Lessons Learned on the Design of Several Tools for Participation on Foot

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Abstract. The classical participation approach in mobility research and urban planning in Germany involves panels, discussions and workshops. Those are mainly targeted towards local residents of urban districts and typically have a homogeneous, older audience. A big part of the relevant demographic cannot be reached using these participation instruments. Additionally, in contrast to car or even bike traffic, pedestrians are not very well covered in mobility research. The conventional instruments of urban planning are not suitable for the evaluation of the requirements and problems of pedestrians in urban spaces. We tackled these different problems and implemented a user-centered and in-situ participation approach for pedestrians, using a mobile application and a web app to engage pedestrians while walking. In this paper we report on our concept and its implementation as well as lessons learned from our field trial.

Keywords: Urban planning; Mobile Participation; Crowdsourcing; Mobile application; Walking; Pedestrians.

1 Introduction

Our project is set up in the field of mobile and pervasive participation, mobility research and urban planning and therefore addresses problems of mobility research as well as issues of the participation process. Common participation processes in Germany rely on directly addressing residents in areas that are selected for restructuring. Residents are reached via postal letters and are invited to participate in public meetings and discussions about possible improvements in the infrastructure in their home district.

However, this approach has three major shortcomings. These shortcomings concern the homogeneous structure of the audience at participative events, the lack of addressing pedestrians that are no residents in the area and the missing context and location reference at workshops and discussion panels.

Available and state of the art instruments for transport and traffic analyses are mainly focused on the capacity of transport infrastructure and are centered on car or bike traffic. An example is classical, typically manual, traffic counting and observation [1]. Another, more participatory instrument are road user surveys, where the choice of means of transport is inquired, usually with regard to certain stretches of

road [2], [3]. Several methods, that aim at measuring walkability – the quality of infrastructure in communities with regards to pedestrians – are, for example, surveyed and compared by Praveen K. Maghelal and Cara Jean Capp [4]. However, mobility related data is still mainly gathered on motorized traffic. A report of the International Transport Forum (ITF) of 2012 calls walking the "neglected transport mode" and describes, that sufficient data on pedestrians is missing [5]. It also reports, that specific methods to collect such data are missing as well [5]. Walked distances are, for example, often not reported when people give an account of their mobility in studies, because the distances are short and people do not remember them. They are also not measured, when the main mode of transport of a distance is another, for example using the train. However, many people walk to reach the train station, but this part of the trip is not recorded separately [5].

The report also points out, that pedestrians often are not represented in urban planning processes and therefore issues of walking are not, or not adequately, addressed.

The results of conventional participation methods and traffic analysis instruments are collected in analogous form and are therefore more cumbersome to analyze and reuse. The methods are elaborate processes and require a lot of resources. Digital artifacts are more easily structured, analyzed and reused (e.g. in evaluation stages after restructuring).

We therefore developed an in-situ mobile participation approach implementing a mobile application,a web app and so-called feedback pillars, that are used to enhance conventional participation efforts in civic restructuring processes and, at the same time, to support the studying of walking as a means of transport. The application is designed to also address younger generations in contrast to the traditional audience of classical participation efforts. It is designed to allow non-residents to contribute to the analysis and to follow restructuring efforts, thus widening the target group of participants. The implemented instruments enable pedestrians to give feedback regarding their situation when they are in this situation. The application, web app and feedback pillars were developed and deployed in a research project on walking as a transport mode in cities that also implemented improvements on pedestrian mobility, in part in the course of existent civic restructuring efforts.

In the following sections, we discuss the motivation for our approach and the resulting requirements towards participation tools for pedestrians. In section 3, we describe the tools we developed, which include an Android app, a web app and so-called feedback pillars and in section 4 we examine existing approaches in related work and compare them to our approaches. In section 5 we report on the deployment steps in our project. The results are presented in section 6 and we present the lessons we learned in the course of our project so far. A discussion and an outlook on future work concludes this paper.

2 Addressing Pedestrians in Participation Processes

Public Meetings, workshops and discussion panels that are designed to include residents in the analysis and the development of plans for district restructuring are

mostly attended by elderly citizens and therefore have issues regarding the representative nature of their results. Problem areas that do not affect this demographic are often not brought up and the implementing authorities only get an incomplete picture of the needs and requirements of the residents and users of the district infrastructure. It would be desirable to involve a more diverse representation of the citizens. However, a younger audience often lacks the willingness to spend time at participatory events, not least because of their occupation with their jobs, kids or education, as also described, for example, by Silverman [6]. In part, this is addressed by implementing special programs that target a specific audience. There are efforts, for example, that directly address the youth and try to involve them in urban restructuring processes. Events are specifically designed to analyze the needs of pupils and children with them in playful workshops, children's councils and the like [7]. However, these are very elaborate programs that require many resources and are therefore not always applicable. Digital participation approaches may involve a more diverse audience, requiring less effort than specific programs. Web-based or mobile solutions are accessible at all times and do not require people to attend lengthy meetings at given times. To many citizens, the possibility of giving feedback on issues in their district or of discussing proposed solutions online may be more attractive than workshops or town hall meetings.

In many areas, specifically in urban spaces, not only the residents walk, in fact, in some places, most of the pedestrians do not live there. This is especially true for city centers or business areas. Many pedestrians that use the city's infrastructure in these areas live somewhere else and come here to shop, to work or for leisure. Their needs in civic infrastructure may very well vary from the requirements of residents, but are not captured in classical participation processes. These pedestrians have no possibility of participating in district improvement if only residents are addressed. Using digital participation instruments, these users may be reached as well.

Another drawback regarding public meetings to understand pedestrians is, that they are not on site. They require attendants to remember situations or places when or where they felt safe, unsafe, or experienced problems crossing streets, places or reaching their destination. It can be expected that negative situations and places come to mind more often than positive issues, because they are better remembered. Also, the circumstances of such issues must be remembered when in the workshop or panel discussion and not all relevant facts may be captured by recollecting situations.

Pedestrians have unique requirements as participants in urban traffic and are therefore a special target group for participation efforts. First, pedestrians are the least protected road users – road accidents involving pedestrians very often result in severe or deadly injuries, see also [8] or [9]. This means that security is the foremost issue that needs addressing considering walking. In order to understand security risks for pedestrians, it is necessary to assess not only situations and locations where accidents happened, but also conflicts that did not lead to accidents. However, these situations may often not be recollected when people are questioned at participation events, probably a long time after they happened.

Beyond security, obstructions are often problems while going on foot. This category involves cars that are parked on the sidewalk, construction works on the pavement or even missing sidewalks. These are situations best recorded when people experience them, since they are perceived by most people as minor hindrance and

then often not remembered, but may pose bigger problems for other people, for example when they are using wheelchairs or are pushing a pram. In order to enable pedestrians to record issues or feedback directly in the particular situation, the digital participation tools must be available in this situation as well.

3 A Toolbox for Participation on Foot

In Germany – the country of car drivers – foot traffic is not in focus of research efforts or in urban planning efforts. Therefore, there is a shortage of best practices for a pedestrian-centered infrastructure. The basic idea of our project was to implement pervasive participation concepts to achieve a better understanding of pedestrians and foot traffic. We implemented different technologies that enable citizens and users of urban infrastructure to report positive and negative feedback on issues they encounter while walking on foot. Our goal is to support the research of pedestrian's issues and to help find best practices, while at the same time enabling citizens to participate in the process. This is why our project is embedded in real-world urban restructuring processes, where positive and negative feedback can be directly put to use.

In order to derive recommendations for restructuring urban infrastructure, positive solutions for pedestrian's issues have to be found and recorded. Mobility scientists and urban planners can collect efficient infrastructure solutions for pedestrians and then transfer such solutions to other locations with similar issues. Negative feedback, on the other hand, may be used to determine where the need for change exists and where (new) guidelines or regulations may be applicable.

So far, pedestrian issues usually have been collected in classic participation processes for urban restructuring. By accompanying the classical participation process in Germany we could determine that it takes place in several steps. Normally, a couple of workshops take place starting at a kick-off event, followed by recording and collecting the needs of residents and users (situation analysis) of the concerning infrastructure that is in focus for restructuring. Following the analysis stage, citizens and representatives of the city are collectively planning measures to be taken (acquire solutions). This is followed by the stage to implement the measures (conversion). During the conversion stage, the flow of information to the citizens often runs dry. They are only included once more when the conversion is completed and the testing of the results (evaluation) may begin.

In order to support these sub-processes of classical participation and to address the described issues of classical participation and pedestrian research, we developed a mobile application (app), a website (web app) and an interactive poster (feedback pillar). Interactive posters or feedback pillars are deployed at a specific site. On them, a given question is asked that passers-by can answer by pressing buttons. These participation tools were deployed in a research project on pedestrians in urban spaces. A mobile application as well as a feedback pillar have the advantage to be used in-situ and can therefore involve citizens directly in the participation process. Using the mobile application while walking, pedestrians can record situations while they are experiencing them or shortly after. This means, situations that are normally forgotten or ill remembered, may now be surveyed as well. In our concept, not only the mobile

application may be used in-situ, but the web app may be used on mobile phones as well, in addition or instead of the mobile application. The feedback pillars also provide immediate on-site feedback. For example, the feedback pillars should be installed in locations that have been reported as problematic by individuals using the app. Using them, the opinion of all pedestrians passing by can be collected.

The usage of the participation tools (app, web app and feedback pillar) is not limited to parts of the committed citizenship that can or would like to be open for events of the classic participation process, but allows all citizens to be involved directly at all times. Using the participation tools consume less time to commit issues to the restructuring process than attending a workshop and therefore is attractive for a younger audience that is very much involved in jobs or education. In addition to the involvement of citizenship that usually does not have time to participate in classic public meetings, the tools strengthen people, who do not dare to speak up in larger groups or workshops. Due to the anonymous communication channel, the user does not have to fear direct disagreement or verbal attacks, which usually might prevent him from contributing.

The full potential of the participation tools become apparent in urban districts like the city center in which citizens go shopping or work but do not live - classical forms of participation would exclude this user group. The tools and their features are explained in detail in the following subsections.

3.1 Android App

We decided to implement a native mobile phone application, because we directly wanted to be able to use the mobile phone sensors, in order to facilitate the creation of feedback reports for the users. We also planned to reach out to our users via push notifications, which is relatively easy to implement in a native mobile phone app.

Due to budget restrictions in our project, we were not able to implement several mobile applications to support all available operating systems and we had to decide for one platform. We then decided to implement an Android app because, according to studies of market research institutes like IDC or Gartner, about 80-85% of mobile phone users in Germany have an Android phone, which is a very good basic cover [22, 23].

The aim in our app design was to digitally enhance the classical participation process by making use of mobile sensors. We argued that people use the app in-situ, therefore they need to commit their actual location in addition the described issue. To do so, participants may use the GPS of their mobile phone. Further, also a GPS track can be recorded to report a route. The use of GPS tracks may be an opportunity to record additional parameters such as walking speed and rest time of the users, in order to better characterize pedestrian's behavior in different situations. As of now, we were not able to implement these features, but are planning to extend our application in the future for use in follow-up projects.

Timestamps allow conclusions about the situation in which the pedestrian was, when he described the issue. For example, the timestamp allows conclusions about the light intensity, whether it was possibly dark or light at that time. Lighting

conditions can have a big influence on the visibility of the pedestrians as well as on their vision and may explain why the issue has occurred. To be able to make more precise statements, further sensors of the mobile phone can be used. Information about the weather or brightness may provide explanations why a problem has occurred. If the problem occurred despite daylight, other factors must be considered. Then the description of the feedback report can be searched for clues, for example, parking cars that obstruct the view towards a potentially dangerous crossing.

Besides using mobile sensors, we wanted to know who is involved in the participation and how contributors could be characterized. In traditional forms of participation, these factors are rarely even recorded. One of the characteristics that can be guessed by the appearance of the participants is for example the age or the sex. Information like the kind of job of participants or the address must be requested. It is difficult to assess the user while they are using the app since there is no direct contact. To verify that the app appeals to a younger clientele, users must be willing to provide that information. We therefore made it possible to submit more personal information, which was stored independently from the user's reports and only used for statistical means.

Since users are hesitant to submit feedback and private information, we developed a security and privacy concept that focuses on transparency for the user and the protection of his identity because users are more easily intrigued to contribute when they may remain anonymous in their contributions. For this purpose, it should be clearly communicated which kind of information is collected as well as the aim of collecting this information. For example, users should know why GPS locations and tracks are stored, or in which manner the registration to the server is made. Personal information is not sent with feedback reports, but kept apart, so that reports may be made anonymously. In order to further increase confidence, the app was designed to make it clear that this is an official research project and that users receive sufficient information about the partners involved. Furthermore, the users should be informed regularly about the progress of the project. We therefore included the possibility to send push notifications to the app, which we used to send news about the project to our users.

In order to be able to react to the emerging requirements that could arise due to the special nature of the project, the app was implemented according to the principle of agile software development in an incremental process. If necessary, the app was enhanced with additional functionalities in app updates during the project.

Feedback Reports. The main function of the mobile application is to record a location or a route, in a so-called feedback report. The creation of a feedback report takes place in two steps: first, the user specifies on a map which location or which route section is to be reported and then they add a short description (Fig. 1).

In the first step - the localization step - the current location of the user is used via GPS coordinates on the mobile phone, but they may alter the chosen location. While using the app with active GPS, the coordinates of the user are not constantly collected and transmitted to the server. GPS coordinates or tracks are only transmitted when the user sends the feedback report to the server. If the user wants to create a new feedback report and the GPS is disabled, a pop-up message will appear. The user can then navigate directly to the settings and activate the GPS - if desired. Otherwise, they can

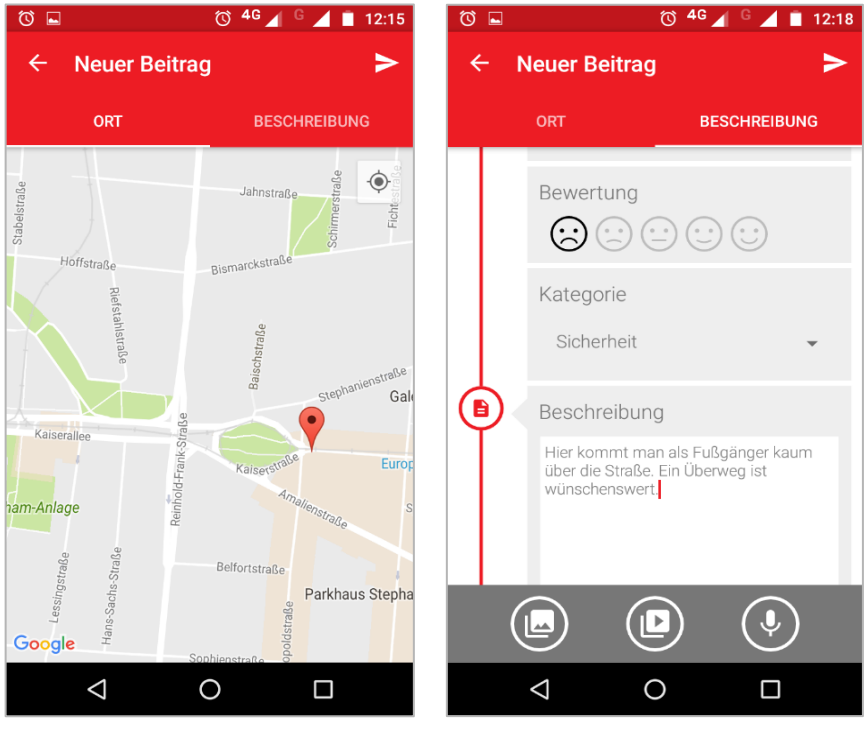

Fig. 1. Recording a location with the mobile application is done in two steps: localization via GPS coordinates and adding a short description

manually move the marker on the map (Fig. 1) without using the GPS. GPS tracks are captured by the mobile phone after starting the recording. Currently, a route can only be recorded in real time, a subsequent specification of a route has not yet been implemented.

In the second step – the description step - the user classifies whether the report is a positive or a negative feedback report by selecting one of the smileys on a scale (see Fig. 1). Besides, the users can add a short textual description of the reported location or route. If favored, they can share additional information to illustrate the situation through one or more kinds of media out of three: the user may add pictures, videos and audios by pressing one of the icons at the bottom (Fig. 1). On the mobile phone, the user is able to instantly take a picture, record a video or record a voice message, using the devices' camera and the microphone. Media may also be added from existing files. To classify the situation that is to be recorded, users have several category options to choose from. One example is the category "safety" as pictured in Fig.1. This example shows why we decided to add the smileys as a shortcut rating possibility: safety is often seen in a negative way but can also be reported positively, like a well-accessible pedestrian crossing.

Data Transmission. By pressing the button on the top right looking like a paper plane (Fig. 1), the feedback report is uploaded to the project server. The secure

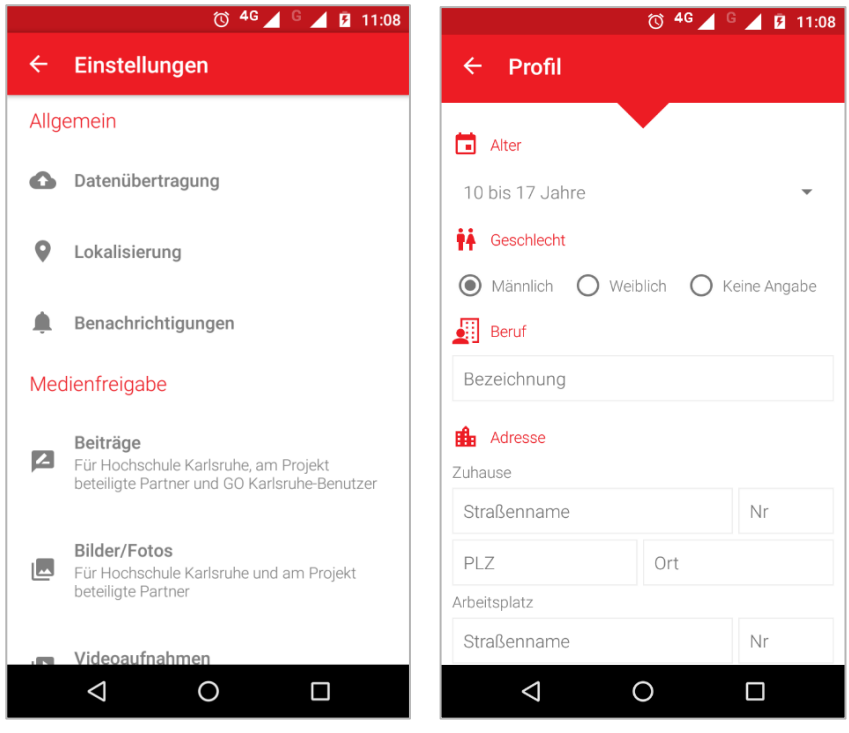

Fig. 2. Users of the mobile application can choose whether their feedback and media may be used and they can fill in a profile

transfer is guaranteed by the encryption protocol SSL. The data is anonymized and stored without user information on the project server to meet the requirement of privacy. Furthermore, the data release of the mobile application is transparent and the control over the data release is up to the user. They can choose freely in the settings, whether their feedback report and added media may be used by the university and the project partners (Fig. 2 left side). Here the user can specify individually for the short description, the images, the videos and the sound recordings, whether they may be used exclusively by the university or may be forwarded to project partners or, in addition, displayed to other users.

In order to avoid exceeding the user's data volume by sending large videos or numerous images, the mobile application has integrated a protection mechanism, which only transmits media via Wi-Fi. If the user is currently not connected to a Wi-Fi network, the media is stored and sent as soon as the mobile phone is reconnected to a Wi-Fi. This is to prevent the user from having a negative experience with the app. The user can enable transmission of the media via the mobile network in the settings of the application (Fig. 2 left side).

Information for the User. In order to create a communication channel to the users, push notifications are sent. These notifications can be received at any time – users don't have to be in the app. A small icon in the notification area on the upper

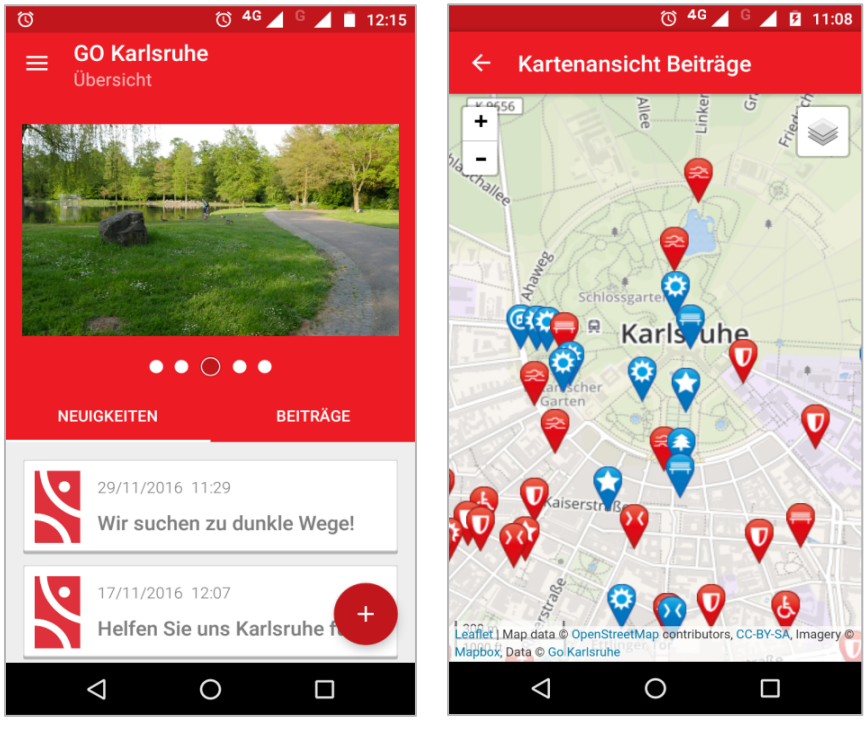

Fig. 3. Start screen with chronologically displayed push messages and the interactive map visualization of all user feedback reports

left edge indicates that there is a message. The notifications normally consist of a title, a picture and a short message. In the start screen of the app, they are displayed chronologically (Fig. 3), whereby only the title can be seen - if one taps it, the message opens. We used the notifications to disseminate the feedback reports received and to communicate the status of the project or to encourage people to write articles on specific topics.

In the course of the project, a map was integrated, that summarizes all user feedback reports on an interactive visualization (Fig. 3) instead of sending push notifications for each new feedback report. The feedback reports on the map can be enlarged, so that the respective short description can be read. There are also numerous filters available to filter by categories or for positive or negative feedback reports.

One of the most important functions that is achieved with the push notifications is the targeted feedback of information to certain parts of the population by using filters. The goal is to involve the citizens that are affected by the issue because they live, work, or regularly shop at a given location.

For the tailoring of the communication channel, it is necessary that the users specified in which district or in which street they live or work. For this purpose, a profile was created in the app (Fig. 2 right side), which can be voluntarily filled out by the users. It collects further demographic data, such as age and gender that are stored independently from the user's feedback reports. The push notifications can be

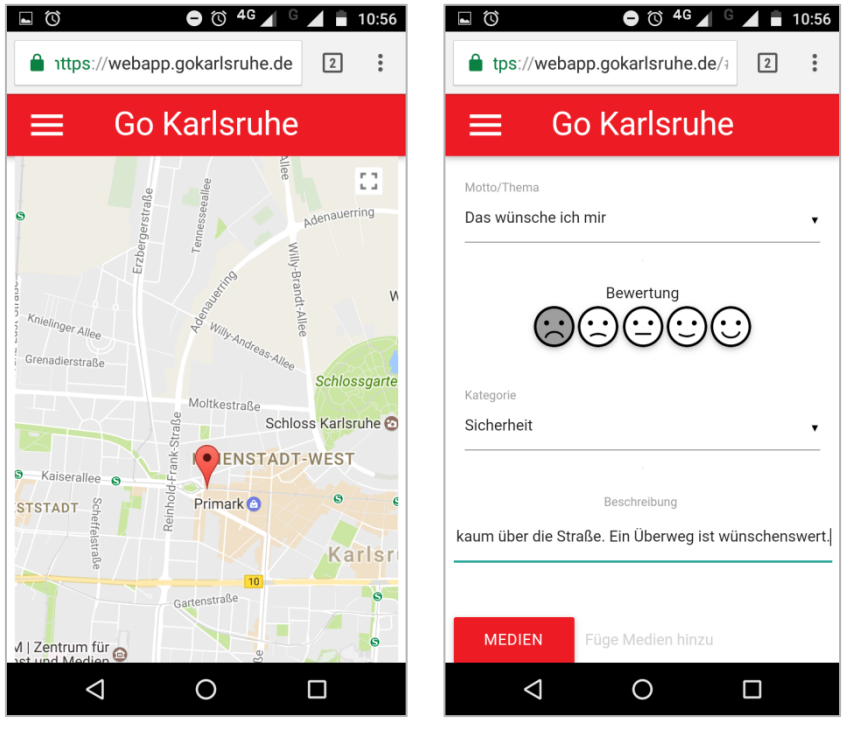

Fig. 4. Recording a location with the website (web app) is done in two steps: localization via GPS coordinates and adding a short description (here: usage on a mobile phone)

specifically targeted by this information and, for example, be sent only to citizens who stated to live or work in the affected district.

Furthermore, the push notifications support URLs. As content of a notification, the respective web site is displayed. We used this to integrate google forms [24] for surveys in the app. Once the user has opened the push notification, the Google Forms was loaded. The questionnaire could be filled out by the user directly in the app and even appeared as if it was part of the app. This feature was and may be used for polls on specific topics or for feedback polls on the app or project itself.

3.2 Web App

After the Android app (short: app) was completed and published in the Google Play Store, a responsive website (web app) based on the app was implemented to reach the citizens that do not possess a mobile phone or whose mobile phone does not operate on Android. Due to the planned course of the project, feedback reports should be generated as quickly and easily as possible by the users. Because of this, and because of restrictions in sensor-access, the functionalities of the app were not fully implemented as a web app. Instead, only the most important feature - sending feedback reports - was implemented at the beginning. Later the web app has been expanded to include new features, which were added in the app, too.

Correspondingly, it was only possible to share locations with the web app (Fig. 4) but no GPS tracks. It works quite similar like in the app. We integrated a map, where the user can choose the location for the localization step and a form for the description step. Certainly, on the web app, pictures, videos or audio recordings may only be chosen from already existing files by pressing the red button called “Medien”. Unlike the app, the button to send the feedback report is not on the top right but at the bottom of the page. Here is a button to get back to the map, to correct the location and a second one to transfer the feedback report to the server.

The push notifications and the profile are planned to be implemented in the future for use in follow-up projects.

3.3 Feedback Pillar

The third tool we implemented is the interactive poster (feedback pillar). We wanted a participation tool that could be used without any digital restrictions directly in-situ by passers-by. They allow a brief survey on the situation at signal systems, public transport stops and many more places without further technology by the pedestrians. There is no need to log in to the system to use it.

The posters consist of an acrylic glass with Alu-Dibond and a vandal-proof box which is mounted on the back of the poster. Alu-Dibond is made up of two aluminium layers with a polyethylene layer in the middle. It is a very stable and long-lasting material. On the acrylic glass, any questions or suggestions for the redesign of a place can be printed.

The pedestrians can vote via buttons integrated in the acrylic glass. For example, the answers to a question can be given on a scale of 1 - 4, with a button below each value of 1 – 4, as you can see in Fig. 5. People can choose between 1 “I can cross very well” to 4 “I have problems to cross”.

Inside the box are Raspberry Pi and Tinkerforge components. The Raspberry Pi is used as processing unit to locally store the incoming votes of the participants (via pressed button) on a SD card. To save power, the stored data is sent in clusters to the server every half an hour via an integrated UMTS stick. As power source, a USB battery charger is used.

In order to be able to make more precise statements on the situation - similar to the feedback reports - it is possible to expand the poster with additional sensor systems. Interactive posters with registration are conceivable to enable profiling. Technologies

such as NFC cards or personal codes allow users to provide personal feedback. Thus, for example, preferred routes can be collected profile-related via various "check-in points" with subjects who are given chip cards for the check-ins. The profile-based measures can be anonymized via an ID in order to remove the assignment to persons and to meet data protection requirements. But there are no cameras or similar technologies planned that jeopardize the requirement of anonymity of the citizens.

Fig. 5. How it could look like: Feedback pillar attached to a traffic light to query the satisfaction of the pedestrians crossing the street.

4 Approaches to Pervasive or Mobile Participation in Related Work

Pervasive participation evolved on the base of e-government approaches, web-based participation efforts and mobile participation, approaches that all try to tackle the problems described in section 2. Several approaches will be introduced and discussed in the following.

Conroy and Evans-Cowley discuss and analyze different web-based e-government platforms in the US with respect to urban planning [10]. They describe first approaches of personalized websites or discussion panels, although most of the surveyed platforms relied on e-mail contact. The surveyed websites mostly did not support electronic submission. However, 60% of the surveyed websites provided some means of application of issues or suggestions, as an important feature to fostering participation of citizens. The authors point out the potential of web-based e-

government platforms, but also the need for technical skills on the part of the planners that deploy the platform. This stresses the need for easily deployed and maintained tools.

The aspect of participation that involves citizens beyond receiving information, is discussed by Brabham [11]. Brabham argues that web-based crowdsourcing may be an enabling technology for citizen involvement in urban planning. Brabham discusses, that the anonymity of the web may facilitate participation for some citizens, a fact that led us to carefully design a privacy and security concept for our application, so that users remain as anonymous as they choose. Brabham also stresses the positive influence of the asynchronous aspect of the web, where people do not choose a certain time and place to contribute. In parallel to our findings, Brabham also describes, that the parameters that lead to a high engagement and many contributions in crowdsourcing projects are not precisely determined yet. The article discusses that marketing tactics should be employed during a crowdsourcing project, which is why we acquired media partners that helped us to spread the word of our mobile application and web app.

Schiavo et al. developed a participation approach based on public displays in order to provide an in-situ means of feedback for citizens [12]. They argue, that mobile or web based solutions exclude citizens that do not have access to a smartphone or to the web and their approach enables participation for a wider demographic. Their approach enables citizens to contribute ideas but also to discuss and rate such ideas. Their application did not have a specific topic of interest, as we targeted pedestrians.

Some of their findings did influence the design of our feedback pillars. In contrast to Schiavo et al. we did not rely on displays, mainly because of vandalism concerns. Our feedback pillars are therefore less dynamic when they are implemented on site, but, in addition to the concept of Schiavo et al. we are able to deploy sensors that provide context to the given feedback.

Höffken and Streich discuss the possible impact of mobile participation on participation processes and argue, that mobile phones may enable bottom-up participation processes, instead of the classical, top-down principle in urban planning [13]. They describe several real-world projects of mobile participation that range from SMS-based feedback in the app Textizen (see [14]) to several mobile applications that enable citizens to report civic issues to the municipal government. Höffken and Streich emphasize the advantage of a multi-channel strategy that includes not only a mobile application but also a website or other channel, in order not to exclude citizens with no access to a smartphone or that use a smartphone with an incompatible operating system. This is also one reason why we included a web app in our project, to prevent exclusion of citizens without an Android smartphone. Höffken and Streich also stress the importance of handling privacy and security sensitively. We addressed this topic with our privacy and security concept. Among other factors, the authors also bring up the effect of low participation thresholds, as people are more likely to contribute if the contribution does not involve a high amount of resources. As it turned out, the participation barriers leading to a low feedback rate posed a problem in our field trial, too.

Another example for mobile participation is described by Prandi et al. [15]. They developed a mobile application for the collection of sensory input and data on accessibility. The mPASS application was designed to implement a crowdsourcing

approach. Just as our project targeted pedestrians as a specific demographic, their approach targeted people with special needs that profit from accessibility data. They describe three types of report that may be reported via their mobile application. The application is able to create reports by recording sensor data and also enables users to submit reports. A third category are reports created by administrators. Our concept includes only reports by users, but, to a certain extent, integrates sensor data for those reports.

The mobile application "Wien zu Fuss" is an app that allows pedestrians in Vienna to record their steps in the city [16]. It implements a gamification approach, where users can compare their walks to those of other users and gain vouchers for local shops. The app also supports route planning and navigation. However, users are not able to explicitly report on routes or issues while walking. As such, the application mainly serves as a motivator for people to walk and visit places on foot and does not provide a participatory aspect. We also offered shopping vouchers as an incentive but did not offer a comparison as a competition between the users.

In several cities in Germany, there are local mobile applications available that enable users to report, for example, damages of infrastructure directly to the administration. Most of those apps provide several administration-related features, as well. Examples for such apps are the KA-Feedback app [17] in the city of Karlsruhe or the Schramberg App in the city of Schramberg [18]. The city of Cologne has a similar application [19], as well as the city of Bonn [20]. The reporting functionality focuses on issues that can be solved or repaired quickly and does not involve planning issues with long-term perspective. However, user statistics and reports from the cities show, that this functionality is well-used. The reporting is relatively simple – in all of the apps, it is possible or mandatory to include a location, possibly supported by the GPS location of the mobile phone. The user is required to give a description and in most of the applications, a photo can be added. Simplicity was also a guideline in the design of our app. The creation of a feedback report should be as simple as possible for the user. However, this creates a discrepancy between simplicity and data collection, as a feedback report is most useful if it contains as much data as possible. This led us to develop the concept of integrating more sensor data in feedback reports – since sensor data is implicitly given and does not involve user interaction. The concept of enhanced sensor data for feedback reports is not implemented yet but will be in future work.

Adenskog et al. describe an approach of testing a mobile application as a tool in urban planning in a living lab in Turku, Finland [21]. The mobile application described in the paper had a broader scope than ours, since it not only addressed pedestrians but was designed to find out about issues or ideas of citizens on urban infrastructure in general. The application allowed citizens to input a range of reports from problems to suggestions and enabled users to interact with other user's contributions. The application also allowed employees of the city to respond to user's contributions. The contributions of other users were accessible in the app in a map as well as a list. The range of features of this application was larger than what we developed in our concept. Our focus on pedestrians and issues about walking in the city led us to tailor our concept to more specific features, for example the recording of paths. The paper describes interesting conclusions on living labs as test method and valuable insights on the collaboration with city officials. In chapter 5 and 6 we

describe our experiences with these challenges. We managed to avoid most usability problems, as were described by Adenskog et al. but had similar experiences and difficulties on activating users to participate.

5 Methodology of Deployment

At the beginning of chapter three, we introduced the sub-processes of classical participation to be supported by digital participation tools. In the following it will be shortly discussed in which form the presented tools can be used. Subsequently the concept of deployment of app and web app is described.

In the course of our project, we deployed both the android app and the web app in a field trial approach, in parallel to classical participation efforts in some districts of the city. As such, our app and web app were applied in a field trial alongside several real restructuring efforts throughout the city. Our main advertising media partner was a local radio station, which promoted the app and web app via short spots on the radio.

At the beginning of the participation process, the situation analysis, the citizens of a particular district are asked what may be changed or where problems arise. The use of the app and the web app will support the collection of the needs of residents and users by getting feedback from citizens who may not come to the event. To acquire solutions, push notifications with Google Forms may be used to get a general opinion instead of the opinion of individual participants of a workshop. It is possible to ask open questions or to send possible measures (for example pictures), users can vote on. During the stage of conversion, citizens can be kept up-to-date via push notifications with pictures or news about the implemented measures. Finally, the results or satisfaction of the citizens can be evaluated after the conversion using google forms questionnaires distributed through the push notifications.

5.1 Alpha and Beta Test

The app was evaluated and improved in terms of functionality and ease of use (usability) in an alpha- and beta phase before it was made freely accessible via the Google Play Store at the beginning of our field trial. For the alpha test, twelve employees of the institute that were not directly involved in the project, installed the app on their mobile phone and tested the functions. Found bugs were recorded as issues in our git repository and fixed by the developers.

For the closed beta test, the app was uploaded to the Google Play Store in developer mode. In this mode, the app is not generally visible but can only be downloaded and installed by people who have been explicitly added via their e-mail address. For the beta test, about 30 of our students were given the task of creating feedback reports and testing the other functionalities of the app. In order to be able to communicate found bugs, a Google Forms questionnaire was created and deployed in the app via push notification. The questionnaire queried in which type of mobile phone and Android version the error had occurred, as well as on which view and how the error was noticeable. The questionnaire could be filled out and sent back while using the app. The received error reports were transferred into issues and also fixed.

The web app was also tested in an alpha and beta test, similar to the app test, and released at a later date.

5.2 Field Trial Stages

Our field trial was structured in several stages, as depicted in Fig. 6. We implemented our tools incrementally due to technical requirements, but mostly in sync with some of the civic restructuring processes in some city districts and based on considerations of possible user activation. A first stage started with the release of the mobile application and some initial advertisement on the research project. In this first stage of user participation via the mobile application, only positive feedback reports could be transmitted. Our goal was to activate users in a positive manner and not to begin the participation project with a negative stance. We also feared that if there were negative feedback reports possible, there would hardly be any positive feedback reports. Citizens showed similar behavior at classic participation workshops that we attended, where negative feedback was predominant. The goal of this first phase was to focus on the development of best practices based on positive feedback reports. The app release and first project stage was accompanied by push notifications and media releases with our radio partners that highlighted our goal to infer best practices from positive feedback reports.

In the second stage, after a few weeks, we introduced the option to create negative feedback reports and in third stage of our field trial, we released the web app as an additional feedback channel that is device independent, in order to attract a greater range of users.

In all three stages, the number of feedback reports was below expectations. Via our media partner and e-mail, we received positive comments on the project and the project's ideas of mobile participation for pedestrians, however the actual number of feedback reports remained low, despite increasing promotion efforts. The introduction of negative feedback reports in stage two slightly raised the number of reported issues, as was expected, since negative issues while walking come to mind more easily than locations or paths that are good to walk. Nevertheless, we were not able to collect as many feedback reports as we would have liked.

We analyzed the feedback we were given about the mobile application, web app and our research project and decided to increase the user motivation. We introduced the feedback map that made feedback reports visible. On the feedback map, all feedback reports by all users (that consented to share their reports) are made available and can be grouped per category and other filters.

To increase the popularity of the app, in fifth stage the advertising on Facebook was increased. Additionally, the project was promoted via the city itself on the city's Facebook page as well as on the Facebook page of the local radio station.

In the sixth stage a short commercial of the app and web app was shown on the screens of the tram for four weeks. We decided to show the commercial on the screens of the tram because people taking the tram are potential users of the app and web app. In most cases they go to the tram stop on foot and after exiting, they continue on foot.

Subsequently, in a seventh stage, we introduced a lottery where shopping vouchers were raffled at the end of certain time periods. The vouchers were promoted through or media partners, the push news in the app and news on the website. The introduction of the lottery posed an additional problem: since we consistently did not include user information in the feedback reports stored on our server, we were not able to determine and contact a winner of our lottery based on the present information in a

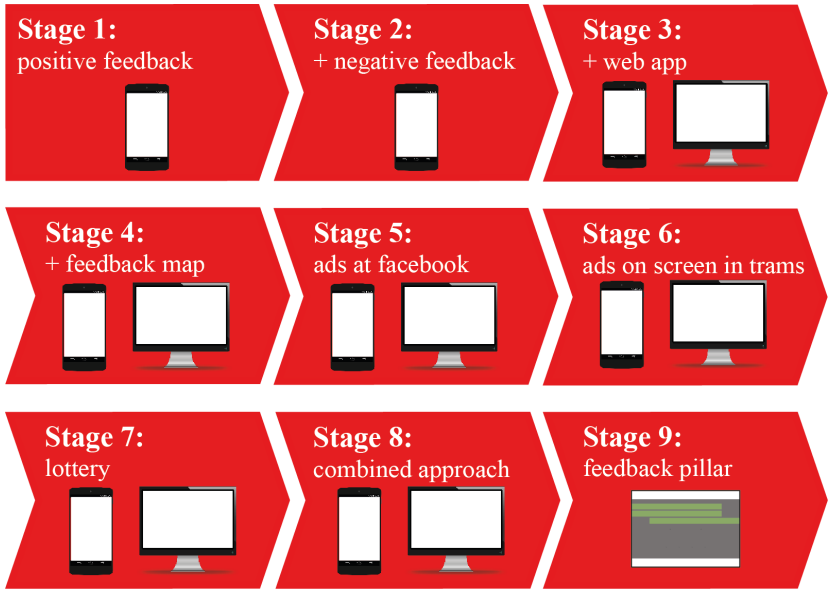

Fig. 6. Several stages of the field trial of the app and web app beginning with stage one on June 2016 and ending with stage 8 on October 2017

report. This is why we extended our application and web app to include the optional and voluntary disclosure of a phone number. The number can only be given per a single feedback report that the user has selected to be used in the lottery. This personal data is explicitly not stored for all feedback reports of one user, so that in further feedback reports and beyond the participation in the lottery, the same privacy level may be maintained as before. The lottery, as was to be expected, introduced a spike in our feedback report count.

In an eighth stage, we employed our app and web app in a combined participation approach in the course of traditional participation efforts in the city. The first use case was a district stroll with residents. In the classical participation efforts for the district, a stroll through the neighborhood with residents was planned as an analysis instrument. At the beginning of the walk, the app was introduced and some Android smartphones with the mobile application were taken along. During the walk, the app was used to record issues the residents were raising on the spot. The feedback to this application of our app was very positive and it was seen as a very useful tool to complement the traditional analysis methods. Use case number two of our combined participation approach was the usage of the app while evaluating the way to school of

primary school pupils. Both approaches yielded several feedback reports that were quite useful, but as expected, the total number of reports during these on-site events was not very high.

The analysis phase of our project is now concluded and in total, 460 feedback reports were collected. They were analyzed and categorized, in order to infer measures that can be taken to improve the infrastructure for pedestrians in the city.

The next phase will be the field trial of the feedback pillars (stage 9), starting in spring 2018, to evaluate situations in situ and without the need of a smartphone.

6 Results and Lessons Learned

Our first results are a fully functional and stable Android application as well as a web app for pedestrian participation. Both app and web app allow citizens of a city to participate in analyses for civic restructuring efforts in-situ and at any time, in contrast to classical participation in public meetings and discussion panels. Our concept also included the design and implementation of a web server for receiving, processing and storing the feedback reports. Technically and with regard to their applicability, both systems have proven themselves useful and deliverable results have been provided, which show further possible applications of both mobile application and web app.

However, as described in section 4, the participation of citizens was not as good as expected and our expectations with respect to reports were not met. Our lessons learned from this experiment are discussed in the following.

6.1 Positive vs. Negative Feedback

Our approach to start with only the possibility of positive feedback and later support also negative feedback showed an increase in feedback reports as soon as negative feedback was possible (Fig. 7). We received several comments that users had difficulties to think of positive situations or places regarding going on foot in the city. A good infrastructure does not require thinking about it and therefore is taken for granted – normally, pedestrians and other users rather notice problems and difficulties, which is what they report. A survey on good infrastructure and best practices probably requires more contextualization for the involved citizens than we did provide in our first stage of the project. In conclusion, we think that mobile or web apps are not the best tools for the development of best practices. However, we suggest a combined approach for a best practice analysis, similar to our use cases in the sixth stage of our living lab. In future work, we would like to plan workshops with the usage of our mobile application as survey tool for best practices, for example in a similar setting as the stroll through the district with local residents described in section 5. The collection of negative feedback reports was more successful and is therefore the core use case for our app.

6.2 User Activation

The influence of promotion via our media partners was not as high as expected. We discussed different reasons and evaluated comments we received from citizens on the issue. Most of the people would only contribute once or twice and downloading an app which has fewer barriers, as depicted in Fig. 7.

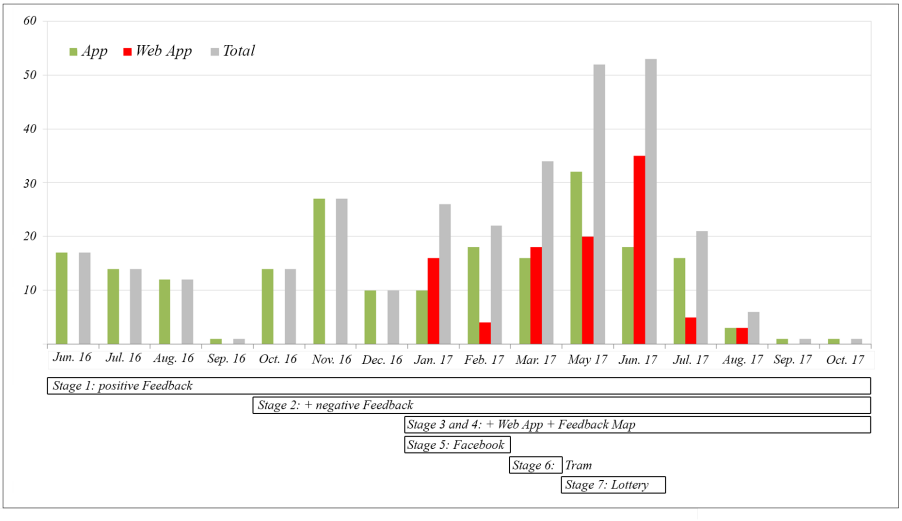

Fig.7. Number of feedback reports in the period from June 2016 till October 2017 in relationship with the several stages of the field trial and advertising

on their smartphone was perceived as too much a hurdle. We could see the impact of introducing the web app,

The analysis of the "google analytics"-data shows clear trends. The proportion of male users with 74% is significantly higher than that of women (26%). Furthermore, the assumption is confirmed that the digital tools, the app and the web app, address younger citizens particularly aged from 25 to 34 (Fig. 8).

We could also see a direct impact of the lottery and conclude that the possibility of a direct benefit for the contributors motivated more than the prospect of participating in restructuring efforts. Here, we could see the conflict between our goal to address non-residents in areas of the city where not many people live but more people work or shop and the motivation to participate in shaping these districts. Not living there has possibly a direct impact on the willingness of people to get involved in the development of an area. However, we are not giving up hope of activating non-residents just yet.

7 Discussion

Our future work involves the development of feedback mechanisms that can be deployed on-site in the city, are independent of personal devices and may be used by all people passing by. We hope, that eliminating the extra workload of downloading an application or searching for a web app will improve user activation. These feedback mechanism is called feedback pillar. The pillar consists of an acrylic dibond poster on which a question with four answer options is printed. Below the answer

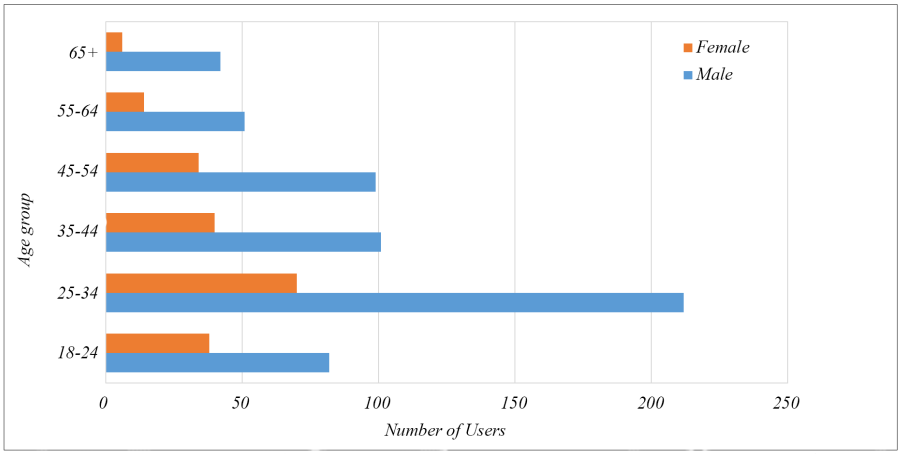

Fig. 6. Number of users divided among the age groups

options are vandalism-proof buttons inserted. Citizens can vote on the above printed question by pressing one of them. A box behind the poster hides the necessary electronics made up of Tinkerforge components. A small calculator processes which button was pressed at what time and saves the data. A USB battery charger supplies the computer with electricity. A connected UMTS stick transmits the data to the project server every 30 minutes.

Additionally, we are currently developing our web app and application to also support the following phases of the restructuring efforts, e.g. the choice of measures to be implemented and their evaluation after implementation. We learned, that in the field of civic restructuring, while focusing on pedestrians, the means of participation need to be as accessible as possible and need to involve as little work by the citizens as possible. The user experience and usability of such instruments should be as high as possible and involves not only the user interfaces, but includes all steps necessary to gain access to the selected tools as well as the media involvement and public relations work during the deployment of those tools.

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