excessive importance should be attached to it. Due to the already strong perception, an expansion of functional elements in the MaaS development tends to be avoided, although this is assigned to the "Possible Overkill" (Martilla and James, 1977) recommendation. A disproportionately high investment would be required to significantly increase the perceived usefulness on a functional dimension. Further, the impact of functional usefulness on the BI is to be regarded as slightly below the average.

Perceived Economical Usefulness

The matrix shows that the rating of economical usefulness of MaaS is perceived to be above average. MaaS is seen as a concept for saving money or improving the financial situation. In between the emotional and functional dimension, the economical usefulness has a value just below the average impact on the intention to use MaaS. A perceived economic added value thus has an impact on the intended MaaS use but should not be overestimated due to its moderate impact level. MaaS use is perceived as economically attractive but tends to have a low impact on the intention to use. For the present, the economical usefulness dimension is to be regarded as a "Possible Overkill" (Martilla and James, 1977), where to question whether investments in economic elements are "too much of a good thing" (Haller and Wissing, 2020b). Nevertheless, a quality reduction on economical dimension should be critically discussed (for each target group). Due to an already adequate perception of economical usefulness above the average of all dimensions, there is no need for action. In this case, the impact on an intended MaaS use takes on a comparatively minor role than investments have a sustainable effect on an increase in use and thus acceptance. Pricing policy resources should be adapted sparingly.

Perceived Social Usefulness

Ultimately, the matrix shows that the social perception of usefulness in MaaS was rated the lowest and shows no significant impact on the BI. No valid statement can be made about the impact of social usefulness perception affecting the intention to use MaaS. Nevertheless, the results reflect tendencies. Social usefulness can be classified as a "Low Priority" (Martilla and James, 1977) attribute and characterized as "not that significant" (Haller and Wissing, 2020c). Social usefulness is the only low-perceived usefulness dimension (below the average). Any investments should not be considered since it is not significantly proven if an increased perception of social added value leads to a higher intention to use MaaS.

CONCLUSION

The results show that the emotional, economical, and functional usefulness dimensions have a significant positive impact on the intention to use MaaS. The more likely usefulness is perceived on these dimensions, the more likely MaaS is used. The social usefulness dimensions, on the other hand, shows no significant influence on the intention to use MaaS. The ecological dimension, meanwhile, proves to be a factor having a significant negative impact on MaaS use.

This study provides a differentiated view of perceived usefulness in the context of MaaS and thus answers the research questions. It was possible to show the extent to which the usefulness dimensions contribute to a BI formation, and which dimensions are drivers from the user's perspective. The results provide a valuable contribution to the state of research on psychological factors influencing the usage behaviour in the context of acceptance research. It highlights the importance of including the user perspective in the development of mobility systems to ensure a sustainable use and acceptance. Nevertheless, it is important to further explore the usefulness dimensions in other markets and temporal realities.

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