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Free Ride in Rush-hour Traffic – Designing Gamified Smart Mobility Systems for Sustainable Use

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Short Paper

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Abstract

A large proportion of traffic congestion can be attributed to daily commute. While smart mobility systems (SMSs) intend to address the resulting challenges by actively changing users' behavior, many SMSs suffer from users' meaningful engagement. Research and practice have started examining engagement factors in order to increase meaningful engagement with SMSs. The question of how traffic participants can be continuously involved with SMSs to sustainably change their behavior has not been answered satisfactorily yet. In our paper, we identify relevant gamification elements suitable to improve meaningful engagement based on a literature study and market analysis. We used a design science approach to derive design requirements. Building on these, we assume comprehensive design principles and used them to derive initial design features. With these, we started a first feature configuration and a prototypical app implementation towards designing a sustainable SMS.

Keywords: Smart Mobility, Gamification, Design Science, Meaningful Engagement, Prototype

Introduction

The trend of cities becoming smart involves digitizing various domains, such as administration, communication, e-government, and traffic (e.g., Giffinger et al. 2007). In this digitalization context, information systems (IS) are needed to optimize existing structures and processes (Lindgren et al. 2019). While the different domains of smart cities usually require specialized IS, the developed systems frequently face the same problem: citizens do not accept them and/or do not remain engaged (Meloni et al. 2014). However, several of the most promising approaches to digitizing cities depend on active and sustained citizen engagement (Lindgren et al. 2019). Traffic and mobility represent a smart city domain in which active citizen participation and sustained engagement are of the utmost importance. There is a common understanding among politicians, practitioners, and researchers that, to overcome problems related to pollution and imminent traffic collapse, road users' behavior needs to change (Schulz et al. 2021). This is particularly relevant to commuters, who cause a large proportion of traffic congestions in conurbations (Schulz et al. 2021). Such behavioral changes may be supported by smart mobility systems (SMSs) that address individual road users, specifically commuters, instead of steering traffic as a whole (e.g., traffic light systems). Since changing commuters' traffic-related behavior has a significant impact on daily routines (which are hard to change), the sustained engagement of commuters with SMSs is currently one of the trickiest challenges in the context of smart cities (Anagnostopoulou et al. 2018; Liu et al. 2017). Numerous SMSs intend to change commuters' behavior via apps that guide users' mobility behavior (e.g., suggesting routes, traveling times, or transportation modes; Benevolo et al. 2016). However, many of these SMSs, which are the focus of our research, frequently lack users' sustainable engagement. One approach to overcome the challenge of sustained user engagement is to gamify IS (Sheffler et al. 2019). The overall objective of the research project we are working on is therefore to design an effective gamified SMS that motivates users to stay engaged, and to develop a respective design theory (Ryan and Deci 2000; Peffers et al. 2018). We focus on app-based SMSs, as these are best suited for changing habits and commuting behaviors (Anagnostopoulou et al. 2018). Many existing SMS apps use gamification elements but fail to sustain long-term usage – suspectedly due to lacking fit of the gamification elements to the user´s needs and personal traits (e.g., Bıyık et al. 2021). Researchers therefore started calling for research explicitly investigating a better tailoring of gamification elements to particular contexts and users (Kazhamiakin et al. 2021, Orji et al. 2018). With our research, we intend to contribute to this discourse. To suggest the most influential gamification elements to a single user, the design of effective gamified systems needs to consider users' needs and susceptibilities (Anagnostopoulou et al. 2018). Yet, existing studies hardly offer precise findings on how to configure gamification elements to address individual needs and personal traits (e.g., Anschütz et al. 2021; Schöbel et al. 2020; Schrammel et al. 2015). For the most part, existing research takes established player types as a starting point for, what we call, feature configuration (Mora et al. 2019). We argue, however, that to implement effective gamified elements in SMSs, knowledge about commuters' needs and characteristics should form the central base for feature configuration (Bıyık et al. 2021) – enriched with several player type characteristics. In this short paper, we therefore present our approach to user-adaptive feature configuration. We developed an SMS app for which we configure the features according to different archetypical commuter types. We present how we added gamification elements specifically adapted to the different needs of commuters. The next step in our research will then be an experiment validating the prototype's design features.

More precisely, the state of research we present here follows up on detailed literature and market analyses, as well as a large-scale study on commuter needs and characteristics potentially relevant for gamified SMS. Based on these previous activities, we present the development of design principles and the respective prototypical instantiation. We particularly illustrate our approach to feature configuration of which we hope might contribute to the calls for research on tailoring gamification elements. We followed the 5-step design science approach proposed by Peffers et al. (2018). We identify design requirements (DRs) and deduce design principles (DPs) which we use to develop a set of prototypical design features (DFs) and configurations for our prototype. The adaptation of features to the needs of a user is necessary for a long-term successful SMS. We refer to this as feature configuration. We introduce our initial prototype design and present the intended steps to validate our design using a Solomon four-group design (Navarro and Siegel 2018).

Theoretical Background

Smart Mobility and Smart Mobility System Apps

Smart mobility is one of the six domains that constitute a smart city (Giffinger et al. 2007). By intelligently using information and communication technologies, an SMS contributes to energy-efficient, low-emission, safe, comfortable, and cost-effective mobility (Benevolo et al. 2016). To address these traffic-related targets, many SMSs intend to change commuters' behavior through apps that guide users in their mobility behavior (e.g., suggesting routes, traveling times, or transportation modes). However, many of these SMS apps, which are the focus of our research, frequently lack sustainable user engagement (Schrammel et al. 2015). Sustained use has been investigated for various SMS domains, including urban information and service platforms (Anagnostopoulou et al. 2018), platforms for route optimization and ticket booking, as well as intelligent transport systems (Busseri et al. 2006). Different pilot projects have also introduced distinctive approaches, such as interactive design elements (Wells et al. 2014) or graphic visualizations of users' mobility data (Froehlich et al. 2009), to impact users' transport decisions. In line with recent literature reviews and market analyses (Anagnostopoulou et al. 2018; Anschütz et al. 2021), we find that existing approaches to user engagement with SMS apps only implicitly address user involvement on a long-term basis, or not at all, or they delegate this task to future research (Liu et al. 2017).

As a consequence, the question of how traffic participants can be continuously involved with SMS apps to sustainably change their behavior has not been answered satisfactorily. Schrammel et al. (2015) tried to use personalized, multimodal route suggestions from a smartphone app to encourage users to make more sustainable mobility decisions. In fact, they noticed a positive short-term change in user attitudes, but no measurable change in behavior. SMSs' weak long-term adoption rates reflect these shortcomings (Anschütz et al. 2021; Busseri et al. 2006). Others used customized recommendations as a specific form of information filtering that exploits past mobility behaviors and user similarities to generate a list of traffic-related recommendations tailored to a user's preference (Orji et al. 2018). Furthermore, studies that cluster commuters according to the choice of transportation means also offer interesting characteristics that may facilitate a better understanding of long-term SMS use (e.g., Benevolo et al. 2016). Consequently, to personalize and perform meaningful feature configurations in SMS apps, we argue that it is important to consider both commuter characteristics and adaptation behavior (Liu et al. 2017). We include both aspects in our research.

Gamification and Meaningful Engagement with Gamified Smart Mobility Systems

Gamification is one way of addressing the challenges of continued SMS use (Kazhamiakin et al. 2021; Meloni et al. 2014). Gamification can lead to continued use, particularly when users are given personalized, individual challenges (Anagnostopoulou et al. 2018; Kazhamiakin et al. 2021; Meloni et al. 2014). Several SMSs therefore employ gamification elements. However, they often rely on the same set of three central elements: points, badges, and rankings or leaderboards, with only slight variations (Conway 2014). The elements are often implemented in a relatively standardized way and are hardly personalized or adjusted to the use context (Conway 2014). As a result, many existing SMS apps use gamification elements but fail to sustain long-term usage (e.g., Bıyık et al. 2021). It can be argued that particularly SMS users might be subject to the hedonic treadmill effect in the long-term (Frijda 1988), i.e., the motivation effect of gamified SMS tends to decrease over time and incumbent habits dominate behavior (Amo et al. 2020). Personalization of SMS apps might be an approach to counter potential treadmill effects (Schöbel et al. 2020). An SMS app must thus manage to tailor the gamification elements specifically to the needs of the users, in our case the commuters, and thus promote long-term engagement. However, to be successful, several of the most promising approaches to SMS apps depend on active and sustained commuters' engagement (Lindgren et al., 2019). Therefore, we employ the concept of meaningful engagement (Liu et al., 2017), which refers to a dyadic understanding of use comprised of enjoyable experiences fostering use continuance, and instrumental experiences stimulating long-term outcome-oriented use.

Regarding our SMS app design, we assume that the gamification elements must support a change in traffic-related behavior (Orji et al. 2018). To that end, Liu et al. (2017), suggest a series of simple gamified tasks that help users to adjust their behavior stepwise (DR1). Yet, sustainable use can only be achieved with an intelligent combination of gamification elements adjusted for the user's personal traits and the use context of the IS (Schöbel et al. 2020; Sheffler et al. 2019). Building on Blohm and Leimeister (2013), we identify seven groups of game design elements for different player types: exploration, collection, competition, status, cooperation (group tasks, team competitions), challenge (time pressure, tasks, missions), and development/organization (avatars, virtual trade). The authors also explicitly refer to usage goals, which are particularly relevant to continued use, especially in the smart mobility field, where users demonstrate a wide range of motives (Schöbel et al. 2020; Sheffler et al. 2019). It should be emphasized that approaches to sustain the use of gamified systems beyond initial adoption are scarce (Liu et al. 2017). We argue that an SMS app should foster use continuance by being a pleasure to use and helping users to complete traffic-related (gamified) tasks (Mora et al. 2019). It should also stimulate long-term, outcome-oriented use that supports relieving traffic congestion by reminding users what an important difference their use makes (Busseri et al. 2006; Liu et al. 2017). Liu et al. (2017) refer to this dyadic understanding of use as meaningful engagement. Because meaningful engagement stresses the relevance of continued and recurring use as well as an outcome orientation, we argue that it represents an excellent concept to qualify sustainable use in smart mobility contexts. As this recurring use is relevant to our SMS app (Groh 2012), our gamification elements should foster such use (e.g., daily or weekly) (DR2). Liu et al. (2017) also present instrumental and experiential outcomes for meaningful engagement in their work. The instrumental outcomes describe the goal of using an IS in a chosen context. In our case this is the long-term and sustainable IS use in the mobility context (Bıyık et al. 2021). The experiential dimension of meaningful engagement deals with the enjoyable experiences of an IS (Liu et al. 2017). Since use is experienced as convenient and fun in the case of meaningful engagement, it is more difficult to stop, which then supports the continued use of an SMS app (Anschütz et al. 2021; Schöbel et al. 2020).

Gamification elements primarily address the enjoyable experiences included in an SMS app (Schöbel et al. 2020). To achieve meaningful engagement, however, the gamification elements must also be adequately aligned with the usage goal (instrumental outcome) to ultimately lead to a change in commuter behavior (Bıyık et al. 2021) – an alignment still often neglected by researchers and system designers (Schöbel et al. 2020). With meaningful engagement, the focus of gamification research shifts from initial adoption to long-term, effective use, and it stresses the role of individuals' goals and needs in attaining target behaviors and outcomes (Agnisarman et al. 2018). Thus, since gamification is always about interaction between the system and the user (Liu et al. 2017), we argue that social as well as individual interaction must be considered when designing an SMS app. Social interaction describes users' interaction among themselves, whereas individual interaction describes how the SMS app interacts with the user (Amo et al. 2020). On the one hand, social interaction among users stimulates traffic-compatible competition and fosters user reputation building among the SMS's user community (DR3) (Schöbel et al. 2020). On the other hand, individual interaction (e.g., using individual challenges such as "spend less time in traffic jams this week") stimulates engagement with an SMS app (DR4) (Amo et al. 2020). Meaningfully engaged commuters will consequently be more likely to follow an SMS's recommendations, and actively contribute to relieving traffic. Gamification elements must thus praise users that follow the SMS's recommendations (DR5) (Liu et al. 2017). Since personalization is an important ingredient in building meaningful engagement (e.g., Agnisarman et al. 2018; Liu et al. 2017), our research process considers the individual commuting profiles and needs of an SMS app user as central to feature configuration. Next, we describe how we tackle the task to design a personalized SMS app with the intent to establish meaningfully engaged users in our research process. In conclusion, we summarize our DRs in Table 1.

Design requirements	Exemplary references
DR1 (Task): Gamification elements must support changing traffic-related behavior by offering simpler gamified tasks that encourage users to adjust their behavior stepwise.	(Benevolo et al. 2016; Liu et al. 2017; Orji et al. 2018)
DR2 (Recurrence): Gamification elements must foster recurring and routine use (e.g., daily, weekly) of the SMS.	(Groh 2012; Liu et al. 2017; Mora et al. 2019)
DR3 (Social interaction): Gamification elements must stimulate traffic-compatible competition and foster user reputation among the SMS's user community.	(Groh 2012; Schöbel et al. 2020; Kazhamiakin et al. 2021)
DR4 (Individual interaction): Gamification elements must stimulate engagement with the SMS with suitable messages and individual challenges.	(Amo et al. 2020; Liu et al. 2017)
DR5 (Dialog support): Gamification elements must praise users who follow the SMS's recommendations.	(Liu et al. 2017; Schöbel et al. 2020)

Table 1. Overview of the design requirements.

Preceding Research Steps

Given the problem statement outlined in the previous sections, we followed the 5-step design science approach proposed by Peffers et al. (2018). First, we identified the problem with two systematic literature reviews, and a comprehensive market analysis in the field of smart mobility apps (Anschütz et al. 2021). Second, we deduced the motivation to develop an SMS app that promotes sustainable use with gamification elements (Peffers et al. 2018). Steps 3 (design and development), 4 (demonstration), and parts of step 5 (description of the evaluation design) fall within the scope of this paper. We present excerpts (due to space restrictions) of our DRs, DPs, and DFs derivation, as well as our first prototype. Communication, the last step in Peffers et al. (2018) approach, is not part of this paper and will be handled in our future research. Based on the literature reviews and market analysis, we adjusted the framework by Liu et al. (2017) to the mobility context as a starting point. To that end, we carefully evaluated which of the requirements they state are suitable to a mobility context, and which are not (e.g., aspects in the context of nonrecurring SMS use).

Others were not specific enough for our purpose and had to be adapted (e.g., task congruence), building on the analyses and findings presented before. We already presented our five DRs as part of the theoretical background (Table 1). Additionally, to come up with a meaningful adaptation design and personalization structures, in the next sections we will focus on the impact of different user characteristics and needs on the DPs implementation in the context of a feature configuration. We will therefore focus our argument on the principle(s) of rewarding and messaging, and we demonstrate how we configure these features in our prototype. To have meaningful user characteristics and needs at our disposal, we collected data on mobility-related characteristics, needs, and susceptibilities from 615 commuters using a survey setup. Using this data, we conducted a cluster analysis (Balijepally et al. 2011). To estimate the number of clusters, we used a hierarchical clustering with the ward distance measure and squared Euclidean distance. The four resulting clusters were evaluated using k-means (Balijepally et al. 2011). Due to space restrictions, we cannot present the detailed results and clusters here; however, we have published it elsewhere (Anschütz et al. 2021). In the next sections, however, we will introduce relevant cluster details to explain our configuration. For our evaluation design (step 5 from Peffers et al. 2018), described at the end of the paper, we use the Solomon four-group design (Navarro and Siegel 2018).

Exemplary Design Principles and Feature Configurations

We recognize that holistically designing a personalized SMS that intends to establish meaningfully engaged users requires a complex bundle of different mechanisms (and their respective DPs), and different features and feature configurations. While a wholesome consideration and integration of these aspects is a long-term goal of our efforts, we also recognize the strain this puts on this paper's scope. We therefore decided to showcase our efforts and the analytical approach we have chosen by using a narrower focus on the principle(s) of rewarding and messaging. We are confident, on the one hand, that such a focus will better enable us to illustrate our approach with the depth and reflection ICIS deserves. On the other hand, an experimental setup demands a well carved-out focus to be conducted meaningfully.

Our focus was on different and specially adapted to the needs of commuters' gamification elements and experiential outcomes. For the requirement of individual interaction (DR4), gamification elements must stimulate engagement with the SMS app with suitable messages and individual challenges. There are two principles that have to be followed to reach this goal. The first principle in this context is a typical gamification element in many IS, and also a necessary one for an SMS app in this field: the SMS app may reward commuters for special achievements (e.g., sustainable driving; DP1 Rewarding) (e.g., Groh 2012; Liu et al. 2017). In an SMS context, such rewards (depending on commuter type) could include badges assigned for having completed a number or specific types of activities, real-world prizes such as public transport vouchers that are frequently offered for collecting accumulated points for specific activities. These can be, for example, different challenges that will be rewarded once completed (Blohm and Leimeister 2013). This could be realized with an overall challenge board with current and available tasks and activities for the SMS app users. The SMS app might have also an achievement pool with all the badges that can be awarded. Not all of the challenges could have visible requirements for achievement (for example, the repeated use of the system or the rewarding of a user-untypical, but positive, behavior) so that people will be encouraged to use the app fully so that they may receive all the badges (Amo et al. 2020). The second principle in this context is that the SMS app should display motivating messages and provide personal and traffic-related statistics (DP2, Messaging) (e.g., Liu et al. 2017; Schöbel et al. 2020). As indicated earlier in the theoretical background section, using rewards in isolation might lead to discontinuance of system use later on, since users are not excited by the rewards anymore (habituation or hedonic treadmill effect as countereffect to long-term success of gamification, Frijda 1988). However, we still argue that rewarding displays a meaningful game-design-element in SMSs, since it stimulates initial adoption, what displays a major barrier for many SMS (Orji et al. 2018). To counter the lack of long-term effects of the rewarding principle, we argue that it needs to be complemented by additional features. We introduce messaging as one such principle here. Like rewarding, the principle of messaging can lend itself to being linked to challenges. For example, there might be a message board with messages as well as new challenges from friends (Wells et al. 2014). In addition to this, it could of course also be important that users should receive motivational messages from the SMS app detailing how to achieve their goals and reach sustainable use of the SMS app (Oinas-Kukkonen and Harjumaa 2008). As we already discussed before, the unsophisticated implementation of levels and badges is not effective for achieving long-term and sustainable use of an SMS app. In addition, particularly levels might lead to a hedonic treadmill effect, thus losing motivational impact over time (Conway 2014). We are able to adjust the gamification elements more adequately by knowing about the different user types (commuter types) for our app and their preferences for using an SMS app, which we gained from the previous commuter classification. We included gamification aspects in our classification instrument, as well as commuting-specific characteristics (Anagnostopoulou et al. 2018), which we enriched with Cialdini's (1993) susceptibility dimensions. The resulting user type groups are receptive to different combinations of gamification elements, especially in the long-term. We are hence better able to combine different gamification elements to impact the user's interaction with the app positively and sustainably (see Figure 1). For the feature configuration, we used a categorization of commuters (Anschütz et al. 2021). For this purpose, in the sense of a design theory approach, it is necessary to specify the user types (and their specific needs and personal traits) in the context of a personalized SMS app (Liu et al. 2017). In our case we apply the user-adaptive feature configuration to two selected commuter types (from the four mentioned above, Anschütz et al. 2021). We have chosen the two that contain the most opposites. Thus, the difference between the often car-focused heteronomous loners and the green routinizers is that the latter emphasize sustainability more strongly. The heteronomous loners are also less interested in autonomy than the green routinizers and are generally satisfied with using their regular route to get to work. In addition, heteronomous loners tend to be more externally determined and very time-sensitive, whereas green routinizers pay particular attention to themselves and the environment and are therefore not only receptive to sustainability arguments, but also to health arguments. Due to the large number of potential feature configurations, we present an excerpt (Table 2) and a prototypical implementation in the next section.

Definition	Basic configuration	User-adaptive feature configuration	
		Heteronomous loners (Short use intervals)	Green routinizers (Larger use intervals)
Rewarding (DP1)	The SMS app will reward commuters for special achievements (e.g., sustainable driving).	Offer rewards for completing brief challenges that aim to make the user use the route that saves the most time from the user's perspective. The user gets (special) rewards for completing the challenge.	Offer rewards for completing long-term challenges that target sustainability and health-related arguments, such as CO2 avoidance. The user gets (special) rewards for completing the challenge.
Messaging (DP2)	The SMS app will display motivating messages and provide personal and traffic-related statistics.	Combination of the successful completion of a challenge with a positive message afterwards about how much time the user has saved today thanks to following a recommendation.	Combination of the successful completion of a challenge with a positive message afterwards that points out how the user's actions to complete the challenge have positively affected the environment.

Table 2. Exemplary feature configurations for DR4 (Individual interaction).

Prototype Development and Prototypical Implementation

The prototype was developed with React, a Facebook library (Majchrzak and Grønli 2017). This enables us to create a first executable app-based prototype of the SMS. The classic prototyping approach was successively continued on this basis. To improve the software quality, we used TypeScript instead of JavaScript as the programming language (Coucheron et al. 2019). Amazon Web Services provided the technical infrastructure. The prototype's executable source code was available for use in an S3 bucket and could be accessed at any time and from anywhere. The data was automatically copied to different instances to protect it against failure, errors, and threats (Majchrzak and Grønli 2017). Firebase was an important tool for supporting the development process and running the prototype. It allows certain aspects of the application to be controlled centrally via a console. For example, functions (e.g., gamification elements) can be activated or deactivated for a certain group of users (e.g., for experimental and control groups in the validation phase), color schemes could be adjusted, or certain texts could be displayed. This enabled us to verify the success of certain measures and to draw certain conclusions. This was done via automatically recorded usage statistics. When using an app-based prototype (and later the final app), we must always consider the error case. With the help of Crashlytics, it was easy to trace what kind of error occurred for which user, and when it happened. This will enable efficient error analysis (Majchrzak and Grønli 2017). Due to space limitations, we show in Figure 1 a prototypical implementation for the feature configuration in Table 2, with a specific zoom-in for the heteronomous loners. We show, as an example, that we want to encourage the user to use the app with specially designed challenges. In the case of heteronomous loners, for example, we offer challenges that aim to make the user use the route that saves the most time from the user's perspective, but also optimally equalizes traffic and avoids congestion from our perspective. However, to motivate the user to repeatedly use our app's suggestions, we combine the successful completion of a challenge with a positive message afterwards about how much time the user has saved thanks to following our recommendation. Our messaging system combines the benefits of gamification elements with those of persuasive design elements (Oinas-Kukkonen and Harjumaa 2008). The combination of these two approaches rounds out the user experience of our SMS app.

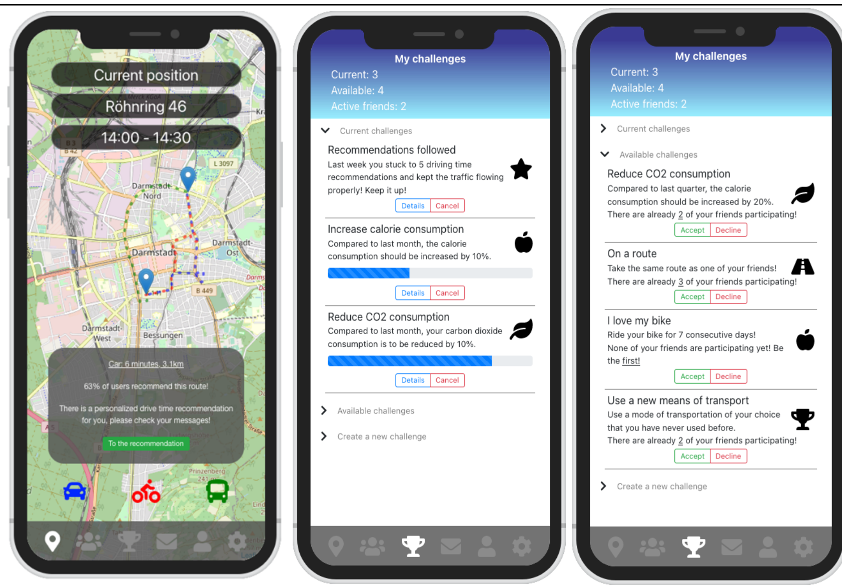

Figure 1. Screenshots of our app prototype (route selection and challenges).

Next Steps and Intended Contribution

In this paper, we present a personalized and gamified SMS app prototype. We also discuss corresponding DRs and DPs that target towards creating meaningful user engagement. In doing so, we hope to contribute to the calls for research on tailoring gamification elements and sustaining SMS use. As we described, the sustained engagement of commuters with SMSs is currently one of the trickiest challenges in the context of smart cities (Anagnostopoulou et al. 2018; Liu et al. 2017). We want to provide the user with individual travel time recommendations and encourage them to use these through an individual feature configuration, depending on the commuter type. Our SMS app not only provides the user with the best possible route, but also equalizes the traffic in the "big picture" and, thus, avoids traffic jams, for example. For this purpose, we have developed a wide range of different gamification elements for the respective context (as presented before as an example), based on our design framework. The next step in our research is experimentally testing and validating the prototype's design features and therefore, also adapting certain gamification elements to personal user traits (controllable with the help of the firebase tool). With the help of the technical decisions made while developing and implementing the prototype, selected features can be switched on and off easily, and their contribution to the continued use of our SMS app can therefore be better isolated and controlled for. For this reason, we will use the Solomon four-group test for validation (Navarro and Siegel 2018). We will use this test in the environment of our students, who are employed (and thus, usually commute to work), are on average 38 years old, and primarily intend to further their education with their studies. We will ascertain the commuting type before the test, with the help of our specially developed questionnaire. The Solomon four-group test includes two different procedures with four different groups, which randomize the assignment of the students to the respective group. The first procedure consists of a before and after measurement with control group (CG). In this case, both experiment group (EG) and CG receive our app in the "basic version" without specially adapted gamification elements, and they test it in the first run. In a second, staggered run, the EG would then receive a version with specially tuned gamification scenarios, while the CG would receive the same version as before to measure corresponding influences. The second procedure of the test is then an after measurement with CG. This is broadly similar to the previous procedure, except that the pre-test of the app in the "basic version" state is omitted.

In the test scenario, we want to specifically check how certain features (see e.g., Table 2) affect users and different commuter types. It is also important for us to determine whether user behavior changes significantly in the direction we intended or not, and we have to make subsequent improvements (e.g., in the number or wording of challenges or messages). We created a questionnaire with semi-open questions to be completed in parallel, to check how a particular feature has affected the user and to verify whether the intended meaningful engagement has occurred. Sample questions here include: "Did the message displayed influence you in your choice of route and mode of transport?" or "Does the choice of tasks presented in this screen correspond to your personal transport habits?". Things that we still need to look at in detail and technically implement after validating the gamification elements include aspects such as ensuring the flow of information about route usage and mode of transport selection (e.g., via GPS), as well as compliance with legal requirements in terms of privacy and data protection. While acknowledging that we still have several evaluation tasks to perform, we also still believe that our research contributes to theory and practice. We contribute to research in that we shed light on how meaningful engagement can be operationalized in the context of smart mobility (Anagnostopoulou et al. 2018). Our DRs and DPs, specifically, along with exemplary feature configurations, may stimulate further design theorizing on the use of gamification in the context of smart mobility and smart cities. From a practical perspective, we demonstrate how typical gamification requirements can actually be implemented and how various game design elements can be combined to stimulate meaningful engagement (Liu et al. 2017).

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