TMaaS: an innovative, multimodal and user-centred approach to traffic management

Delphine Grandsart, Evelien Marlier, David Geerts, Kevin Sanders, Sidharta Gautama, Dominique Gillis, Angel J. Lopez

European Passengers' Federation, delphine.grandsart@epf.eu, European Passengers' Federation, evelien.marlier@epf.eu, Leuven University, david.geerts@kuleuven.be, Leuven University, kevin.sanders@kuleuven.be, Ghent University, Sidharta.Gautama@UGent.be, Ghent University, Dominique.Gillis@UGent.be, Ghent University – Escuela Superior Politécnica del Litoral, Angel.Lopez@UGent.be

Abstract

The 'Traffic Management as a Service' (TMaaS) concept offers traffic management capabilities through a cloud-based platform. Without having to invest heavily in hardware, a city can simply subscribe to the platform in order to gain access to all available – multimodal and real-time – mobility-related data for their territory. TMaaS offers the tools to not only visualize data and manage traffic, but also to communicate with citizens. The platform automatically monitors the data flow and is able to send personalized messages to individual citizens, who in turn can reply to these messages and feed information back to the system. In this paper, we discuss the stakeholder research that was conducted and how it results in user-centred functional and design requirements for the TMaaS platform.

1 Introduction

A great number of small and medium-sized cities [1] around the world struggle to get a grip on traffic and mobility. The current traffic management solutions available on the market are cost-intensive, hardware-based and primarily focused on cars [4]. Traffic Management as a Service (TMaaS), on the other hand, offers a less costly, flexible and cloud-based solution for multimodal urban mobility management, where the focus is on citizens, policy implementation and public benefit. The TMaaS project will deliver two key outcomes: a mobility management dashboard for traffic managers and local (transport) authorities enabling them to better visualize and manage urban mobility systems, and a citizens' dashboard that pro-

vides information to the population and notifies users in the event of disruptions or accidents.

Without having to invest heavily in hardware and based on existing data sources, a city can simply subscribe to the platform to get access to all available – multimodal and real-time – mobility-related data for their territory. Data from multiple sources, for example public transportation schedules, bicycle counting systems, floating car data, but also weather and air quality information etc. can be shown on a single dashboard. The TMaaS platform automatically monitors the data and is able to send personalized messages to individual citizens through the social media channel(s) of their choice. Travel alternatives are calculated and notifications are generated whenever there is information (for example traffic jams, road works, train delays, events, …) relevant to a specific end-user. Citizens also have the possibility of replying to these messages and feeding information back to the platform. This crowdsourced input is an extra data source enabling a city to react faster to any mobility-related problems.

In order to achieve this, TMaaS not only needs to tackle technological challenges in terms of service connection, data integration and analytics, it also needs to address important questions on business rules, technology neutrality, data privacy and ownership. The challenge for TMaaS is to bring this together in a scalable and cost-effective solution accessible for small and medium sized cities. In multimodal traffic management, cities in Europe and around the world may have different concerns depending on their size, urban mobility strategy, governance structure, budget, citizen participation etc. Application uses can range from day-to-day vehicle flow and parking monitoring to pedestrian flow management during city events and support for tactical urbanism for citizen-friendly city streets. As a generic platform that is scalable for an international market, the TMaaS solution needs to address common needs for cities as well as citizens related to urban mobility.

TMaaS (tmaas.eu) is a three-year project co-financed by the European Regional and Development Fund through the Urban Innovative Actions Initiative that provides urban areas throughout Europe with resources to test new and unproven solutions to address urban challenges. The TMaaS consortium consists of a unique mix of private and public partners – local government (city of Ghent), universities (Ghent, Leuven), industry (TomTom, Be-Mobile), SMEs (Waylay, De Staatse Ruiter) and citizens (represented by the European Passengers' Federation) – who cooperate towards achieving the goals described above.

The first TMaaS pilot is being implemented and tested in the city of Ghent, Belgium (2019). The ultimate aim, however, is to build a flexible modular system that can be replicated and customized. In the following phase therefore (2020), three 'Replicator Cities' will have the opportunity to work with the TMaaS team on creating their own local TMaaS dashboard.

In this paper, we focus on the case of Ghent. With approximately 260,000 inhabitants, Ghent is the second largest municipality in Belgium. The city has good road and rail connections to surrounding areas and does not suffer from chronic road traffic congestion as much as other major European cities do. Nevertheless, mobility management ranks high on the city's priority list as the city attracts over a million students and visitors every year, and commuter traffic is putting a lot of pressure on the mobility system.

2 Stakeholder involvement in TMaaS

In order to design and develop a sustainable and successful Traffic Management as a Service platform, the requirements from the different stakeholders in the mobility ecosystem need to be mapped out and analysed. In this section, we explain which stakeholders we identified, how we involve(d) them in the project and why. Later on, we will outline in more detail the research methods, the main results obtained and how these are used further on in the TMaaS project – and beyond.

2.1 Relevant stakeholder groups

Within the TMaaS project, we consider relevant stakeholders to be any individual, group or organization that is somehow impacted by the outcome of the project, i.e. those who may become (potential) users or partners of TMaaS; those on whom TMaaS can have a positive or negative impact; and those who could contribute to better solutions with their knowledge or experience.

The main stakeholder groups for TMaaS (Figure 1) include local actors such as citizens (for example elderly people, people with reduced mobility, families with children, etc.), visitors (commuters, students, people visiting the city for shopping, to attend an event, etc.), local (transport) service providers (police, firemen, public transport operators, taxis, shared mobility providers, etc.), local authorities, local companies (shops, catering sector, entrepreneurs, etc.) – but also stakeholders at a higher (i.e. regional, national, even European and international) level such as policy makers, citizens' representatives, mobility experts, IT[1] & ITS[2] industry, and transport service providers and transport authorities in other cities.

[1] Information Technology
[2] Intelligent Transportation System

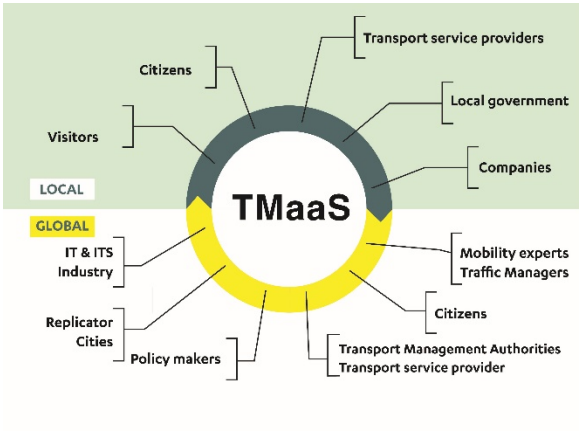

Fig. 1. TMaaS stakeholders overview

We decided that freight/logistics do not fall within the scope of the TMaaS project as this target group requires very specific types of information e.g. on accessibility for trucks (road width, turning radius, height limitations, …) or on regulations (access restrictions, delivery periods, …) – that are available through other, more specialized tools that are already on the market. Tourists were also excluded from the stakeholder research, because this group needs a tailored approach that would require extra time and resources.

2.2 Stakeholder involvement in TMaaS

Stakeholder involvement is an essential component of the TMaaS concept. In fact, its strongly user-centred approach is one of the project's most innovative features. By involving them from the beginning, we aim to raise public awareness and engagement among all stakeholder groups involved. In addition, we want to make sure that the services developed within the TMaaS project are consistent with their (current and future) needs and expectations. Stakeholder feedback helps the TMaaS team to improve the project outcomes and gain insights into drivers, barriers, risks and opportunities.

Throughout the whole duration of the TMaaS project (2018-2021), activities are planned to keep the stakeholder groups informed and engaged. The focus changes each year. During the first year, our principal aim was to gather insights on user requirements regarding data sets (information) and functionalities for the TMaaS platform. During the second year, the focus lies on the development of the TMaaS prototype for Ghent and on evaluating its design and interfaces. During the third year, we will evaluate the stakeholder involvement processes and write recommendations. In the remainder of this paper, we focus on the activities that have taken place in the first year of TMaaS.

Stakeholder research was broken down into three main parts: mapping requirements of policy makers and traffic managers, mapping citizens' requirements, and monitoring and coordinating with a wider group of stakeholders. The latter group consists of representatives from diverse interested parties such as local companies, mobility experts, transport service providers, etc.

3 TMaaS stakeholder research: methodology

Various methods were used for the stakeholder research activities, including desk research, interviews, an expert focus group, diary studies and co-creation workshops (Figure 2 shows the recruitment message used on social media, illustrating TMaaS' user-centred approach). The choice for these particular methods was based mainly on their suitability for achieving our research objectives – which differed according to stakeholder group – considering the advantages, limitations and the type of results that each method would generate.

Fig. 2. User engagement is at the heart of the TMaaS approach

3.1 Mapping out requirements of policy makers and traffic managers

Information on traffic planners' and traffic managers' requirements regarding the TMaaS platform was collected through desk research – review of relevant literature e.g. produced by expert groups within the context of other European projects – and audits (interviews) in a diverse sample of cities [2].

The desk research focused on gaining general insights into the current status of traffic data and traffic management, open data policies and business models, and deployment of ITS for multimodal traffic information applications. In addition, in-

terviews or 'audits' were conducted with representatives from six small to medium-sized cities [1] with a different size, population density, geographical location, and that were at different stages in their development of a traffic management centre: Ghent and Mechelen (Belgium), Durán (Ecuador), Bielefeld (Germany), Helmond (the Netherlands) and Ahmedabad (India).

The audits covered several aspects of traffic management:

- the general context in which the traffic centre works (mobility policy of the city; role of traffic management)
- traffic management tools (how the traffic information is used within traffic planning and traffic management)
- incoming data sources (what data sources are available and used; are there any gaps in data availability; is data owned, purchased or shared)
- data processing (data flow; technical requirements for data, software and hardware)
- outgoing data/information (what type of data/information is distributed by the centre and to whom?)
- operational and organizational aspects (organization of the traffic management team; position within the city administration; external partners)
- business models (how is the traffic management financed; does it generate any income of its own; what budget is allocated?)
- further plans and evolutions (improvements; optimization).

The exact content of each interview varied according to the type of city audited. For cities starting up traffic management the focus was more on expectations and ambitions, whereas cities with an already active traffic management centre were able to provide more specific information on its functioning. The interview questions also varied according to the profile of the interviewees. Mobility planners or traffic managers were asked about mobility aspects (traffic management tools, incoming and outgoing data); data/IT specialists were asked for feedback on data processing and in- and outgoing data sources; and (financial) managers were asked to comment on the organization and financial models [2].

3.2 Mapping citizens' requirements

Two studies were carried out in order to gain an understanding of citizens' needs and wishes relating to the TMaaS system. The target audience was defined as residents of the city of Ghent as well as people living outside of Ghent who visit the city on a regular basis. In addition to these geographic characteristics, our target audiences differ in age, occupation (student, working, unemployed / retired), civil status and their available, preferred or most frequently used modes of transport.

3.2.1 Diary study

An initial survey was carried out with the goal of gaining a clear and complete picture of the citizens' travel behaviour over a longer period of time during their normal everyday life. It was also aimed at understanding the problems they face and solutions they find while travelling and planning their journeys. In order to capture the longitudinal aspect of the travel behaviour while still gaining an overall understanding of the behaviour, we used a method that combines a snippet-based travel diary with an in-depth interview [12] [5].

Fig. 3. Diary materials used by the participants during the two weeks of diary-keeping

Based on a questionnaire that was disseminated through social media, we recruited nineteen participants with different demographics, life situations and available and preferred modes of transportation. The sample included 11 females and 8 males aged between 22 and 69. Participants received a box with a small pen, two example cards, an instructions card, a set of planning diary cards and a set of on-the-road diary cards (Figure 3). The diary cards contained a pre-defined set of questions about their travel planning and travel behaviour and experiences, designed so that they could be filled out quickly. The smartphone app Moves [9] was used to track the participants' journeys over time and estimate the mode of transport used, and served as a quality check for the diary data.

Participants were instructed to fill out their planning diary cards every time they were planning a journey and were made aware of the fact that travel planning can sometimes be carried out rather subconsciously and without actually looking up information, when just anticipating an upcoming journey [11]. They were further instructed to fill out their on-the-road diary cards during or right after a journey.

Participants filled out the diary for two weeks, after which an individual interview was conducted with each participant (Figure 4). Interviews were recorded. During

this interview, all of the completed diary cards were laid out across a table to create a timeline of the participants' travel behaviour over the previous two weeks. The participants were asked to describe the planning and travel process for each of the cards. Further questions were asked to get a more detailed idea of the behaviour, about recurring journeys for instance or differences between planning cards and their corresponding on-the-road cards. At the end of the interview, participants were given help to uninstall the Moves app if they so wished and received a gift voucher worth 40 euros.

Fig. 4. Discussing the diary cards with a participant during an interview

A total of 18 interview recordings were transcribed, one recording had failed and was excluded from further analysis. NVivo 12 data analysis software [10] was used to highlight 1,402 quotes in these transcriptions. 224 codes were then created from these quotes, which were then organized into nineteen themes using the affinity diagramming technique. These nineteen themes fit into four categories: travel planning, travelling, context and interacting with information.

3.2.2 Co-creation workshops

In order to gain inspiration for possible features of the TMaaS platform, as well as gaining an understanding of which functions could be interesting for the citizens of Ghent, two co-creation workshops were organized. Participants were mainly recruited from the pool of applicants for the diary study. Some additional recruitment was carried out to reach out to students and older participants. A total of 25 people participated, spread across two workshop sessions.

As a preparation for the workshop, participants filled out travel diaries [5]. At the workshop, they were given a brief introduction to the TMaaS project, after which they were divided into groups of three or four participants. For the first ideation activity, three decks of ideation cards were created (Figure 5) [3]. Deck 1 consisted of cards describing travel goals (e.g. work (distance 5 – 20km), shopping in the city centre). Deck 2 consisted of cards describing either modes of transport (e.g.

tram, bicycle) or personal factors influencing travel behaviour (e.g. in a hurry, carrying a lot of luggage). Deck 3 consisted of cards describing external factors influencing travel behaviour (e.g. rain / wind, road works). The contents of the ideation cards were based on the results from the previous diary study.

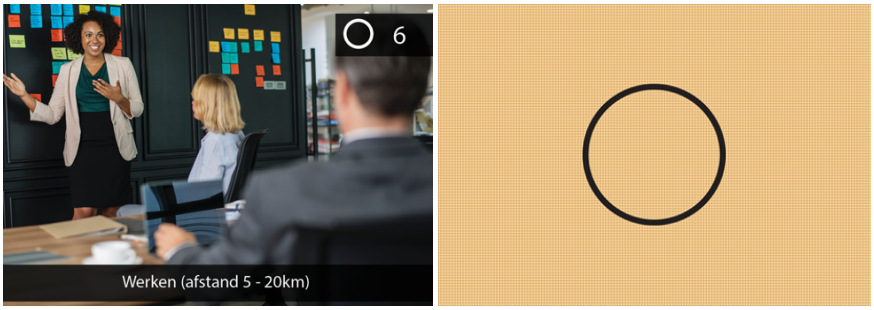

Fig. 5. Example of an ideation card as used in the co-creation workshop. Front (left) displaying the travel goal / mode / context, back (right) indicating the deck it belongs to

Several ideation rounds were carried out, following a card-drawing sequence that was explained on a board. In each round, participants were first asked to come up with a travel scenario based on the cards drawn, and then to ideate a function that would enable the TMaaS platform to support the traveller in this scenario by providing information. This could be either a function in which the participant would actively look up information (pull), or a function in which the system would send a message containing information to the participant (push). Lastly, participants were also asked to reflect on the occasions when this function could best be used, within the context of their travel scenario.

After this first ideation session, participants moved to the adjacent table to vote on their three favourite ideas from another group. For each of the two to three ideas that obtained the most votes from a group, the participants were asked to individually fill out a personalization sheet, to re-design the function conceived by the other group, so that it would best fit their own personal life and situation. They were also asked to describe what personal information the system would require to optimize this function and how they could provide the system with feedback to help improve the function. Participants were thanked for their participation and were given a gift voucher worth 40 euros.

All of the creation sheets (49) and personalization sheets (66) that were filled out during the workshop were analysed. Based on the function and information needs that were described, as well as the underlying concepts and ideas that could be derived from the function and problems that were indicated, a total of 160 codes were extracted using NVivo 12 [10] and categorized into 7 themes by means of an affinity diagram. Out of the seven themes that arose from the analysis, five related directly to an element that falls under the scope of TMaaS. The themes “push in-

formation" and "timing" relate to the Alerts system in TMaaS; "pull information" and "interaction with platform" relate to the dashboard of TMaaS; and the "general personal information" theme relates to the personalization part of TMaaS. Two other themes, "booking / purchasing services" and "peer to peer communication", do not fall within the current scope of the project.

3.3 Wider group of stakeholders

In-depth interviews were conducted with representatives of diverse local stakeholder groups such as shopkeepers, local transport service providers, employers, students, etc. who were invited to give their opinion on the datasets that need to be integrated in the TMaaS platform and on user requirements regarding the functions the TMaaS platform should have. A first round of interviews was carried out with local stakeholders. In a second round, regional, national and EU stakeholders were also addressed.

The aim was to study the information needed by the different stakeholder groups in order to make a well-informed decision on their journey and to map out their expectations of the TMaaS platform. The stakeholder representatives also identified possible barriers and drivers for the uptake of the platform, as well as opportunities and threats (SWOT[3] analysis). To structure the interviews, a questionnaire was drawn up with these specific objectives in mind.

4 Main results of the stakeholder research activities

Here, we present the main results obtained during the stakeholder research. The results are presented per stakeholder group. More detailed information can be found in the TMaaS deliverables covering 'Requirements for data collection for traffic management' [2], 'End-user requirements' [13] and 'Initial report on monitoring a wider group of stakeholders' [7] (available on tmaas.eu).

4.1 Cities: policy makers and traffic managers

One of the first topics in the interviews with traffic managers was the current use of traffic data. In most cities, the focus is still on 'connected infrastructure' data (i.e. data collected about infrastructures, typically data for a specific road segment or intersection). More recent techniques for collecting data from vehicles (e.g.

[3] Strengths, Weaknesses, Threats, Opportunities

floating car data by GPS[4] tracking) or from people (e.g. smartphone tracking) are used much less frequently.

There are still some obstacles in cities to adopting innovative data applications. For example, there are some concerns about the availability and quality of traffic data. Other challenges relate to technical system requirements (e.g. privacy protection and data security). Some of the interviewees expressed doubts about the benefits of traffic management (possible negative impact, e.g. better traffic information may encourage drivers to avoid congestion by using other routes through residential areas or school environments) and the limited responsibility of the city (in terms of road categories, territory, tasks). Internal and external governance issues (e.g. project ownership, cooperation with other departments and external partners) are also seen as problems.

Traffic data can be used in a variety of applications, from simple traffic analysis (understanding urban traffic and mobility by recognizing patterns) and traffic monitoring (a derived analysis focusing on evolution in time) to sharing traffic information (with mobility partners, other road users, citizens) and, ultimately, traffic management (optimization of the road network organization in response to the actual traffic situation) [2].

Cities often start with traffic analysis and then evolve naturally towards more complex applications. Once certain types of traffic analysis have been implemented, the next step is to re-evaluate the same data on a frequent basis and after that, share the information with other partners and/or citizens, to finally manage traffic according to the lessons learnt. The main challenge for cities is to take the first step: to become acquainted – through simple, start-up demonstration activities – with the potential and limitations of traffic data and build up experience about how to use this data for traffic analysis.

Existing market solutions for traffic management are mainly high-end, complex and expensive tools that suit the needs of large cities but overshoot the requirements and budgets of smaller or medium-sized cities that are only just starting to build up experience in traffic analysis.

The TMaaS data platform could provide a technical solution. However, audits revealed that there is also a need for broader support, such as training and guidance on specific aspects of traffic data and applications, e.g. technical (data quality, data processing), legal (data property, privacy restrictions), organizational (tasks and responsibilities, business models) aspects. Networking between cities for exchanging experiences is also a point requiring attention.

[4] Global Positioning System

4.2 End-users: citizens

While the results of both the diary studies and co-creation workshops covered a wide range of subjects, the current paper focuses specifically on how the information system can support different types of users, with different types of planning habits, for different types of journeys.

The diary study interviews demonstrated that people's travel planning behaviour varies depending on the person and type of journey. Some never really plan their journeys and just see as they go along, while others plan their journeys more carefully beforehand and know exactly what they are going to do. In both cases however this can depend on the specific journey in question.

4.2.1 Planned and unplanned journeys

In the case of planned journeys, participants explicitly look up or compare different transportation modes, routes and/or timing options. Different modes of transport are compared based on attributes such as speed (affecting travel time), comfort, flexibility and price. Furthermore, the different possible modes and routes differ in terms of safety and convenience. For example, parking is often mentioned as an inconvenience for using the car and certain roads are considered dangerous for cyclists. Many of these parameters that are considered when planning journeys are interpreted differently by different individuals.

P17: "…I am much faster by bike, right? […] By car it takes me at least 15 minutes and then it is between 5 and 10 minutes to walk from the car park to here. By bicycle it is just 10 minutes total."

P08: "That is almost always by car, picking up the kids. […] However, [name] would much rather have me or someone else bring them and pick them up by bicycle, but then I won't make it in time."

With unplanned journeys no information is looked up beforehand and no comparisons are made between specific options. This may be true for instance for spontaneous journeys that are decided upon at the last minute, or recurring journeys, such as commutes, that one makes on a regular basis. People may also not always consider all the possible options and carry out their journeys by habit, for instance by always taking the car.

In terms of functions for an information platform, different situations need to be taken into account. For those who like planning their journeys, the system should make it easy to find the information that is relevant to them and ideally also help them to compare their options. Participants in the co-creation workshops suggested different ways of displaying important information such as plotting it on a map

or making the information audible by using text-to-speech technology. They also suggested different ways to search for, filter and compare relevant information by using keyword searches for instance, sorting options based on price or geographic proximity to a certain target location such as the current location, displaying only POIs (points of interest) along a certain trajectory and filtering different map layers to turn on and off certain types of information.

4.2.2 Alerts before and during the journey

The system could send alerts to its users to inform them when an important traffic-related event occurs. It could therefore be valuable to register a planned journey in order to be kept up-to-date with information about incidents and conditions that may impact it. Similarly, users might want to be notified about events affecting recurring journeys, which can be particularly useful because people are unlikely to actively look up information in such cases.

Real-time travel assistance based on an itinerary was also a theme that came up in the co-creation workshop. Participants suggested sending out pre-journey status summaries, which would be particularly helpful in case of incidents or conditions that would cause them to deviate from their original travel plan, traffic jams for instance, car parks full or public transport delays. In addition to notifying the users of expected problems, participants suggested that the system should help them to solve these problems, for instance by suggesting alternative travel itineraries.

General alerts are another element that could be useful to everybody, regardless of their itinerary and whether the journeys are planned or unplanned. Such general alerts contain information that is likely to have an impact on a specific user, such as roadworks in the area where the user lives, or on the state traffic in general, such as hazardous weather or public transport strikes.

If alerts are to be useful, it is important that they are all timed properly. Depending on the content, this timing could be as soon as the information is known (e.g. train delay), a specific amount of time in advance of the event (e.g. roadworks) or before the user is going to start their journey (e.g. traffic jam on the user's route).

There is a slight difference in the data that is used for these two different categories of alerts. General alerts mostly contain information that is known (planned roadworks) or predictable (hazardous weather) upfront, while real-time travel assistance alerts are more likely to be based on real-time mobility information.

As mentioned earlier, it is important to consider the personal context in which the journeys take place. People may differ in terms of their available modes of transport, their attitudes towards and preferences for different modes or taking different routes, and the impact that weather conditions have on their decision-

making. In order to maximize the usefulness of the information and alerts provided, it is important to take these personal contextual factors, preferences and attitudes into consideration, so that the system can share information that is relevant to the specific users and thus provide them with more effective information. It is also important to note that users must be able to change their preferences and switch the alerts function on and off at all times.

4.3 Wider group of stakeholders

Most stakeholders interviewed for TMaaS were really enthusiastic about the concept. In their eyes, TMaaS will create a great added value because all mobility information will be integrated in one platform. At the present time, first- and last-mile solutions (shared cars and bikes, ride-sharing services, …) do not feature on most existing mobility apps. As a result, the information that is offered isn't complete.

Stakeholder representatives say that the TMaaS system will empower them by shielding them from the underlying complexity of different, non-integrated, fragmented information systems and procedures. In order to be able to make a 'smart' travel choice, they suggested it should be possible to compare travel time, distance and price when planning journeys within or to Ghent.

The following information / data sets are considered to be the most important: information on roadworks, real-time parking data (on and off road), real-time public transport schedules, safe cycle routes, pricing, accessibility of transport hubs and information on car/bicycle sharing activities. The stakeholders only want to receive notifications that are consistent with their personal travel preferences.

The interviewees appreciated the fact that it will be possible to give feedback to the system. By doing this, peer users could provide updated and real-time information additional to that provided by the other data sources. The interviewees stated that this crowdsourced information should be checked and moderated and people should be informed about what is being done with their input. Ideally, this two-way communication can be used to get assistance when needed (for example when a disruption occurs).

The interviews also provided some suggestions for specific stakeholder groups:

- For local businesses and companies, it would be handy to have a TMaaS plug-in that can be installed on their website, so they can alert their customers and clients when necessary.
- For people with reduced mobility or a visual impairment it is really important that the TMaaS platform offers audio navigation and auditory notifications. They suggested applying the universal design principle.

▶ Students said that it would be helpful to see where bike repair services are located, so they can go to the closest one when they have a flat tyre or need assistance. Offline availability of TMaaS would also be handy.
▶ For visitors to Ghent, information on traffic jams, road works, events and available parking would be really interesting.
▶ Cyclists say it would be handy to receive information on the weather conditions and the availability of shared bicycle systems.
▶ Public transport users want to receive real-time information on travel time, delays / disruptions and pricing.

5 Conclusions and lessons learned

Stakeholder involvement is an essential part of the TMaaS approach. By involving all stakeholder groups from the beginning of the project, we aim to raise public awareness and engagement, and make sure that the outcomes of the project are consistent with the requirements and expectations of potential users (both professionals and citizens). In this paper, we focused on the stakeholder activities conducted during the first year of TMaaS, with the objective of gathering insights on user requirements regarding data sets and function of the TMaaS platform.

A lot of valuable insights were obtained during the stakeholder research. The technical developers of the TMaaS platform indicated that the wish list with functions and the input regarding data sets was really useful for the data inventory as well as for the architecture and design of the platform and interfaces. The recommendations from the stakeholders' SWOT analysis will also be incorporated in the TMaaS risk management. The future commitments that the stakeholder representatives are willing to make (help with dissemination of results, testing the prototype in the next phase of the project) were also seen as providing added value.

Wherever possible and relevant, the suggestions from the different stakeholder groups will be taken into account. The MoSCoW[5]-method was used to prioritize stakeholders' needs. They all receive feedback on what is being done with their input, which datasets and functions will be implemented, which will not and why not. For example, citizens indicated that they would like a mobile TMaaS application that is easy to use while on the move, whereas this falls out of the scope of the project (only a website is foreseen) and is therefore not feasible in terms of time and resources. In other cases, datasets are not available, e.g. on crowdedness of buses and trams, or accessibility of public transport vehicles and mobility hubs. As all stakeholder groups have their own priorities and wish lists, the MosCoW ap-

[5] MoSCoW is a technique for prioritization. It stands for Must Have, Should Have, Could Have, Won't Have this time.

proach also helped to balance the needs of each of these groups and manage their expectations regarding the eventual outcomes of TMaaS.

In this paper, we have focused on stakeholder involvement in the city of Ghent. Based on our experiences in Ghent, recommendations will be formulated to enable replicator and other cities to set up their own stakeholder monitoring and engagement plan. Here's a brief overview of the main lessons learned:

- Stakeholder involvement requires continuous attention. It takes time to keep all stakeholders on board and communicate with them on a regular basis.
- Qualitative user research is a valuable tool that helps to understand citizens' behaviour and underlying attitudes, needs and motivations.
- It isn't always easy to manage expectations of all the stakeholders. Everybody has their own wish list. The MoSCoW method can help to set priorities.
- A clear definition of research objectives and choosing an adequate method to fit these objectives, are critical success factors for all stakeholder activities.

Acknowledgements

This project is co-financed by the European Regional and Development Fund through the Urban Innovative Actions Initiative.

Urban Innovative Actions is an Initiative of the European Union that provides urban areas throughout Europe with resources to test new and unproven solutions to address urban challenges.

Based on article 8 of ERDF, the Initiative has a total ERDF budget of EUR 372 million for 2014-2020.

Reference List

[1] Dijkstra L., Poelman H., Cities in Europe: The new OECD-EC definition, European Commission. 2012

[2] Gillis D., Lopez A., Gautama E., D7.1.1 Requirements for data collection for traffic management, TMaaS project. February 2019

[3] Golembewski, M., & Selby, M. (2010, August). Ideation decks: a card-based design ideation tool. In Proceedings of the 8th ACM Conference on Designing Interactive Systems (pp. 89-92). ACM.

[4] Imperial College London (2010). State-of-the-art of urban traffic management policies and technologies. Report as part of CONDUITS project (7th Framework Programme).

[5] Joshi, M. S., Senior, V., & Smith, G. P. (2001). A diary study of the risk perceptions of road users. Health, Risk & Society, 3(3), 261-279.

[6] Lucero, A., Vaajakallio, K., & Dalsgaard, P. (2012). The dialogue labs method: process, space and materials as structuring elements to spark dialogue in co-design events. CoDesign, 8(1), 1-23.
[7] Marlier E., Initial report on coordination with the wider group of stakeholders, TMaaS project. November 2018
[8] Marlier E., KPIs for monitoring and coordination with wider group of stakeholder, TMaaS project. May 2018
[9] Moves app, consulted in 2018. https://moves-app.com/
[10] NVivo qualitative data analysis software; QSR International Pty Ltd. Version 12, 2018 https://www.qsrinternational.com/nvivo/nvivo-products
[11] Nyblom, Å. (2014). Making plans or "just thinking about the trip"? Understanding people's travel planning in practice. Journal of Transport Geogra-phy, 35, 30-39.
[12] Pielot, M., Church, K., & De Oliveira, R. (2014, September). An in-situ study of mobile phone notifications. In Proceedings of the 16th international conference on Human-computer interaction with mobile devices & services (pp. 233-242). ACM.
[13] Sanders K., Report end-user requirements, ideation and overview match functionalities & technical requirements, TMaaS project. April 2019

Full Information about the authors

Delphine Grandsart
European Passengers' Federation
Kortrijksesteenweg 304, 9000 Gent, Belgium
delphine.grandsart@epf.eu

Evelien Marlier
European Passengers' Federation
Kortrijksesteenweg 304, 9000 Gent
evelien.marlier@epf.eu

Kevin Sanders
Leuven University (KU Leuven)
Meaningful Interactions Lab (Mintlab)
Parkstraat 45 bus 03605, 3000 Leuven, Belgium
kevin.sanders@kuleuven.be

David Geerts
Leuven University (KU Leuven)
Meaningful Interactions Lab (Mintlab)
Parkstraat 45 bus 03605, 3000 Leuven, Belgium
david.geerts@kuleuven.be

Dominique Gillis
Ghent University,
Department of Industrial Systems Engineering and Product Design
Technologiepark 903, 9052 Gent-Zwijnaarde, Belgium
Industrial Systems Engineering (ISyE), Flanders Make www.FlandersMake.be
Dominique.Gillis@UGent.be

Sidharta Gautama
Ghent University
Department of Industrial Systems Engineering and Product Design
Technologiepark 903, 9052 Gent-Zwijnaarde, Belgium
Industrial Systems Engineering (ISyE), Flanders Make www.FlandersMake.be
Sidharta.Gautama@UGent.be

Angel J. Lopez
Ghent University
Department of Industrial Systems Engineering and Product Design
Technologiepark 903, 9052 Gent-Zwijnaarde, Belgium
Industrial Systems Engineering (ISyE), Flanders Make www.FlandersMake.be
Facultad de Ingeniería en Electricidad y Computación, Escuela Superior Politécnica del Litoral (ESPOL) – Campus Gustavo Galindo, Km 30.5 Vía Perimetral, P.O. Box 09-01-5863, Guayaquil, Ecuador
Angel.Lopez@UGent.be

Keywords

TMaaS, Traffic management, stakeholder engagement, co-creation, user requirements