

Smart Cities Through Implicit Participation: Using Gamification to Generate Citizen Input for Public Transport Planning

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Abstract. In this paper, we present a case study of the mobile app and ecosystem *Trafpoint*. *Trafpoint* is a system for registering when and where people travel by public transport, using gamification in an attempt to convince more people to travel in environmentally friendly ways. We argue that the *Trafpoint* app is a good example of what we call “implicit participation”, where user-generated data from volunteers generate valuable input for the political decision-making process. With the growth of sensors, smartphones being ubiquitous, and the growing interest in the Internet of Things, this form of participation has the potential to become very valuable for decision-makers in the coming years.

Keywords. eParticipation, smart cities, gamification, mobile development, case study

Introduction

As of 2009, more than 50 percent of the world’s population live in urban areas [1], and this number is forecasted to increase in the coming years. Cities occupy only 2 percent of the planet, but account for 60-80 percent of energy consumption [2]. As the sizes of cities grow, so does the challenges facing cities [3]. These challenges include issues related to public health and socio-economic factors [4], energy consumption, transport planning and environmental issues [5]. Air pollution caused by traffic jams is but one concrete example of the many challenges facing growing cities [6]. Therefore, it is an obvious need for cities to be “smart”. Smart cities refer to “places where information technology is combined with infrastructure, architecture, everyday objects, and even our bodies to address social, economic, and environmental problems” [7].

Many researchers and political theorists see political participation as an important way of enhancing democracy [8]. By engaging more citizens in political processes, the citizens will take more responsibility for their own situation, and contribute more to society. Simultaneously, other research [9] has shown that citizens are not that interested in participating. Their main interest is that government provides services in a good way.

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For the last decade, there has been many initiatives to utilize electronic communication to improve participation. However, citizens report they appreciate the opportunity to communicate, but remain passive and do not believe eParticipation projects will improve democratic engagement [10]. Those who report to be active participants in democratic processes only makes up a small percentage of the population [11].

Amnå and Ekman [11] claim that while a lot of research has presented participation as an active/passive dichotomy, we should rather think of it in terms of degrees of participation, ranging from completely disinterested to completely active. While the group of active citizens is relatively small, there is a latent political interest, called “standby participation”, in a much larger group of citizens. This group follows political news and current affairs, has opinions and will participate if something triggers their interest [11]. While some argue that political participation is in decline, others point out that civic engagement is as strong as ever, but not in the same way as in the past [12]. One way of using this engagement could be what we call passive, or implicit, participation, for example by using their smartphones to send data to decision-makers.

In this paper, we present one example of implicit participation. Trafpoint is an app and digital ecosystem for monitoring and improving public transport, developed by a consortium of private and public partners in Southeast Norway. We argue that Trafpoint is a good example of how implicit participation can contribute valuable insights to decision-makers, in an area highly relevant to the challenges faced by the smart cities of the future. At the time of writing the system has not yet been implemented. Thus, this paper presents ongoing research and will hopefully be expanded if and when data from a full implementation becomes available.

1 Related research

1.1 *Smart cities*

Cities are growing at a rapid pace, and this growth brings with it several challenges related to infrastructure, pollution, traffic congestion and social problems [13]. In response to these challenges, the research area Smart cities has emerged in recent years.

Reflecting the novelty of the area, there are many and varying definitions of the concept. Doran and Daniel [14] define Smart City as “Interaction of systems enabled through ICT’s” (p.60). They include economic, environmental and social systems in their definition. Urban challenges addressed with smart solutions are seen as “wicked problems” – problems and challenges that require coordination and collaboration between several disciplines and organizations [15]. Angelidou [16] expands on existing definitions through a comprehensive literature review, and adds four assets, or objectives, for smart cities: Human capital (citizen empowerment and knowledge creation), social capital (social and digital inclusion), behavioral change (sense of ownership and meaning) and a humane approach to change, where technology responds to the needs and interests of the user.

One of the more recent and influential articles, at least in the eGovernment field, is that of Gil-Garcia and colleagues [13]. Based on a review of academic literature and practitioner tools, they present a framework for smart cities. ICT’s, data and information makes up the technology side, while the social side consists of government (institutional arrangement, services and management), society (knowledge economy, human capital,

collaboration) and the physical environment. Their claim is that smart city projects should be evaluated based on the components of this framework.

On the technology side, the Internet of Things (IoT), such as sensors in smartphones, and (big data) analytics are popular topics. A sensor is a component that is capable of detecting changes in its environment and convert this change into an electrical signal. Many mobile devices have built in sensors, e.g., a GPS sensor or accelerometer. These sensors can be useful for things such as traffic monitoring [17]. The data collected can be analyzed using a range of techniques, and used for predictions, pattern recognition, forecasting, visualizations and decision-support [18].

1.2 *Implicit participation through gamification*

Democracy comes in many shapes and sizes. In direct democracy, each citizen takes part in a political decision. This can be done through popular votes. Switzerland is famous for having popular votes on a multitude of topics, and direct democracy experiments are found in countries as diverse as Italy, Paraguay and Bolivia [19]. Representative democracy is a model where citizens choose representatives to act on their behalf for the upcoming election period. The voters may then change their mind on who to support on the next election [19].

The idea of participation is to give citizens more influence between the elections. Several mechanisms have been proposed to facilitate such participation. Citizen' initiatives is one way to influence political agenda by collecting signatures. The governing body would then be obliged to discuss or vote on the matter within a certain time limit [20]. Other, more informal alternatives are discussion forums and consultations. Participatory budgeting is a process where citizens have a direct influence on budget spending. In some cases, governments allocate a portion of the budget for citizens to decide upon [21].

However, all these mechanisms require the citizens to spend a certain amount of time to take part in the participation. If citizens find the process too time-consuming, they may choose not to participate out of convenience, by not having opinions on a topic. This could especially be true for the large group of "standby participants", citizens who are interested in politics and society, but who still choose to remain mostly inactive [11].

In order to get this relatively large group of citizens to participate, decision-makers can implement passive crowdsourcing, which requires less commitment and time than other forms of participation [22]. This can be done by using sensors and smartphones, coupled with analytics software that provides important data for decision-makers (see i.e. [24-26]), and by adding elements of gamification we provide citizens with additional incentives to become participants without having to spend a lot of time reading or debating. Gamification can be defined as "*the use of game design elements in non-game contexts*" [23]. Gamification is seen as an important element of user experience and user engagement, and can be applied to make applications more interesting [24]. One approach to this could be by awarding user contributions through a points system, where a leaderboard and possibly also other rewards provides incentives for participation [25].

2 **Research approach**

The objective of this paper is to show how citizens can become participants in smart city initiatives through implicit participation through their smartphones. In order to

address these objectives, we have conducted a qualitative case study of *Trafpoint*, a system consisting of applications for monitoring public transport, and an analytical engine.

We collected data for the case in November 2015 and February 2016, and consists of e-mail interviews with the developer, participation in a workshop between the developer consortium, members of the ICT industry in Telemark, Telemark county Smart cities' office and representatives from the urban planning industry. At the workshop, the development team presented and demonstrated the system, after which there followed a long discussion about the system in relations to smart cities in general, and for Telemark County more specifically.

Follow up-interviews with the lead developer and a representative from the county were conducted via e-mail in February 2016. A video recording of a presentation of the system has also been part of the data material. As interviews were electronic, there was no need for transcription. The first author made field notes at the workshop in November 2015. In addition, the County council's web site has been a source for documents and plans related to the case.

The data is analyzed by applying the case findings to the framework of Gil-Garcia, Pardo [13], in order to examine the maturity of the case and identify any possible weaknesses. In addition, we discuss how this and similar projects can be used to engage more people in decision-making through implicit participation.

3 Case presentation and findings

A consortium with members from business and academia created *Trafpoint* as a response to a call for innovations in transport planning, presented by the IT industry organization in Telemark. The consortium has four members from business, IT and nanotechnology.

The innovation challenge that started the project was "how can we get more people to travel by public transport, in a region where most people prefer to travel by car?"

Trafpoint was created to answer this call. The system consists of four elements. The first is a mobile app that users can download, using beacon² and Bluetooth technology to automatically register when people board and leave the bus. When the user's phone moves outside of the bus-mounted beacon's range, the user is registered as having left the bus. Users build the environmentally friendly profile by earning miles for each trip, and can share their position on the leader board on social media such as Facebook. This social aspect is where the developers hope gamification will help to motivate more people to travel by bus, by creating a social pressure and contest for who is the greenest traveler.

The second element is an application that counts all passengers entering and leaving the bus, using video and a motion-detection algorithm created to recognize people without identifying them. The application runs on cheap hardware, and the motion-detection can be adapted for different distances between camera and object. Data about passengers boarding and leaving is registered in real-time and transferred to the back-end.

² For information on beacons, see <http://www.webopedia.com/TERM/B/beacon.html>

The third and fourth elements are the back-end analytics. All data is transferred to a cloud-storage Hadoop database, which uses parallel processing to calculate live statistics for when and where people are travelling.

This is coupled with a front-end that decision-makers can access to perform analyses of public transport use. The current version registers daily statistics for each stop – How many people enter and leave the bus, the times of day with heavy traffic, and the total amount of people on the bus are examples of the statistics being recorded. The road authority maintains the list of bus stops, and Trafpoint imports this list at regular intervals. The front-end also uses Google maps to visualise transportation patterns. Predictive statistics is not part of the solution at present, but there are plans for implementing this when the amount of data is large enough to facilitate prediction.

While Trafpoint is promising, the application has yet to be implemented on a large scale. So far, the findings reported are from development and pilot testing. The developers report that they are still working on commercializing the system, and they are working with several partners from the private sector, as the technology behind Trafpoint is just as interesting for airports, shopping centers and other large constructions where people flow is an issue. As a private company, their focus is on profit, and they report they will take the technology in the direction that is most promising in terms of maximizing profits.

3.1 Analysis: Trafpoint as a smart city project

Gil-Garcia et al [13] has created a framework for smart cities consisting of ten dimensions, grouped into four categories. While the framework is meant to evaluate cities, it can also be used to examine individual projects. The following section analyses Trafpoint according to this framework.

The first three dimensions are concerned with the inner workings of government. *Public services* is the first dimension, as effective services are essential for creating smart(er) cities [26]. Services aimed at reducing transport emissions are mentioned specifically [26]. In light of this, Trafpoint can be a valuable application for smart city development, as its objective is to get more people to travel by bus. *City administration and management*, the second dimension of the framework, points to the use of e-government, efficiency and proper funding for new projects. Here, Trafpoint meets its first hurdle. As the county government is yet to make a decision on implementation, the entire project is in danger. *Policies and other institutional arrangements* is the third dimension, and includes visions for the future and policies supporting these visions. While the county has established a Smart City office, this is but a small part of the county's office for regional planning. There are no hits for "Smart City" or related subjects on the county's web site.

The next three dimensions are related to society, and aimed at uncovering if the region has sufficient resources to support smart city development. The dimensions *Human capital & creativity; Governance, engagement, & collaboration; Knowledge economy & pro-business environment* examines collaborations between civil society actors, education and knowledge levels, and the presence of high-tech and creative industries capable of transforming policy into actual products and services [13]. As Norway is large country with a scattered population, these dimensions are difficult to meet outside of the largest cities. In the Trafpoint case, the project involves actors from three different counties working together. Using ICTs for communication and collaboration means this is not a big obstacle, as the collaborative environment is strong.

Here too, government and formal obstacles are more visible. For example, the representatives from Telemark County expressed concerns that the project involved too many actors outside of the county. When each county works towards its own interests, this presents an additional challenge for inter-regional collaboration.

The next two dimensions are related to the physical environment. *Built environment and city infrastructure; and natural environment and ecological sustainability* examines the physical infrastructure of cities (road, rail, communication) and holds these up against the objective of environmental sustainability. Compared to the rest of the country, Telemark has a lower share of public transport: Only 3% of journeys, compared to 8% as the national average [27]. The county's objective is to increase this number, but there are several challenges related to infrastructure. The population is scattered across one city region with 90.000 inhabitants, and several smaller towns and villages. Centralization of public offices and services means that more people have to travel longer distances to get to work, school etc. [27]. If Trafpoint is implemented, it can help to increase the share of public transport, both through analytics of travel patterns and through the gamification aspects of the mobile app.

The final two dimensions are grouped under the heading technology and data. A smart city should have a well developed communications infrastructure, and they need to have access to, and analysis of, data from relevant areas such as traffic, power, health, safety and others [13]. According to the post and telecommunication authority, the southern parts of Norway have good coverage of 4G mobile Internet, and high-speed fixed broadband is readily available, at least in the more densely populated areas³. This means that at least in the city region, the infrastructure is not an obstacle for Trafpoint and similar applications. The data registered by the system can be used to optimize public transport schedules, in order to make public transport accessible and usable for more people by examining when and where people travel. This could be supplemented with additional data from car transport (for example from tollbooths) in order to create a better match between people's travel needs and public transport schedules.

4 Discussion and Conclusion: apps for implicit participation?

Traditional forms of participation require the citizens to spend a certain amount of time to take part in the participation. If citizens find the process too time-consuming, they may choose not to participate. This could especially be true for the large group of "standby participants", citizens who are interested in politics and society, but who still choose to remain mostly inactive [11]. Passive crowdsourcing has been proposed as a solution for getting input from this large group [22]. Smartphones, coupled with analytics software that provides important data for decision-makers [24-26] is one way of getting citizen input, and gamification provides incentives for citizens to become implicit participants[24].

Applications such as Trafpoint meet these criteria, and can become an important way of engaging the large group of standby participants. While the video-based monitoring of people boarding and leaving the bus does a good job of collecting data, the mobile application takes it a step further by making the citizen take an active choice to participate. Gamification elements mentioned above, such as the leaderboard with your personal green footprint and social media sharing, makes participating more fun. If

³ http://eng.nkom.no/topical-issues/reports/_attachment/16031?_ts=14abf0b9644

enough citizens start sharing their green habits in social media, network effects and the competition to be the greenest traveler can potentially contribute to lasting change in people's travelling habits, and to even more becoming engaged, participating and contributing their own data – which in turn helps decision makers to find the optimal solutions for public transport.

As all research, this paper also has its limitations and questions. Trafpoint, while the focal point of this paper, is but one example of how smartphone sensors and analytics can help recruit more citizens to become participants. Unfortunately, questions about implicit participation has to be answered with the word potential. As the application is still in the pilot stage, there is no real data on this as of yet. Future research, if the application is implemented, will examine if this potential has been realized.

Potentially, all the relevant smart city areas such as transport, pollution, health and others, can use the same techniques to gather input from citizens and thereby contribute to even better services. The question is if citizens are willing to install a number of apps on their smartphones, for all kinds of data collection. An ordinary citizen might be interested in contributing data on a number of issues, but having individual applications for this would soon take up too much space on the phone. An important area for future research could therefore be to examine if it is possible to create one single “participation app”, where citizens can choose different types of data they want to share.

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