A Multi-stakeholder Process of Designing a City Platform for Sustainable Behavior: Lessons Learned

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Abstract. Many studies focusing on behavior change for sustainability have demonstrated the effectiveness of persuasive technology. However, changing behaviors with respect to climate change is a systemic, complex problem that involves not only end users, but other stakeholders as well. In this study, we applied a user-centered approach to engaging with multiple stakeholders on a city scale in the design of a web and mobile sustainability platform. We structured a process that allowed us to engage with local administration, service providers and citizens to derive requirements and design of the system. We report on our initial results and on our reflections from this process. We argue that integrating urban data in behavior change support systems can support personalization and better context understanding. We also point that when addressing sustainability from a system perspective, stakeholder engagement is a continuous process and designers need to ensure agency of all those involved. Understanding other factors which impact behavior can also provide an opportunity for synergy between persuasive systems and other interventions, such as infrastructure improvement.

Keywords: Persuasive Systems Design, behavior change, sustainable behavior, platform, multi-stakeholder, user-centered design, systems thinking.

1   Introduction

As the urgency of tackling climate change is becoming a priority across countries, the interest in persuasive technologies has grown in the non-profit, governmental and policy arenas. So far, persuasive technology has engaged with end users in order to trigger behavior change. Such applications have targeted mobility [1], energy consumption [28] and waste behavior [5], among others. However, many interventions in this area are "incremental" and fail to engage with "the systemic nature of sustainability as a

problem" [3]. The complexity of climate change requires practitioners and researchers to engage with a much wider ecosystem of stakeholders, beyond consumers.

In this paper, we present our approach of engaging with three types of stakeholders in the design of a web and mobile platform aimed to support local sustainability. We contribute our reflections on possibilities of integrating urban data for increased personalization and better definition of urban contexts which can impact sustainability choices. We also report on applying a user-centered approach to engaging with a complex range of stakeholders in deriving requirements for a persuasive system. We learned that stakeholder engagement is continuous and that designers should structure their process in a way that can support agency of all those involved. We also concluded that other factors, such as life transitions or infrastructure availability, can be both a barrier and an opportunity for enhancing the effects of persuasive systems.

2   Related Work

The scale and impact of behavior change systems tackling sustainability has been recently under scrutiny [17]. Notably, the idea that minor corrections in human behavior can lead to significant climate benefits has been challenged by calls for more holistic change [16]. These discussions have materialized in two directions which are relevant to our work: integrating approaches based in *systems thinking* [16] and a concern for the *process and methods* [3] applied in the design of persuasive sustainability systems.

The *system thinking* approach invites researchers to "grapple with the multi-scalar complexity" of sustainability as a "wicked" problem [24]. This body of work is largely exploratory and argues for designing at a different scale and with a greater variety of stakeholders [16]. It acknowledges that framing sustainability as an issue of personal choice in a marketplace "may obscure the broader political and regulatory questions that attend significant change" [9]. From this perspective, the dynamics of communities [11], the circumstances and decision-making at a community level, as well as in policy making [26] have provided researchers with new ways of exploring the design and impact of persuasive sustainability.

On a *methodological* level, the concern is to broaden the scope of engagement in persuasive system design. The rationale is increased transparency of the values and ethical issues of systems and their improved acceptance [7]. Participatory [7, 8, 14], user-centered [21] and value sensitive design [7, 15] have, therefore, gained ground in the field of persuasion. And while user-centered design has been applied in the development of city-wide applications [12, 18, 25], approaching this process from a multi-stakeholder perspective has been less prevalent in persuasive technology. For example, Stibe and Larson [25] provide tools for social engineering of "persuasive cities", but their work focuses on a generic segmentation of citizens and leaves out other stakeholders relevant in a city governance context.

3 Context of the project

Our work took place in the context of a partnership with the City of Salzburg, as a part of the Smart City Masterplan. The local administration was interested in encouraging pro-environmental behavior of citizens. The measures implemented until that moment had primarily focused on technical and infrastructure projects in the field of mobility, energy planning and energy efficiency. Most of these had a very small or no public engagement component, for example changing public lighting systems to be more energy efficient. The topics of *bike mobility* and *consumption behavior* were highlighted as key priorities. This focus was informed by most important issues for the city, such as increased congestion and supporting local sustainable production and consumption.

A partnership (the "consortium") was formed between the city, a local technology company and two research institutions. The partnership aimed at developing a local sustainability online platform: a persuasive system available on web and mobile. The main aims were formulated as (1) acting as a central information hub with respect to local information on sustainability, (2) encouraging sustainable behavior of citizens and (3) making existing services in this domain more visible. Based on these objectives, we worked towards developing an approach to engage with relevant stakeholders in the city. We aimed to answer the questions of (*RQ1*) How to assess the requirements of different stakeholders through a structured process? (*RQ2*) What can be learned about the design of persuasive systems through multiple stakeholder engagement? and (*RQ3*) What can be learned about behavior change on a city scale through integration of urban data? In section 4 we answer RQ1 by detailing our process. In section 5 we briefly present our results from requirements gathering in the form of three clusters of features. In Section 6 we discuss our reflections with respect to RQ2 and RQ3.

4 Approach to structuring a multi-stakeholder process to elicit requirements for persuasive systems

In this section, we highlight our process of mapping stakeholders and engaging them through workshops, surveys and individual meetings in order to elicit requirements for platform design.

4.1 Mapping of stakeholders relevant for a city platform

In order to identify direct and indirect target groups, a stakeholder mapping process was implemented. We use here the term "stakeholder mapping" as understood in urban planning [26] and complex systems theory [6]: a framework to conceptualize the different constituencies in the city and the relationships between them.

Target group definition. Fig.1 illustrates the three stages of the mapping process, from left to right. As a first step, the consortium partners identified three target groups: the citizens, the local administration and the service providers. "*Citizens*" were defined as local inhabitants of the city, interested in pro-environmental services. "*Service pro-*

viders" were understood as private, public or non-profit entities who offer a sustainability-related service or manage an initiative in this area. For example, a food delivery service which provides takeaway from sustainably-aware restaurants. Finally, the "*local administration*" was defined as the municipality, through its various departments.

First stakeholder mapping. In a second step (green), the stakeholders and relationships between them were identified in more detail. The process took place offline and online. In a face-to-face meeting, consortium members individually reflected and wrote down on post-its suggestions. The notes were collected and grouped together and potential relationships were illustrated. Afterwards, the notes were digitized and additions were made based on desk research. A contact list with information about the managers or leaders for each institution or organization was also made.

For the *local administration*, the entry point was the Smart City Manager, who was also a staff member directly involved in the project. The Urban Planning Lead and the City Biking Coordinator were identified key contributors. It became evident that the Smart City Manager was the most adequate person to engage other departments in the project. That is because various departments support the delivery of the Smart City Masterplan, although they make decisions with regard to their own resources.
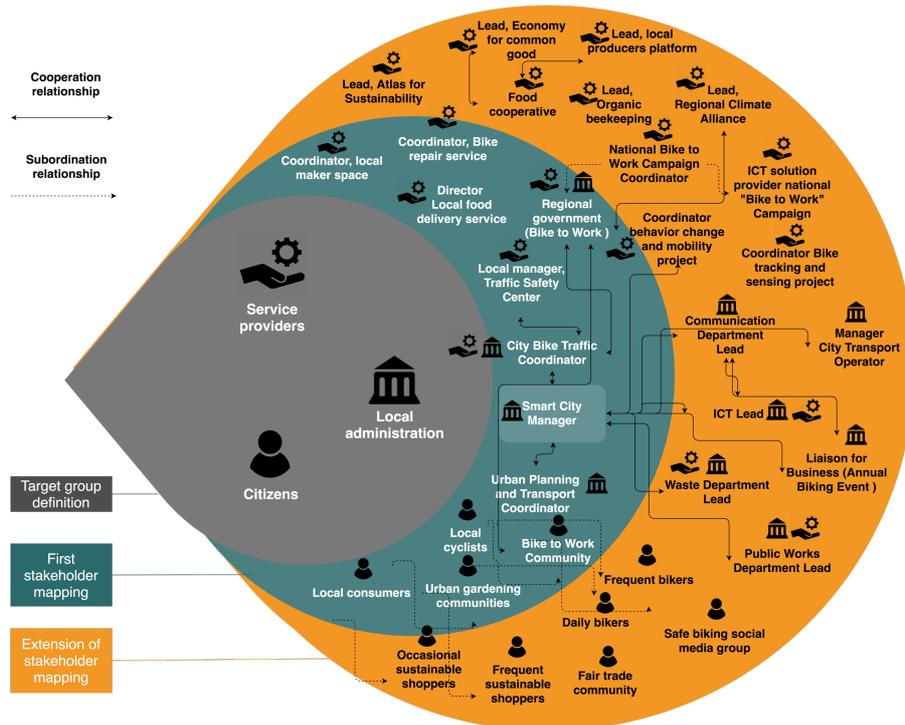
Fig. 1. Stakeholder map: target group definition, first mapping and mapping extension.

For the *services*, the mapping included both biking and local consumption. Most of the stakeholders providing these services were independent of each other, such as the local maker space, a traffic safety center or a local bike repair service. However, some stakeholders proved to be both part of the local administration and service providers, at the same time. For example, the Bike Coordination team manages a number of public services, such as a "bicycle box" renting service.

The *citizens* were grouped thematically in (a) local cyclists and (b) local consumers. Known communities such as urban gardening and the "bike to work" communities were also included.

Extension of stakeholder map. As a third step, an extension of the stakeholder map was made following the initial work on user requirements, as described in Section 4.2 below. References to other stakeholders from the different activities were collected and continuously added. In order to streamline the process, a collection of materials was prepared for a swifter onboarding. A short project description, a draft template for confirming interest, with different options of integration in the platform was made available to service providers. In the later stages, mock-ups of the platform were added.

In the *local administration*, several departments became of relevance for the platform design and implementation throughout the process. The Waste, ICT and Public Works departments were added as administration and service providers, in the areas of recycling (Waste), open data layers (ICT) and urban design improvements (Public Works). The City Transport Operator and the Liaison for Business and the Communications Department were key to consult for the possibilities of offering incentives from the city.

Additional *services* were suggested in the area of local consumption by a local engagement expert. Representatives of two new large-scale projects were also included. As the Bike to Work campaign is coordinated regionally, but forms part of a larger national initiative, the national coordinator and the ICT provider for the national campaign were added.

The *citizen* surveys provided additional information about potential segmentation of citizens. Daily and frequent bikers, as well as the frequent and occasional sustainable shoppers were identified as the main target groups. A local fair-trade community and members of a social media group on "safe biking" were also added.

4.2 Structuring the requirements and design process

In order to elicit requirements from the different stakeholders, we structured our process according to user-centered design principles: defining the goal and vision, assessing needs and requirements, design and specifications (see Fig.2). We ran four types of activities: extended consortium workshops, surveys, service provider workshops and individual meetings. The output of each stage was used in structuring the next.

Goals and vision. In this step, an extended consortium workshop (WS1) was organized, which was attended by the interdisciplinary project staff members: the company in charge of the platform design and development, two research institutions, one uni-

versity and the Smart City Manager. The workshop was "extended" as others not directly working on the project took part: local administration staff and external consultants working with local government, totaling 15 participants.
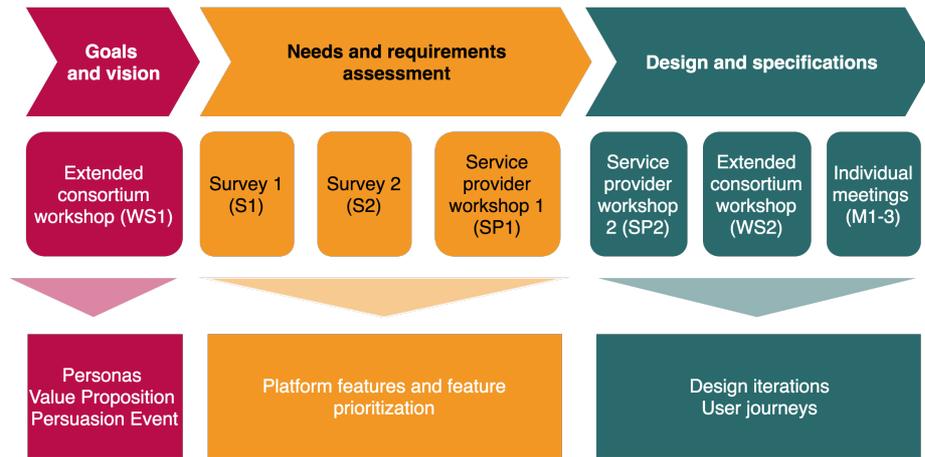

Fig. 2. Overview of the multi-stakeholder engagement process: goals and vision, needs and requirements assessment and design and specifications

The templates from the open source Platform Innovation Toolkit [29] were used. Participants worked in groups of 3 to 4. We had three successive rounds of discussion on the templates for Personas, Platform Ideation Canvas and Platform Service Canvas [29]. After each round, the groups presented the results of their work and discussed any open issues. The output of the workshop was structured into "personas" and value propositions for each of the three target groups. Insights with respect to expectations, motivations and technology use were mapped to define the "persuasion event" for each target group, according to the Persuasive System Design [20] model. The results showed the different contexts and potential value proposition for each target group.

Needs and requirements assessment. In order to elicit needs of citizens and service providers, two surveys (S1 and S2) and a service provider workshop (SP1) were organized. A separate activity was not held for the local administration, as the needs of the municipality had been extensively covered in WS1.

The first survey (S1) was focused on bike mobility and was implemented during a local annual biking fair. Participants filled in the questionnaire on tablets with the help of a staff member. No monetary incentive was offered but respondents had the opportunity to participate in a raffle where 3 vouchers worth 50 euro were awarded. The survey gathered 135 responses. The survey contained questions about biking behavior, as well as the use context for the platform, awareness of local biking-related services and preference with respect to platform features and incentives.

The second survey (S2) was published online and distributed by the local administration and partners through their social media channels. The survey gathered 41 valid responses. No monetary incentive was offered in this case either, but again 3 vouchers

of 50 euro each were awarded based on a raffle. The questionnaire contained items about consumption behavior, and additional questions about awareness of local sustainable services and feature preferences.

The first *service provider workshop (SP1)* aimed to elicit initial requirements from the service providers. An invitation was sent based on the first stakeholder mapping (see Fig.1). The workshop was attended by 6 participants. Participants were first introduced to the goal of the project. A discussion followed, which was organized in three rounds. In the first one, participants presented their service, usage rates and challenges. In the second one, the focus was on future development plans. In the third one, participants were asked to reflect and propose platform features.

Design and specifications. Based on the insights provided in the previous stage, design mock-ups were prepared. An initial concept was introduced, based on the idea of collecting "city heartbeats" through sustainable actions, as a shared and gamified objective by all users (see Fig. 3). Platform features were grouped in order to answer the needs highlighted.
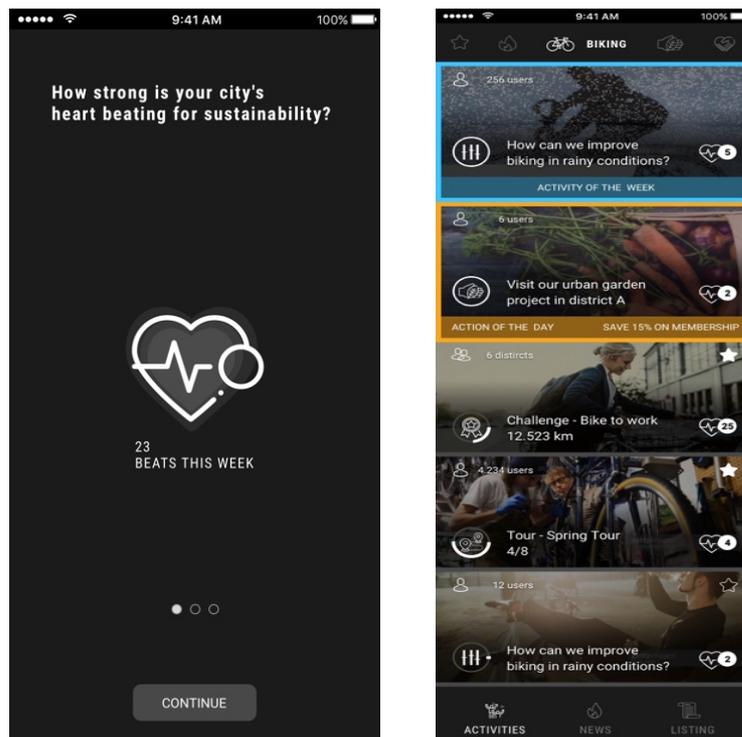

Fig. 3. Mock-ups of platform design: gamified objective (left) and overview of activities (right).

A second *service provider workshop (SP2)* was organized in this phase. An invitation was sent again and the workshop was attended by 9 participants. The workshop again started with an introduction of the new services. As most participants had not attended the previous workshop, the presentation of the services was followed by a

discussion on the feature clusters. For each of the categories, participants were invited to discuss (a) feedback on the presented features, (b) suggestions for improving the features or adding new ones.

The second *extended consortium meeting (WS2)* was attended by 8 participants and was also focused on the platform design. An initial summary of the findings in the requirement phase was made, including the survey and workshop results, an extended list of features and a priority map for feature development, as well as initial designs. The discussion took again place in three rounds, one for each of the three feature clusters. This time, the discussion was not in groups but in a roundtable format. For each of the categories, the features were presented, then comments on the feature proposals were made and a final round of suggestions and changes took place. Suggestions and changes were mapped on a flipchart, throughout the discussion, by a notetaker, and after the workshop, they were coded and structured for follow-up.

Finally, *individual meetings (M1-M3)* were organized, with the Biking Coordinator and the ICT Department of the local administration. The first two meetings took place with the Biking Coordinator. The discussions were semi-structured and focused on biking services provided by the municipality and specific requirements for them. The third meeting took place with the local administration ICT department. The topics were the integration of open data layers and other types of data (not open) into the platform.

5   Results

We report on the initial results following the "needs and requirements" phase, on the three clusters of features and the possibilities for integrating them with persuasive approaches at a community scale.

Information provision. This cluster refers to possibilities for citizens to access information about sustainability-related activities and services. Initial suggestions included content production in the form of an online magazine, as well as accessing services through a listing or on a map-based feature. News updates from services and "tips for sustainability" were also mentioned. Integrating local events in the form of a calendar would help users find out about thematic activities in this area. Possibilities of integrating local, open and sensor data into the platform were offered by the city. The information provision cluster could be linked to application of persuasive strategies, for example through suggestion of visiting a sustainability service or place based on the user location on the city map.

Participation. This cluster refers to ways of stimulating the user's sustainable behavior. Initial proposals included the possibility of a token system which could be exchanged for monetary or in-kind rewards. Such in-kind rewards could consist of vouchers, loyalty offers or discounts for the local sustainable services included in the application. Gamification tools, such as challenges, dashboard, achievements were also suggested. In order to encourage and monitor participation, mobility, consumption behavior and event attendance could be tracked.

Engagement. This cluster was meant to stimulate sustainability of users by encouraging participation in the local community. Thus, citizens feel they are not solely acting

on their own, but their efforts matter at a local and global scale. Social media sharing, crowd sharing, community challenges and community rewards were all suggested. An emphasis was placed on favoring cooperation approaches as a social influence strategy, as opposed to competition or comparison. Additionally, citizens would be able to rate or report on sustainability services and such feedback would be collected by the municipality for follow-up. The results from the process showed that stakeholders placed a great importance on the added value of the platform at a local level and on answering concrete user needs, such as finding local information.

6 Reflections from engaging with multiple stakeholders for persuasion at a city scale

In this section, we reflect on the lessons learned throughout the process of engaging with multiple stakeholders in system design. We address RQ3 by highlighting identified opportunities with respect to the integration of urban data for persuasive design. We also share our lessons learned on the value and limitations of stakeholder engagement at a city scale (RQ2).

6.1 Use urban data to understand behavior

Designing for persuasion at a city scale opens up some exciting opportunities to collect and use urban data to better understand behavior. Working with multiple stakeholders generated conversations about ways of integrating multiple data sources. This could inform city-wide behavior change strategies [4, 10], in order to improve profiling and personalization, as well as to understand place-based factors in behavior.

Integrate urban data to inform personalization. In our discussions referring to information provision, opportunities for integrating different data sources were identified together with the municipality and other partners. These include city and regional open data layers, GPS, mobile tracking and sensor data. Additionally, these could be integrated with data collected by the system, such as location-based behavior of user, mobility tracking, accessing sustainability services, accessing information categories, services or activities. This can lead to more effective, just-in-time interventions which are not just based on user type, but also on user location and likelihood of wanting to access a particular service in a particular moment. Preferences for services and day-to-day behavior can lead to a better understanding of "micro-moments" of decision making [22], where users might be more susceptible to persuasion.

Understanding contexts for persuasion. Contextual awareness for recommender systems is a growing research area [2, 19]. We suggest, based on our work with stakeholders on a city scale, that integrating applications with other types of data at an urban scale is an opportunity for understanding contexts before persuading. This can lead to awareness about infrastructure, urban design or service availability needs. For example, a particular home-work route may not be ideal for biking, and dangerous or uncomfortable locations can be improved through infrastructure investments before the user is "persuaded" to bike more. The lack of a local market in a specific area might prove to

be a hindrance in shopping more sustainably or show the need for a delivery service. Urban design can also be configured to nudge towards other choices, based on place-based information.

6.2 Stakeholder engagement is a continuous process

As suggested in more recent and holistic approaches to sustainability persuasion [16], we took a stand with respect to stakeholder mapping that was grounded in urban planning and complex systems theory [6, 13]. We understood the design of our system to be intrinsically linked to the existence, dependencies and relationships of different stakeholders on the local level. We also understood this mapping process to be continuous and not strictly limited to the very initial project phase. Three strategies have supported us in a continuous expansion of our understanding of local constituencies: flexibility, time planning and easy onboarding.

Remain flexible. The dynamics and realities on a city or system level can change: new initiatives and projects may appear while others fall short of their goals. Additionally, even when being thorough with the mapping strategy, it is highly likely that not all knowledge is available to researchers and designers from the very beginning. Depending on the size of the system or city, the scale of the mapping process might seem overwhelming. We found that staying flexible in the requirement phase was a good strategy to ensure new stakeholders are constantly added and information is not missed out. We made sure, in this way, that we have reached a sufficiently critical mass of stakeholders to be able to draw conclusions for system design.

Allow for sufficient time for needs gathering. As pointed out by others, participatory and user-centered design is a time-consuming and resource-intensive process [14]. However, altering designs due to inclusion of stakeholders too late in the process may prove to be even more costly. Therefore, sufficient time is needed for gathering requirements from different constituencies. We had planned for an initial 6 months for identifying needs and requirements, which was expanded to 8, to allow for a proper analysis of the data. We could therefore plan for additional meetings where needed.

Ensure you can onboard stakeholders easily. Constantly including new stakeholders is a time-consuming process, especially if the system purpose and goals needs to be presented and explained to each. For easier onboarding, we used several strategies, such as short project descriptions, templates for statement of interests and a short project pitch including mock-ups, that can be used in any workshop to reduce briefing time. Additionally, to simplify discussions with service providers, we have provided three options for participation in the platform, based on two levels of integration: basic (service listing) or extended (data collection and possible API integration). Therefore, follow-up could be done swiftly with each service provider, based on their preference and possibilities of integration.

Based on these strategies, the depth and extent of the process ensures no essential information has been missed in the requirement phase. To ensure participation and transparency, stakeholders can still be engaged in the process of platform design. Several options to do so have been made publicly available on the local administration and project channels.

6.3   Ensure agency of all stakeholders

Designing in the space between multiple stakeholders involves also permanently nego-tiating development priorities for system design which are not the same for everyone. We engaged with political ecology locally [16], and the with the multiplicity of stake-holders who would be using our platform differently: the citizens as end users, the mu-nicipality as a platform provider and the services as engaged partners. We designed our process in order to give equal voice to all three.

Design a balanced process. Our mix of activities with the different stakeholders allowed us to adequately identify potential overlaps and divergences in terms of re-quirements. As we aimed to work on a city scale, our choice of starting with an extended consortium workshop in the "goal and visioning" phase enabled us to clarify target groups, value propositions and the design context. We deliberately worked closely with the local administration in this stage and instead focused on the citizens and service providers for requirements gathering. That allowed us to avoid an over-emphasis on the city management needs, as the local administration was also a project partner.

Be transparent when prioritizing requirements. In some respects, the three target groups had the same requirement, as was the case with "information provision". In other cases, requirements did not overlap entirely. For example, the citizens were inter-ested in providing feedback, to which the local administration was open, on condition of providing a useful way to filtering requests. In such cases, we made sure that a feature proposal would answer the needs of different target groups. We were also transparent in all activities about the results of inquiring other target groups. For the feedback fea-ture, for example, we ensured that citizens could make suggestions, but the possibility of "upvoting" by other users provides the local administration with a way of prioritizing and structuring the information. An alternative way for prioritizing needs would be to follow up on requirements with joint meetings between all target groups. However, the efficiency and the challenges of such a format would need to be tested.

6.4   Limitations and opportunities

The enthusiasm for behavior change support systems is growing, not least because it promises to bring about desired results in a cost-effective way. However, both designers and organizations might oversee the fact that conceptual frameworks in behavior change disregard other factors that influence a behavior. Previous applications of par-ticipatory design to persuasive technology have showed that designers must be ready to not design technology [12]. At a city scale, we find that while two other factors can strongly influence behavior, they can be both a barrier and an opportunity to improve persuasive technology.

Life transitions. The role of life course events in decision making has been studied in connected domains, particularly in transport planning [23]. In our first survey, we also found that 20% of respondents do not cycle daily because they moved too far from work to do so. The same respondents were less likely to change their behavior due to having more information about available services. However, we were also able to lev-erage life transitions for improved effects. For example, a partner project focusing on

new residential developments enables us to target a sub-group who will be moving shortly to new housing and, therefore, would be in a position of changing routines.

Infrastructure. The availability of infrastructure may also play a big role in sustainability choices. 24,44% of the first survey respondents would bike daily if they had improved bike routes between home and work. On the other hand, 77% to 97% of respondents in the second survey felt they were sorting out waste correctly, due to availability of different waste bins. To improve effects of the platform, we therefore aim to combine our work with infrastructure improvements planned by the local administration, such as the extension of bike paths and closing down streets for traffic. Such synergies with other ongoing public investments were a result of the different workshops where complementary initiatives took part.

7   Conclusions and Future Work

This paper has presented our approach to applying a user-centered process on a city scale to derive requirements of a persuasive platform. We engaged with three types of stakeholders (citizens, service providers and local administration) through workshops, surveys and individual meetings to understand the potential for local change for sustainability. We reported on our initial results, namely integrating persuasion with three other feature clusters: information provision, participation and engagement. In this process we discovered that integrating urban data with persuasive system design can improve personalization and context understanding. We also learned that stakeholder mapping in a city context is a continuous process, that requires time, flexibility and easy onboarding. Balancing a multi-stakeholder process requires a careful design of activities and transparency in dealing with divergent requirements. Finally, we found that other factors impacting behavior such as life transitions and available infrastructure can be both a barrier and an opportunity for enhancing the effects of persuasive systems. Future work includes the finalization of the application and its testing in user studies, both in a lab setting as well in a natural environment, on a city scale.

Acknowledgements

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14

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