Public design of digital commons in urban places: A case study

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Abstract

This paper can be framed within the growing interest in the public dimension of technology design: it proposes a framework for the public design of urban technologies by elaborating on the concepts of digital commons, matters of concerns and engagement. The framework is discussed through the case study of a mobility application developed within a wider project of digital commons design. We contrast a Smart City approach and a urban computing one, and we argue that the latter is more fruitful in the long run, since it entails elements for the establishment of forms of recursive engagement of users, who co-produce digital commons together with technology designers as a response to their matters of concern. Applying our framework to the design of urban technologies, we conclude that design should support collaborative practices starting from the articulation of matters of concern to designing in a participatory way.

Keywords: matters of concerns, recursive engagement, smart city, urban computing, mobile applications

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1. Introduction

There is a growing attention to the public dimension of design, that is the capability of designers to engage with issues that are relevant for the society they live in (Bødker, 2006; DiSalvo et al., 2014). This aspect is particularly relevant to the field of urban computing (Forlano, 2013), where many research projects are tightly connected to the specific environment in which they will be deployed. In this paper, we frame the relation between public design and urban computing by mediating it through the concept of digital commons: after articulating our theoretical tenets in detail, we discuss our point of view in the light of a case study dealing with the design of a mobility application. Our argument is located in the problem space of current changes in the design of digital technologies, which has shifted from focusing on individual experiences to problematizing the social and public dimensions of technology production and use. We focus on the city, starting with an understanding of urban places as characterized by social relations and by the emergence of practices and subjectivities. The complexity of such scenario is in our opinion incompletely represented within the concept of "Smart City", one of the dominant narratives in the industry and governments' perspective on the relation between digital technologies and urban places; we believe instead that the academic discourse on urban computing is better suited to analyse the relationship between the city and the practices occurring in it since it promotes a focus on people, technology and spaces (Foth et al., 2011b).

On top of this grounding, we articulate a perspective on digital commons: shared artefacts which can be taken over and self-governed by concerned people. We suggest that the design of digital commons can be grounded in the concepts of "matters of concern" and "recursive engagement", both of which emphasise the articulation of people concerns as part of the designers' role, thus highlighting a fertile ground for public design. In particular, we will discuss how publicly designed digital commons should be able to stimulate the formation of recursive publics, which engage with the technological and institutional elements that allow their existence as a public, deepening their knowledge and domains of action.

We support our line of thought by discussing the case of a mobility application that has been intended as a digital commons and which followed a process of public design moving from the identification of concerns to the stimulation of engagement and the preliminary constitution of a recursive public. More specifically, we discuss two instantiations of the same techno-

logical artefact: one in which the approach to engagement has been driven by a situated and participatory perspective, in line with the urban computing approach, and one characterized by a top-down engagement strategy, more in line with the concept of the Smart City. In conclusion, we show how a urban computing approach has stimulated a more sustained engagement, and we reflect on some lessons learned during the project.

2. From personal to public design

Over the last 40 years, methods for the design of digital technologies have adapted to the needs and activities of the context in which technology was used. Starting from the 1980s, a number of researchers have argued for the importance of human factors in computing systems (e.g., Shneiderman (1980)). The collaboration among experts in engineering, computer science and psychology gave rise to the field of Human Computer Interaction (HCI) (Card et al., 1983), which focused on performance metrics such as efficacy and efficiency. Their work highlighted the need for optimising the use of computers and introduced the concept of usability (Nielsen, 1994). At the same time, Computer Supported Collaborative Work (CSCW) emerged as a research field which investigates computers as a support for "cooperative work arrangements" (Schmidt and Bannon, 1992), mainly focusing on workplace settings such as offices and factories.

Over the years, there has been a growing awareness that people should no longer be considered as mere "human factors", but should rather be understood as "human actors" situated in a context and with individual characteristics and values, as Bannon (1991) initially argued. Consequently, in the late 1990s the focus moved from performance design towards experience design (De Angeli et al., 2002; Hassenzahl , 2014), and from the workplace to personal contexts. Following this line of thinking, User eXperience (UX) became an essential part of requirements, and subjective dimensions such as aesthetics, enjoyment, and pleasure became relevant quality metrics (Hassenzahl and Tractinsky, 2006).

Currently we are experiencing a move from experience design to public design, as design is increasingly dealing with complex and diverse contexts and is addressing societal and political issues. This shift has been referred to as the "third wave" in HCI (Bødker, 2006) or "design in the wild" (Dittrich et al., 2002; Rogers, 2011; Chamberlain et al., 2012). These reflections highlight a need to define how the process of public design should be achieved;

in line with DiSalvo et al. (2014), we consider public design as "a collection of design tactics and strategies" that can have the effect to "expose and re-imagine constraints and parameters surrounding issues and problematic situations" (p. 2405).

The basis of this approach is Dewey (1927) definition of public as groups of people who come together in order to trigger an action to deal with a shared issue. In this frame, it is important to differentiate between designing for already existing publics and designing in the public domain, where publics might be in formation (Le Dantec and DiSalvo, 2013; DiSalvo et al., 2014). When dealing with public formation, engagement becomes a crucial element to promote participation and proactiveness (Le Dantec and DiSalvo, 2013). Therefore, such approach requires an understanding of the context we are designing for, that in our case is the city.

A city can be described using two key concepts: "space", which relates to the structure and geometry of the physical setting, and "place", which refers to the use of space, characterized by experiences and interactions (Harrison and Dourish, 1996; Dourish, 2006). Oldenburg and Brissett (1982) considered urban places as the most important element in social life and the base of democracy, and portrayed them as an intermediate place between the house and the workplace. In addition, these authors argued that interactions occurring in the urban places might in turn influence, in a recursive process, the construction of the house and of the workplace. In this view, the urban context represents a unique and complex social setting influenced by culturally situated practices and flows, and characterized by the centrality of the subjects living in the city.

2.1. The Smart City

The last decade has seen the emergence of "Smart City" as a very popular label for referring to an approach to city renewal that is technology-pushed and corporation-driven; this vision has been widely supported by some public administration. A noticeable example is the European Commission which in 2012 has established the "European Innovation Partnership on Smart Cities and Communities". As reported by the EU, the projects funded through the Smart City label are lead by public authorities (36%), business (26%), and only 16% have an academic leader. The remaining part is shared between NGOs (6%), private individuals (2%), and other entities (14%). Since the beginning, the vision of the Smart City has been characterized by a technology-centered approach. For example, Bowerman et al. (2000) define the Smart

City as a place characterized by the "use of advanced, integrated materials, sensors,electronics, and networks which are interfaced with computerized systems comprised of databases, tracking, and decision-making algorithms." (p. 1).

The urbanist Greenfield (2013) has critically elaborated on how the Smart City narrative and practices target public administrations as potential customers of corporate-provided solutions, rather than addressing directly the needs of people living in the cities. This understanding deviates from a human-centred and situation-oriented conceptualization of computing in the urban space. This limitation has been highlighted by several scholars: Hollands (2008) has pointed to the technology-pushed, neoliberal, epistemologically problematic assumptions of several Smart City projects; Townsend (2013) argues for a participatory approach to the Smart City, where public ownership of urban technologies is more relevant. We agree with these critiques and we refer to urban computing as an alternative approach to the relation between technology and the city.

2.2. Urban Computing

Urban computing can be defined as the integration and activation of digital technologies in the urban context of everyday life, stressing the centrality of people living in the city (Paulos and Jenkins, 2005). In the academic debate, the focus on people rather than on technologies has been particularly stressed by the scholars who have coined the label "Urban Informatics" to further identify an approach posing its research questions on people, places, and technologies (Foth et al., 2011b) and building on theories and methods from social sciences and design disciplines (e.g. Dourish et al. (2007)). In the remainder of the paper, we will generally refer to urban computing as the set of academic discourses on people-centred technologies in urban places (including both the labels "Urban Informatics" and "Urban Computing"), in contrast with the top-down, corporate-promoted approach of the Smart City.

Several researchers in the field of urban computing agree that the city cannot be analysed as a mere spatial container, but rather as an action-setting place where infrastructures and practices are intimately related (Williams and Dourish, 2006; Brynskov et al., 2009; Dalsgaard and Halskov, 2010; Memarovic et al., 2012). In this understanding, the city can be seen both as the place where design takes place and as the outcome of co-production activities performed by designers and users of technologies (Forlano, 2013).

Paul Dourish and colleagues (Dourish et al., 2007; Bassoli et al., 2007) highlighted the relevance of mobility applications as urban computing instantiations, distinguishing two different generations. In the first one, mobility was seen as a problem to be solved through technology: such problem could be in turn the disconnection of workers from a stable situation, the dislocation and the subsequent need for guidance, or the disruption of social situations. In the second generation, mobility is seen as a resource, and technologies are designed both to leverage the wealth of potential social interactions emerging through mobility and to be able to situate themselves in the different contexts of the city, being sensitive to the different locations. Camacho et al. (2012) elaborated a similar argument in relation to IT-based services currently offered in public transport; such services appear to be increasingly passenger-centric, aiming at making journeys more enjoyable: in this case, locality can provide enhanced opportunities for engagement, for example by fostering the exchange of information among passengers.

In the second generation, design of mobility applications can be intended as a deliberate intervention in the world through the construction of technological artefacts: it can support dense experiences, the continuous innovation of the practices of living together, the everyday interactions of people, and their engagement with sociality and urban life. Intervening through design in the urban context means to participate to the construction of the places people inhabit, the things they see, the experiences they have, and the promotion of their imagination (Forlano, 2013). However, the process of public design is difficult to achieve, document and evaluate. Several researchers in fact report the complexity of prototyping urban computing systems as they require building a critical mass of participants before social behaviour can be investigated (Zimmerman et al., 2011; Chahine and Tomitsch, 2013); furthermore, they highlight a limitation mainly related to the need for going beyond the bootstrapping phase in order for evaluation to be meaningful, and this is difficult to achieve because of time and budget issues of many current research projects.

The complexity of designing technologies in the city suggests that there is a space for an interdisciplinary approach to urban computing (Camacho et al., 2012). In particular, we believe that the design of urban computing can support recursive dynamics, deepening the engagement of users toward collaborative practices. We agree with the claim of Foth et al. (2011b) on Urban Informatics being able to address issues and opportunities that go beyond the urban dimension, tackling wider social issues. This is why we

explore the possibility to develop a public design perspective which is supportive of alternative social practices, is oriented to the common, enlarges the scope of human collaboration, and promotes the strengthening of practices situated in the urban landscape.

3. Design Framework

In order to locate our public design framework in contemporary debates on society and design, we will refer to three main concepts: digital commons as a way to link design activities to wider societal possibilities (Marttila et al., 2014); matters of concern as the content of design issues (DiSalvo et al., 2014); recursive engagement as the ability of people to take care of what allows their existence as a group and, through this, to widen their perspective on what they are concerned about (Kelty, 2008).

3.1. Digital Commons

The way in which technologies are designed and in which they translate an overall vision of the city as a common place are key points in a design process. We propose the concept of commons as a possibility to promote a renewed form of distribution of social wealth: elaborated by the Nobel prize Elinor Ostrom, the commons has been further discussed by many scholars, either more critically oriented like Bollier (Bollier, 2008; Bollier and Helfrich, 2014), or more liberal as Benkler (2006). More specifically, the commons is a third-way institutional arrangement to manage specific resources, be they natural or digital, that is neither the state or the market, but rather a collective effort of the people directly interested in managing the resources through means that are based on democracy more than on hierarchies (Ostrom, 1990; Hess and Ostrom, 2007; Bollier, 2007). Typical examples of commons related to natural resources are water, pastures, or fishery seas, while typical examples of commons related to digital resources are Wikipedia and the various forms of Free and Open Source Software.

As observed by several social scientists, even though the commons is based on procedures that are more democratic than hierarchical, this does not necessarily imply more justice (e.g. Coleman (2013); Tkacz (2014)). The attention to justice in the design of digital technologies is not new, as questions on the public responsibility of technology designers were already present in Wiener (1954), where the author stressed how technology could sustain social practices either oriented to liberating the subjects or to reproducing

hierarchies. To include justice in the relationship between the commons and society at large we leverage on the more general concept of the common (singular), intended as the ensemble of shared material and symbolic resources that sustains the possibility of humankind to live together, including natural resources and digital wealth (Hardt and Negri, 2009). If the commons are the articulation of particular (and fruitful) institutional arrangements, the common is a political perspective of societal transformation supporting practices of mutual sharing and collaboration that can leverage the institutional gains and peculiarities of the commons.

The common is one of the ways through which justice can be introduced in an account focused on procedures and organizations like the one on the commons. To include justice as a balanced way of distributing access to shared resources and contributing to them, the common should be situated, thereby recognising that having a local perspective provides an epistemological privilege in understanding the world, as pointed out by Haraway (1988). In a local perspective, design comes from somewhere and not from the detached perspective of nowhere (Suchman, 2002). In a common-oriented perspective to urban computing, the city is the place where subjects take shape, their ability to live together is continuously constructed, and the possibilities for diversity and social interactions multiply (Hardt and Negri, 2009). Technologies, or digital commons as we can now consider them, become concrete elements supporting active human agents in the shaping of their urban environment, their subjectivities, and their life in common.

3.2. Matters of concern

The public design framework we articulate aims at the development of digital commons through the articulation of matters of concerns. If technology design traditionally entailed deciding how artefacts should work or which experience they should enable, public design starts from the premise that the boundaries of what to be designed are blurred. In this design context, designers might lose control over the object of design, as there can be diverse understandings about what artefacts are for and how they should be used (Sengers and Gaver, 2006). Designing artefacts which are susceptible to interpretation open up opportunities for reflection on what Latour (2005) defined as "matters of concern": technology and knowledge are seen as something people are concerned about rather than something established on "matters of fact", the declaration of absolute reality. The focus on matters of concern stresses the instability of technologies, their social uncertainty, and it relates

directly to people's concerns with the implications of the technology (Latour, 2005). As DiSalvo et al. (2014) pointed out, in this understanding the role of the designers moves from "providing solutions or initiating change" to articulating "issues and giving form to problematic situations" (p. 2404). In this context, designers are not only dealing with a public as an external object of intervention, but they are actively participating to the formation of the publics they are dealing with, both through the design process and the resulting artefacts (Le Dantec and DiSalvo, 2013).

Several examples of how looking to the design process through the lens of matters of concerns might trigger different interpretations of a technological artefact are currently emerging. For example, real-time ridesharing platforms such as Uber have recently become popular as an alternative solution to public and private transportation. Passengers, who enjoy higher flexibility and lower prices than with existing transportation services, have received the platforms positively. In addition, non-professional drivers, who are paid for this service, have been involved in processes of professionalisation, like forms of unionisation. On the contrary, European taxi drivers associations see these platforms as an unfair threat to their business and have organized several protests to request their cease. Some governments are supporting the protests, as a taxi service performed by non-professional drivers can be prosecuted according to existing laws; yet, the Commissioner responsible of the Digital Agenda for Europe has called for an agreement between taxi drivers and the platforms.

This example shows how identifying matters of concern as potential design themes implies tasks that are non-trivial: matters of concern are by definition controversial, and this opportunity to give rise to public disagreement makes the design process complicated. In our framing, matters of concern initiate a positive engagement towards digital commons, potentially promoting the construction of a recursive public that can question the surrounding context.

3.3. Recursive Engagement

The existence of a recursive public within Free and Open Source software contributors has been identified by the anthropologist Kelty (2008) as one of the key aspects of their influence in contemporary relations of power and knowledge; other scholars have recognized that Free and Open Source software practices can indeed nourish the common (e.g. Bollier (2007) and Hardt and Negri (2005)). Kelty states that "a recursive public is a public that is constituted by a shared concern for maintaining the means of association

through which they come together as a public" (p. 28): in our perspective, recursivity is the distinguishing feature of engagement in public design, as recursive engagement is the capability of a public of being able to take care of the infrastructure that allows its existence as a public. Public design should therefore produce not only useful artefacts, but also the means for discussion, improvement, and future autonomy of the publics engaged.

Engagement can be facilitated by the creation of attachments (Marres, 2007), a concept that can help to elaborate on participation when designing technology (Le Dantec and DiSalvo, 2013). Marres highlights that publics' reasons for participation are not rooted on the expression of a popular will but on the articulation of a public issue (Marres, 2007). This difference is especially relevant for design, since the possibility to articulate matters of concern and discuss controversies is what differentiates publics from other kinds of actors (Le Dantec and DiSalvo, 2013). The articulation of matters of concern does not only allow people to identify and engage in public issues, but it also enables the emergence of new relationships between individuals, resources, and objects: these relationships can be defined as attachments. According to Marres (2007), attachments can be created by means of dependency or commitment, affecting the kind of resulting engagement. The focus on attachments should not be understood as a dichotomy between dependency or commitment, since for instance public participation involves a combination of both.

In the context of urban computing, the topic of engagement covers a variety of social, professional, and technical practices (Foth et al., 2011a); moreover, Dalsgaard and Halskov (2010) have argued that engagement is a crucial factor in promoting the participation and proactiveness of people. Rogers (2006) suggests that "bounded" rather than "pervasive" technologies can foster engagement, since they will make it easier for people to take the initiative to construct, improve and control their interactions with the world. She claims that this shift "requires moving from a mindset that wants to make the environment smart and proactive to one that enables people, themselves, to be smarter and proactive in their everyday and working practices" (p. 418). Summarizing, we can say that Rogers refers to what we introduced as a situated attention to "design from somewhere" (Suchman, 2002), that can be interpreted as stimulating a recursive process among people, providing them with the means to affect their surroundings.

We look at public engagement as a highly relational phenomenon. In particular, we identify four characteristics that help to clarify the relations

between people and a digital technology, once they get associated through attachments: 1) the physical presence of people in the world affects how people attribute meaning to technology, even before a conscious sense-making process happens (Dourish, 2004; Fritsch, 2009); 2) the use of the technology is part of wider social practices, including also as the relations between users and non-users (Dalsgaard and Halskov, 2010); 3) people can be aware of being observed while engaging with the technology, and that has implications for its actual use (Dalsgaard and Hansen, 2008); 4) the specific content of the technology affords dynamic relations between people and the technology itself more than being a static element (Dalsgaard and Halskov, 2010). These four elements are part of the way through which engagement gets constructed, they intersect with the distinction of attachments as relying upon dependency and commitment, and help to frame attachments through the situations in which people actually use the technology.

In the following section, we discuss a case study of public design of digital commons in urban places where our framework was applied, showing how our experience suggests that the proposed approach can yield promising results.

4. The Case Study

The case study we reflect upon is the Smart Campus project, which started almost three years ago with the goal of creating an ecosystem that may foster students' active participation in the design and development of services for their own campus. Basically, Smart Campus is an instance of public design trying to stimulate the emergence of recursive practices among its participants: referring to the theoretical framework discussed earlier, the project can be considered as a digital commons entailing processes of public formation through different forms of engagement. Smart Campus represents a digital commons since the software produced is released with an open source license and the project aims at encouraging concerned people to take charge, stimulating forms of self-governance. The final aim of Smart Campus was to foster "participatory development", intended literally as leaving the design and development to the project participants: these therefore became a public taking care of sustaining the existence of the project (De Angeli et al., 2014).

In our research we attempted to document, analyse and reflect on specific design interventions performed during the project, a combination of user-centred and participatory design. The project was led by a core team (defined in the following as Smart Campus Lab or Lab), whose composition varied over

time but generally included five designers, ten developers and five members of the management. The Lab ran activities to facilitate forms of recursive engagement that could foster the formation of a public: the association of students and people who gather around matters of concern addressed by the designed artefacts (mainly smartphone apps). These activities were meant to set the conditions for the extension of the user base of the apps from the circumscribed environment of the campus to the "wilder" context of the city.

4.1. The mobility app

In this paper, we will focus on a mobility application implemented within the Smart Campus project, since it allowed us to investigate the same technology introduced to the city through two different approaches. The application had two different instantiations, *ViaggiaTrento* and *ViaggiaRovereto*, in the two cities of Trento and Rovereto: these are located in similar cultural contexts (the Province of Trento, in Italy), but differ in their size and in the adopted strategies of user engagement. The way attachments were constituted, the social practices the technology was part of, the way people felt observed, were all elements differentiating the situations in Trento and Rovereto.

Geographically, Trento is a medium-sized city (115,000 inhabitants approximately), composed of an historical centre and of several suburbs spread over the surrounding hills and along the river Adige, thus covering a rather large territory (158 km^2 approximately). The nearby city of Rovereto covers a smaller territory of approximately 50 km^2, and counts a population of less than 40 thousand people (therefore, the population proportion between Trento and Rovereto is approximately 2.75). In Trento, user engagement has been a constantly ongoing activity, for instance with the involvement of students in the project since its very beginning through their academic courses but it received very moderate support from the public-administration. The approach in *ViaggiaTrento* has been people-centred, relying on mobility as a resource for design and public formation: in one word, it was a urban computing approach. In Rovereto instead, the launch of the application was celebrated by a press conference of the Mayor, with a massive media coverage by the local newspapers (both elements were absent in Trento), with a group of users that was more anonymous and distant from the designers: briefly, it was more a Smart City approach.

Our main point in the discussion of the case study is that the different approaches to users' engagement with the apps, one more people-centred

while the other more top-down, resulted in different trends of adoption and use, supporting the thesis that a continuous work is more fruitful in the mid- to long-term than a strategy based exclusively on press and broadcast communication. Let us firstly describe how the application had been designed (see Table 1 and Bordin et al. (2014)).

Starting date	Stage	Activities	N. participants
December 2011	Identifying matters of concern	UCD activities by researchers (e.g. focus groups, diaries, workshops, questionnaires, interviews)	HCI '11 (N=60)
October 2012	Beta testing	UCD activities by students (i.e. questionnaires, diaries, interviews and focus groups)	HCI'12 (N=90); Sociology'12 (N=17)
October 2013	Public release	UCD and PD activities for new apps design	HCI'13 (N=117); Sociology'13 (N=18)

Table 1: Summary of activities in the design and evaluation of ViaggiaTrento.

4.2. Identification of matters of concern

At the beginning of the Smart Campus project, we aimed to identify matters of concern which could promote the emergence of a public interested in forms of urban life oriented to the common. To achieve this result, we applied several User-Centred Design (UCD) techniques (e.g. focus groups, diaries, workshops) to investigate and collect the needs of the students of the local University: we were especially interested in identifying what issues were affecting their daily experience of academic life in order for our contribution to be more meaningful. In other words, we aimed at understanding students' "matters of concern", i.e. the basis of public design as we define it here.

This initial set of activities involved 60 bachelor and master students. Commuting turned out to be one of the less pleasant moments in a student's day: scientific departments and most student accommodations are located

outside the city centre, generating a substantial traffic of students typically travelling by bus. More specifically, students reported the unreliability of transport as one of the factors preventing them from using public transport, even though they expressed their intention to do so. Issues included the frequent bus delays, a generalised lack of knowledge about timetables, location of bus stops and routes of each line, together with the absence of a unique point where to find this information altogether.

This situation was part of a context where the quality of transports was considered good but not exceptional by public transport users. To provide a picture, we rely on the 2012 edition[1] of the corporate social responsibility report issued by the local transport company, which reported that 63% of local bus rides in Trento was on time and added that, in response to an explicit request issued by the local Municipality about reducing the cost of public transport, they operated a general reduction of service. No information was instead provided about the situation in Rovereto. The report then compares such data with the quality of service perceived by citizens, investigated through a series of interviews carried out by the company: 300 people were interviewed over the phone, while another 200 were interviewed in person. The first group of people rated the local mobility service with 6.8 out of 10 in Trento and 7.9 in Rovereto; the second group rated it about 7.7 in both cities.

Comparing this corporate report with our set of qualitative data we identified conflicting matters of concerns. While the local transport company tends to highlight punctuality as a main strength of the offered service, students seem to be more concerned about the frequency of bus rides, which is perceived to be insufficient since buses are often overcrowded. Recently, this issue appeared particularly relevant for students commuting to scientific departments: some of them started a campaign on Facebook, called "Giveme5" (from the number of the relevant bus line) which invited students to take pictures of overcrowded buses and publish them on the Facebook event page. Unfortunately, as reported by the students who started the campaign (personal communication), unfavourable meteorological conditions hampered the participation, which was minimal. The promoters, a national students' organization, are nonetheless considering the organisation of future similar campaigns.

[1] http://goo.gl/EhSluj

Figure 1: Homepage of ViaggiaTrento

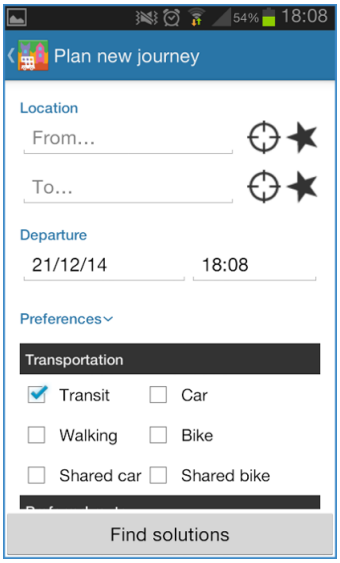

Figure 2: Journey planning functionality

4.2.1. Artefact design

The Lab designed the mobility application concept in Spring 2012 based on collected matters of concern. ViaggiaTrento whose homepage is represented in Figure 1 allows planning of trips over different means of transport (i.e. local trains, buses, car sharing, but also personal car and walking): by entering the departure and arrival addresses and the intended departure time (Figure 2), the system suggests different travelling options. The system is able to take into account user preferences, such as the most frequently used means of transportation, and the characteristics of the preferred travel, such as shortest walking distance, least number of changes, and fastest route. Users can save their recurrent routes, such as the path followed while commuting: by specifying a limited time span of interest, they can receive push notifications on their smartphone in case a delay or service interruption affects their route. The application can also provide real-time information about the availability of slots in the public parking lots of the urban area: these facilities are listed by increasing distance from the automatically detected position of the user for easier consultation.

The application relies on the active participation of travellers in order to provide real-time, accurate information about delays: users standing at a bus stop or train station can broadcast a delay notification through a quick

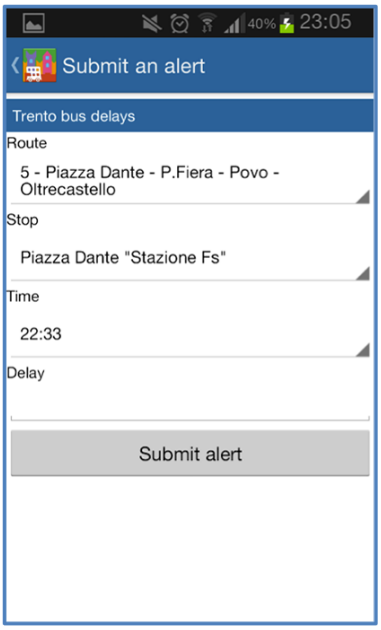

Figure 3: Form for delay notifications

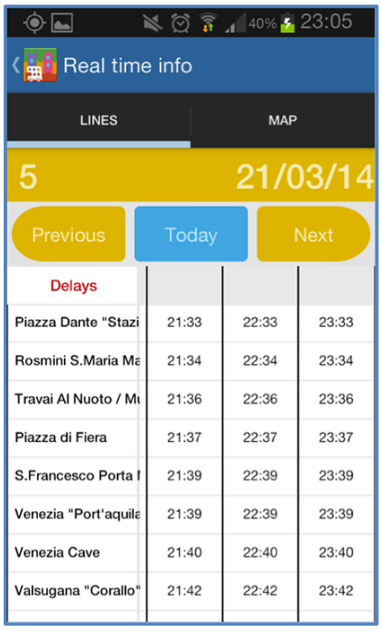

Figure 4: Timetables of the local buses

form (Figure 3), specifying which ride they are waiting for and how late it is. The notification is then propagated to all users monitoring the same ride, or whose journey would be affected by the delay. This information is also shown on the timetables for urban and extra-urban buses and local trains (Figure 4).

4.2.2. Beta testing

ViaggiaTrento was first released to the students attending the Human-Computer Interaction (HCI) class (N = 90) at the local Department of Information Engineering and Computer Science in October 2012. In this way, the project was presented as a real-world application of the approaches taught in class; at the same time, the specific skills of these students allowed them not only to provide feedback on the existing artefact, but also to generate, design, and code new services for their own needs. In order to ease testing and evaluation, we provided students with smartphones equipped with a data plan, with the agreement that the devices had to be returned upon graduation or withdrawal from the experimentation.

Students were involved in UCD activities, such as questionnaires, diaries, interviews and focus groups to assess the quality of ViaggiaTrento. These

activities resulted in a large amount of qualitative data, which were analysed in order to derive suggestions for improvement; given the large amount of material to process, extraction and prioritisation of provided feedback was performed by several researchers in parallel, who then met to reconcile their findings. Filtered suggestions were then transformed into mockups and integrated into the app; proposed functionalities included, for instance, timetable checking, which had not been envisioned in the original design. The students' involvement highlighted also the ambiguity of the name of the app at the time, JourneyPlanner, that seemed abstract and delocalised. This fact prompted the designers to change it to ViaggiaTrento, a way of underlining its situated character.

Over the time, we focused our efforts on engaging a wider group of users starting from the HCI students: to this end, several communication channels were set up to associate the Lab and the users, allowing students to directly provide their feedback to the project team. The communication channels ranged from a forum, social networks and a bug tracking system to personal diaries, face-to-face meetings, and questionnaires. Through these channels, students reported technical and usability bugs, but also commented on possible improvements and new functionalities. All these proposals were collected and used to progressively refine the apps, accommodating the suggestions coming from the forming public.

One year later, in Fall 2013, we involved the new cohort of computer science students attending the HCI class (N = 117) in similar activities and under the same smartphone and data plan conditions. Activities were in this case more oriented towards promoting the engagement of other students and applying Participatory Design (PD) methodologies rather than on applying UCD techniques to improve the design of the apps, especially given the greater maturity of ViaggiaTrento.

4.2.3. Public release

After several months of user testing, we realised that the app seemed to be stable and usable enough to expand its user base beyond the initial group: therefore, we released ViaggiaTrento on Google Play in October 2013, making it available to all citizens and not only to students. However, the advertisement of the application was minimal, concentrated mainly on the campus, and lead by the Lab. In the same period, leveraging on the available technical components, we created a customised version of the application called ViaggiaRovereto for the nearby Municipality of Rovereto, that requested it,

soon released it on Google Play, and promoted it through the local press. In this case, the Municipality was available to provide us with more data: therefore, ViaggiaRovereto also informs people about public notices regarding mobility issued by the Municipality and concerning, for instance, detours or roadwork.

Given this context, we performed a user study in order to fit the application even more to citizens' needs: this time, however, we involved a different group of users, thanks to the collaboration with a technical high school in Rovereto. Many of these students commute to this institute from all over the Province and from nearby valleys, and some live in student houses during the week: therefore, they are in a similar logistical condition as University students in Trento, although they have different social and cultural practices due to their belonging to a younger part of the population. A group of approximately 30 third-year students (16-17 years old) was therefore introduced to the basic concepts of usability, evaluation through field studies and scenario prototyping; then, they were asked to try out *ViaggiaRovereto* in their daily life for a month. At the end of this period, students came up with a variety of ideas about functionalities they felt necessary, such as the possibility of planning a journey by specifying the intended arrival time rather than the departure time. Proposals also addressed the interaction design of the application: for instance, one of the students suggested prompting the user for delay notification rather than relying on her intrinsic motivation to actively open the relevant form, as this would facilitate user contribution and result in increased collaboration. The Lab indeed explored several ways of integrating the possibility of prompting a request for notification, for instance investigating an application developed by another research group which could be leveraged to serve this purpose; however, technical reasons such as the high battery consumption of such an application have so far prevented the implementation of the suggested feature.

Despite these interventions, the approach in Rovereto was driven mainly by the public administration who mediated designers engagement with the public in a top-down fashion, typical of the Smart City approach to users engagement. On the contrary, in Trento the application emerged from the public and was only minimally supported by the public administration. In the following sections we will present results in terms of the engagement with the two applications, *ViaggiaTrento* and *ViaggiaRovereto*, as examples of the same digital technology sided by two different engagement strategies.

5. Recursive engagement: Analysis

To analyse engagement we look specifically at data on adoption, trends of use, and we present a thematic analysis of people comments on the project forum which represented the main channel for the articulation of matters of concerns and recursive engagement.

5.1. Adoption

Since the release of ViaggiaTrento on Google Play, the number of active installations has grown (Figure 5). As of June 9th, 2014, we have reached 886 active installations over 1415 total downloads (63%); the average rating is 4.5 out of 5 with 64 reviews. This is indeed a good result if compared with the other apps about Trento available on Google Play[2]: only four of these urban mobility apps, in fact, exceed a thousand downloads. The most downloaded one is the official app developed by the local transport company and advertised on buses: launched in January 2014, it has more than 5000 users, but shows the very low rating of 2.7 out of 5 and rather negative comments overall. The other three apps we take into account all have between one and five thousand users; however, one of them only provides information about events in town, while the others only provide a subset of the ViaggiaTrento functionalities (e.g. timetable checking or journey planning). The rating of all these three apps is anyway below 4 out of 5.

The positive evaluation on Google Play suggests that the process conducted before the public release of the app, involving students in the evaluation of the project and in the suggestion of new functionalities, has proven effective in achieving maturity of the interface and of the background technical component. This can be confirmed looking at the phone carrier of the devices on which *ViaggiaTrento* has been installed (Figure 7): TIM phones are the majority, and this can be explained by this being the carrier of the smartphones provided to students participating in the project; yet, we can see a steady increase in the number of *ViaggiaTrento* installations on smartphones with different carriers, which is indicative of the formation of a user population that extends beyond the initial group of students[3].

[2]Here we rely on the data provided by Google Play, which displays the number of downloads in terms of intervals, e.g. "less than 1.000", or "more than 1.000".

[3]According to AGCOM, the national authority on communication, TIM and Vodafone own approximately 30% of the market share, Wind 23%, and Tre 10%.

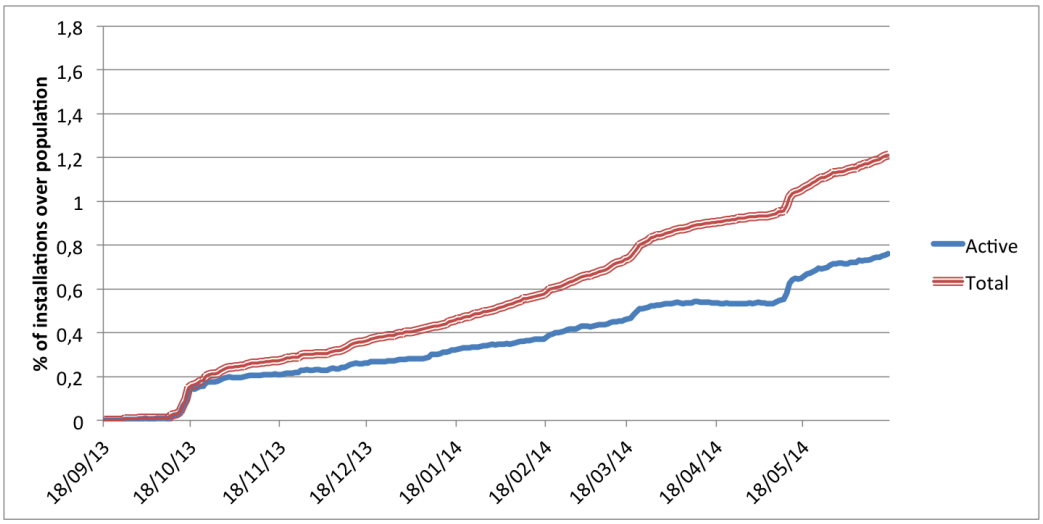

Figure 5: ViaggiaTrento installations

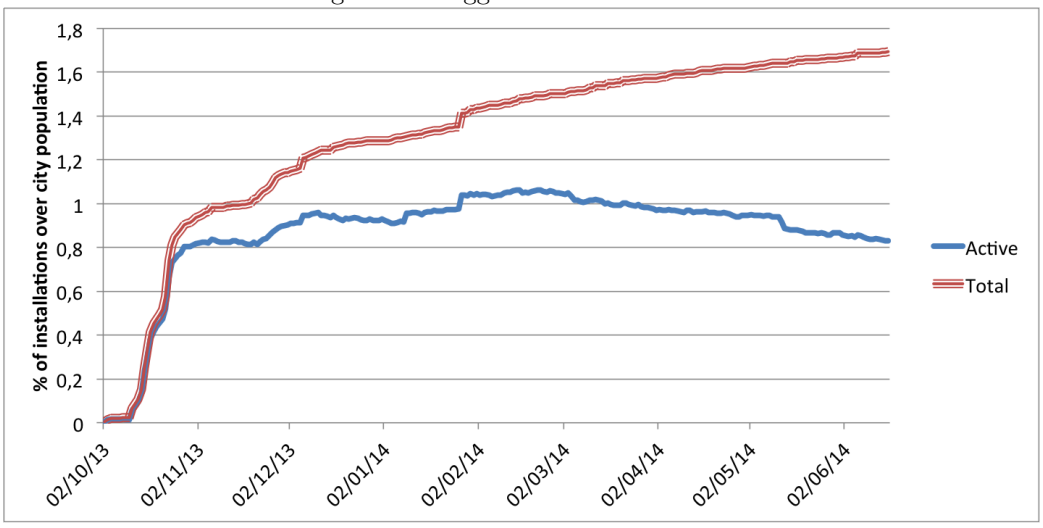

Figure 6: ViaggiaRovereto installations

ViaggiaRovereto was released on Google Play around mid October 2013 as well, reaching around 300 active installations within the first two weeks (Figure 6). However, the number of installations has been growing little since then, topping approximately 400, but overall remaining almost stable. As of June 9th, 2014, the app had reached 324 active installations over 660 total downloads (49%); the average rating over 33 reviews is 4.5 out of 5. In this case, no other app about urban mobility or urban events appears to be available on Google Play for comparison.

Contrasting the adoption of the two applications, we can see that despite the two applications reached the same number of users in proportion to the population, in the case of ViaggiaTrento, the increase in the number of installations was almost constant until June 2014. In the case of ViaggiaRovereto instead, the number of installations grew very rapidly in the first days after the release; however, it then came to a slow arrest and then steadily dropped.

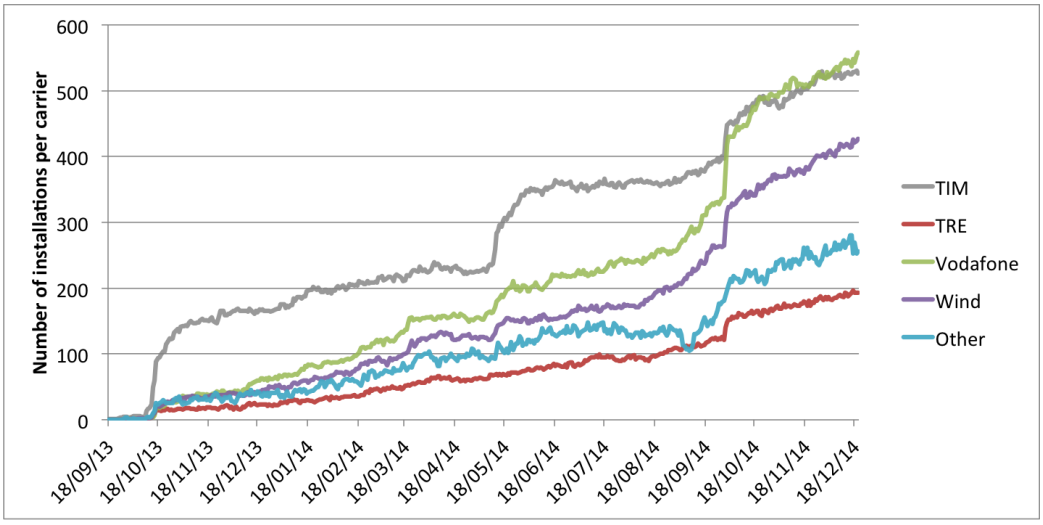

Figure 7: ViaggiaTrento installations over time per carrier

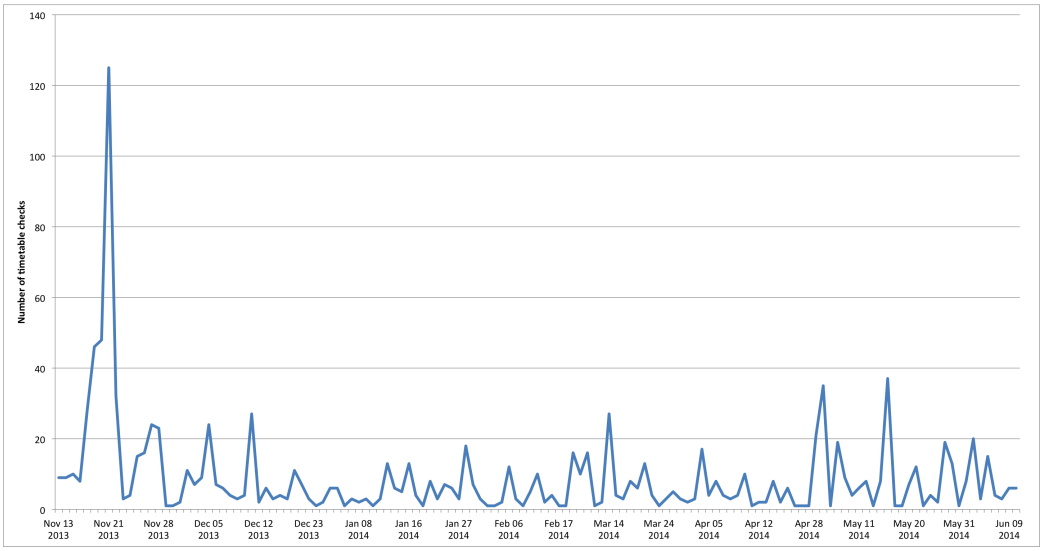

Figure 8: Total timetable checks in ViaggiaTrento

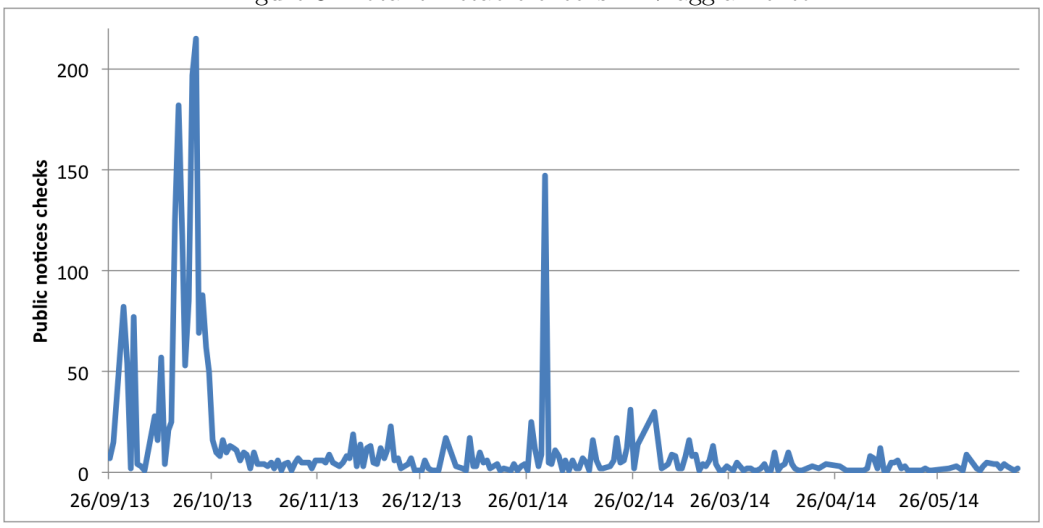

Figure 9: Public notices checks in ViaggiaRovereto

5.2. Trends of use

As timetable checking was a functionality introduced after suggestions by potential users, we are now looking at how this functionality has been used. The chart in Figure 8 shows that, after a peak immediately following the launch of the application, the activity around the application is still constant. In fact, since the release of the ViaggiaTrento app on Google Play, timetables have been checked 1189 times.In the case of ViaggiaRovereto instead, we realised that the timetable checking activity was very low, whereas the most frequently used feature of the application was checking traffic-related public notices (about roadworks, detours, etc., see Figure 9), a functionality which was not available in ViaggiaTrento.

A similar pattern can be noticed focusing on the more collaborative functionality of the two apps, delay notifications. Similarly to the charts about the number of apps installations (Figure 6, Figure 5), we can see that *ViaggiaRovereto*'s user base is indeed little lively in the use of this functionality (Figure 11): their involvement appears to fade progressively after some time after the public release of the app. In the case of *ViaggiaTrento* instead, we witness once more the existence of a consolidated user base contributing content to the app (Figure 10). Although these differences, it is interesting to notice how citizens used both applications especially to broadcast transport delays during disruptive events, such as a transport strike on December 2013 or a snowstorm at the end of January 2014.

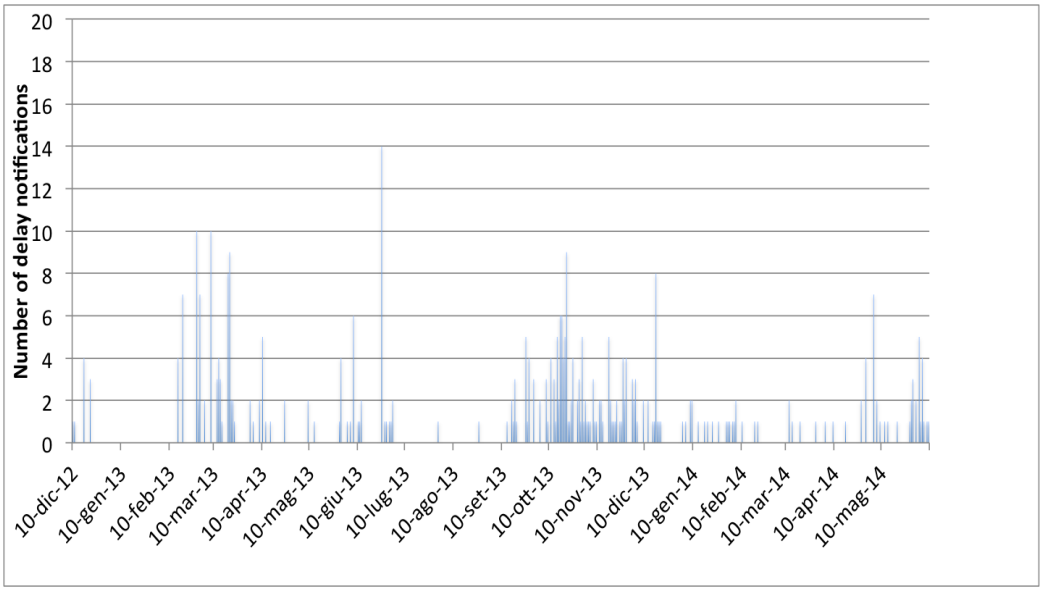

Figure 10: Delay notifications in ViaggiaTrento

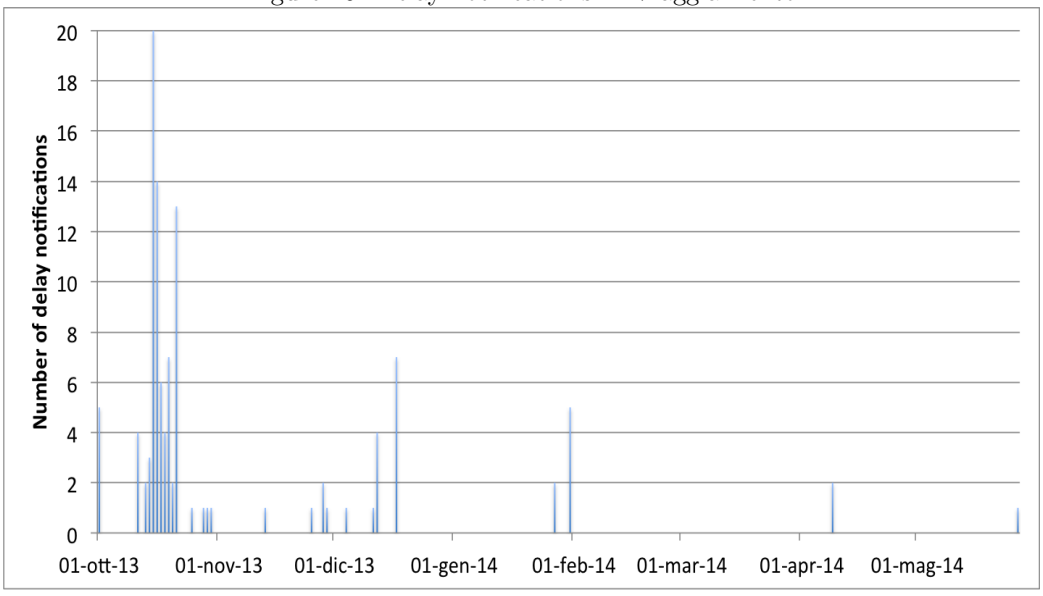

Figure 11: Delay notifications in ViaggiaRovereto

5.3. Articulation of matters of concerns

The different level of engagement between the users of the two apps is reflected also by the dialogue between the Lab and users, which was channelled through an online forum and virtual diaries where students wrote comments regarding all of the Smart Campus apps. The forum was opened on 7th November 2012 and, by 18th June 2014, it contained a total number of 92 threads and 382 replies about ViaggiaTrento and 2 threads and 3 replies about ViaggiaRovereto. The first diary entry was written on October 2012: 115 entries here concern ViaggiaTrento and 15 concern ViaggiaRovereto. ViaggiaTrento users have been largely more active in communication than ViaggiaRovereto ones. We will now analyse the content of forum threads about ViaggiaTrento in particular, as they constitute the most lively source, although in the last months there seems to be an increasing occurrence of posts which end up with an issue which is not answered by anyone, or suggestions which do not receive any feedback.

After performing a thematic analysis (Smith, 1992) of the posts in the forum, we identified seven main content categories: usability issues, suggestions, device issues, bug reporting, data issues, help request, and communications (see Table 2). Usability issues contain problems related to information architecture, data visualization, and interaction design; and suggestions contain proposals on how to improve existing functionalities or add new ones. Device issues are due to the smartphone on which the app was running and include errors such as faulty internet connection or GPS localization; bug reporting refers to posts where users describe issues due to app flaws; data issues are related to inconsistent or outdated data; help requests are related to posts in which users required additional information on how to use a feature or functionality; communications mainly concerns messages from the Lab, such as those informing about new features or upgrades of the app, and very few from users.

Table 2 illustrates the number of threads in the forum, along with number of replies, distributed per category. Usability issues and suggestions are the categories which generate the highest interaction: this is probably due to the fact that these are the two categories that most involve the users and challenge designers and developers. It is in fact through usability issues and suggestions that users can indicate how to improve existing functionalities by referring to daily life situations and without referring to more "technical" matters. In some case, these suggestions were posted together with mockups of the interface, a sign of strong engagement. On the contrary, communica-

Theme	Definition	Threads	Replies
Usability issues	Problems related to information architecture, data visualization and interaction design	16	117
Suggestions	Ways to improve existing functionalities or add new ones	21	108
Device issues	Runtime errors related to technical problems	21	80
Bug reporting	Errors related to software flaws	17	28
Data issues	Problems related to inconsistent or outdated data	8	33
Help request	Information request on how to use a feature or functionality	5	10
Communications	General communications from the Smart Campus project or from users	4	6

Table 2: Themes on ViaggiaTrento in the Smart Campus forum

tion and clarification are the most unidirectional categories: replies are very short, if any, and no proper discussion is ever engaged.

The forum served as the main locus for the collaborative articulation of students' matters of concern. Under this interpretation, we can notice two interesting aspects in the use of the forum. First, comments regarding usability, device and data issues become less relevant over time, while comments proposing new functionalities become increasingly frequent. Also, as the applications became more mature, developers progressively tried to actively involve users into the implementation. In the last months, developers explicitly invite people to contribute by implementing solutions to the bugs they spotted or by improving existing functionalities. However, no user has picked up on these invitations in the case of *ViaggiaTrento*, while participatory development has been achieved in the case of other apps built in the Smart Campus project (De Angeli et al., 2014).

The second interesting point regards the topic of the messages.The specific problems or suggestions emerging in the forum refer to the wider context in which the use of technology is taking place, envisioning both the enlargement of the potential providers of information, or opening up political or institutional issues. Looking at the content of the suggestions, we can see

how, for example, a student suggested to include bus drivers as providers of information, drawing upon an experience of cancelled buses: *"There were a lot of us in Povo* [the suburb where the scientific departments are located] *today, blocked by snow, and the buses were not circulating because they had no snow chains. An imperative, a priority for Journey Planner* [first name of the app]*, would be to allow Trentino Trasporti* [the local transport company] *first, or the bus drivers themselves, to send notifications and messages to the users."* [7 December 2012, "Communications!"]. In another example, referring to data quality, one of the Lab members made explicit political issues with the local transport company: *"Unfortunately it is not a matter of technology, but merely a political one: Trentino Trasporti still does not give us their data despite our pressures and the municipality of Trento ones."* [11 December 2012, "Communications!"]. Another example highlight the priority for students to have information about full buses: *"According to me, as it is something that happens daily, it would be useful to be able to broadcast the fact that a bus is full (e.g. the n.5 at 8:01am) and that is thus impossible to board."* [19 March 2013, "Indicate full buses"]. These examples point to the institutional and political context surrounding the adoption and use of ViaggiaTrento, letting us move to the discussion of the presented results in the light of the approach of public design of digital commons that we are proposing here.

6. Discussion

We have described a case study that deals with two very similar technological artefacts, ViaggiaTrento and ViaggiaRovereto, showing how they have been deployed with two different approaches: in the case of ViaggiaTrento, users (and students in particular) have been constantly engaged since the initial phase of the project, with practices that developed toward being participatory; in the case of ViaggiaRovereto, the application was promoted by the local municipality and through broadcast communication. We have summarised these two approaches through the dichotomy between urban computing and Smart City, the former people-centred, the latter more top-down. The two approaches have brought to different results in terms of engagement.

6.1. Summary of results

Both approaches led to the same user base in proportion to the city population. However, if in Trento we see a growing number of active installations,

in Rovereto we recognize a peak followed by a decrease. This suggests that the urban computing approach, nurturing the relation between designers and people, has proven more effective in sustaining recurrent use. We also wish to highlight how a constant engagement allowed us to go beyond the bootstrapping phase of the ViaggiaTrento adoption and to observe a more mature, consolidated situation with respect to what reported by Zimmerman et al. (2011), Camacho et al. (2012) or Chahine and Tomitsch (2013), who instead discuss situations that have a smaller scale and show some limitations (e.g. project participants were paid in Zimmerman et al. (2011)).

The difference between ViaggiaTrento and ViaggiaRovereto emerges also in relation to the production of new information (i.e. digital commons). In fact, in Trento more than in Rovereto, delay notifications entails a social practice of collaboration which results in the provision of information that is not even available to the local transport company itself. Such information can establish a new set of relations both among people, who contribute to the well-being of the overall population of bus users, and between people and the city itself, as stressed by scholarly literature: for example, Casey (2003) found that the availability of real-time data significantly increases the use of public transport, while Zimmerman et al. (2011) states that it can foster bootstrapping of urban computing mobility projects by supplementing a static dataset. Although there can be issues of reliability and trust in the quality of provided information (Chahine and Tomitsch, 2013; Zimmerman et al., 2011), in our case the relevance in both places of external events, like the cited strike and snow storm, seems to indicate that the data provided by users are of good quality.

In addition, the participation of users in the discussions going on in the forum, with a significant disproportion between Trento and Rovereto, points to the fact that the engagement strategy adopted in Trento has been more fruitful in sustaining participation in the shaping of the application itself. Moreover, it shows that there is indeed a group of people who are willing to engage in activities that can turn them into a public, since the existence of a group deeply concerned with the issue at stake is the precondition for any kind of design that aims to sustain the formation of a public. These are the three main results in relation to the literature on urban computing we presented before, and they suggest that a urban computing approach helps to achieve better results in terms of sustained user engagement than a Smart City one, which however is faster and less expensive.

6.2. On Public Design of Digital Commons

If we do an interdisciplinary exercise, and we try to read these results through the framework of public design of digital commons, we can see a larger picture, that helps us to elaborate general design suggestions. We begin this interdisciplinary exercise with the concept of the common, intended as the ensemble of the material and symbolic resources that allow human beings to be together (Hardt and Negri, 2009). We have already pointed out how the provision of real-time information contributes to promoting the use of public transport (Zito et al., 2011; Casey, 2003). This nourishes the common as it helps intervening on the environment, the ensemble of our shared material resources.

Furthermore, the delay notification functionality is also interesting in terms of the institutional arrangements supporting the common, that are the commons. Delay notifications are constituted as information collaboratively produced and easily accessible, one of the two basic components of the commons (Hess and Ostrom, 2007): the shared resource here is the information spread through the application rather than the application itself. In a common-oriented perspective, technologies enable the construction of social relations and not only the isolated/individualized access to services.

Moreover, if we look at the conversation that unfolded through the forum, we can see how the application was part of a collaborative effort between the Lab and the users' population. Even though it did not go through a full participatory development process as it happened for other applications developed in the Smart Campus project (De Angeli et al., 2014), collaboration was going on in the design phase of ViaggiaTrento, with a trend that moved from comments on actual functionalities (e.g. bug reporting) to proposals of future functionalities. The forum acted therefore as one of the ways through which users could participate in shaping ViaggiaTrento according to their needs, expressing their matters of concern (DiSalvo et al., 2014). Summarising, in a common-oriented perspective, the technologies designed nourish the common through the construction of social relations, and technologies themselves become the objects of collaborative production, that are the digital commons. Participation is, therefore, the building block of public design.

When reading the process that supported such kind of complex engagement, we can recognize more elements of the theoretical framework we illustrated. In fact, the way requirements were collected made it possible to build up the Smart Campus applications intercepting students' concerns. As we noticed, the relevance of transport is grounded on the physical location

of many students' accommodations, one of the main characteristics of engagement with technology (Fritsch, 2009). In particular, the general need for more information on public transport was detailed by specific concerns on finding such information and required the engagement of the public transport company to provide accurate data and to participate in the notification of delays.

It has already been stressed how the trends of adoption and use of ViaggiaTrento and ViaggiaRovereto reflect the different engagement strategies in the two locations, participatory and continuous in Trento and top-down in Rovereto. We also described how the Lab has been, in the last period of our observation, less interested in sustaining a dialogue in the forum. Despite this, we are not witnessing a significant decrease in the number of installations or of delay notifications: we can thus infer that users' engagement does not rely mainly on the attention of the Lab, but rather on an established social practice, something the users engage in due to its specific capability to support their everyday life. This enriches the picture: public design of digital commons should include an initial phase of deep commitment by the designers, to promote the emergence of sustained engagement of users and of collaborative social practices. Once collaboration is established, the designer commitment can start to decrease.

To summarise, this discussion has focused on how a common oriented perspective was promoted and established constructing the conditions for specific social practices to emerge. Moreover, we have two different forms of digital commons: the shared amount of information on delays and the application as the focus of conversations and discussions. The engagement in such practices has been sustained by intercepting and supporting users' everyday concerns, which are not only confined to the students' population, but rather span to the population of bus passengers as witnessed by our data on usage trends and phone carriers.

That helps us claim that public design of digital commons should focus on technologies that nourish the common and the social relations able to make the technology itself an object of collaborative production; this can be achieved through participation and by addressing people's concerns in design, with a deep initial commitment of the designer, in order to promote the emergence of public engagement and collaboration that can sustain a digital commons despite a declining commitment of the designers. When applied to urban technologies, as in our case, such approach contrasts top-down narratives like the one on the Smart City, aligning the results of our

work with an intention shared by many observers (Townsend, 2013; Hollands, 2008).

We are aware that questions remain about the ability of the approach to scale to contexts wider than the locality of a specific city, as any city has its own peculiarities in terms of serendipitous encounters and forms of sociality. Nevertheless, in our approach the co-construction of the city by designers, technologies, and people, as discussed by Forlano (2013), is oriented not only to the public dimension but acquires also a potential for nourishing the common. This task is not only intellectually worth but socially important.

7. Conclusions

At the beginning of this article, we framed our contribution as part of a shift in the design of digital technologies that is more and more oriented toward the public dimension of social life. The urban context, in particular the focus on urban places, has helped us to introduce the framework of public design of digital commons. In this framework, design begins with what concerns people to stimulate forms of recursive engagement able to make people more and more engaged with the technology designed until they take over design and development of the technology itself.

To discuss our framework, we referred to the Smart Campus project, intended to favour collaborative and participatory practices of design and development of urban digital technologies. Moreover, our comparison of a urban computing and a Smart City engagement strategy paved the way for a discussion that helped us suggest key points for the public design of digital commons. In particular, we highlighted two aspects: first, public design of digital commons should target technologies that allow the emergence of social relations able to make the technology itself an object of collaborative practices, thus nourishing the common. Such goal can be achieved addressing directly people's matters of concern through an initially sustained engagement on the designer side.

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9. References

Bannon, L., 1991. From human factors to human actors: The role of psychology and human-computer interaction studies in system design. Design at work: Cooperative design of computer systems, 25–44.

Bassoli, A., Brewer, J., Martin, K., Dourish, P., Mainwaring, S., Jul. 2007. Underground aesthetics: Rethinking urban computing. IEEE Pervasive Computing 6 (3), 39–45.

Benkler, Y., 2006. The Wealth of Networks: How Social Production Transforms Markets and Freedom. Yale University Press.

Björgvinsson, E., Ehn, P., Hillgren, P.-A., 2010. Participatory design and "democratizing innovation". In: Proceedings of the 11th Biennial Participatory Design Conference. PDC '10. ACM, New York, NY, USA, pp. 41–50.

Bødker, S., 2006. When second wave HCI meets third wave challenges. In: Proceedings of the 4th Nordic Conference on Human-computer Interaction: Changing Roles. NordiCHI '06. ACM, New York, NY, USA, pp. 1–8.

Bollier, D., 2007. The growth of the commons paradigm. In: Hess, C., Ostrom, E. (Eds.), Understanding knowledge as a commons: From theory to practice. MIT Press, Cambridge, MA, pp. 27–40.

Bollier, D., 2008. Viral Spiral: How the Commoners Built a Digital Republic of Their Own. New Press, New York, NY.

Bollier, D., Helfrich, S., May 2014. The Wealth of the Commons: A World Beyond Market and State. Levellers Press.

Bordin, S., Menendez, M., Angeli, A. D., 10 2014. Viaggiatrento: an application for collaborative sustainable mobility. EAI Endorsed Transactions on Ambient Systems 14 (4).

Bowerman, B., Braverman, J., Taylor, J., Todosow, H., Von Wimmersperg, U., 2000. The vision of a smart city. In: 2nd International Life Extension Technology Workshop, Paris.

Brynskov, M., Dalsgaard, P., Ebsen, T., Fritsch, J., Halskov, K., Nielsen, R., 2009. Staging urban interactions with media façades. In: Human-Computer Interaction–INTERACT 2009. Springer, pp. 154–167.

Camacho, T., Foth, M., Rakotonirainy, A., 2012. Pervasive technology and public transport: Opportunities beyond telematics. IEEE Pervasive Computing 12 (1), 18–25.

Card, S. K., Newell, A., Moran, T. P., 1983. The Psychology of Human-Computer Interaction. L. Erlbaum Associates Inc., Hillsdale, NJ, USA.

Casey, C., 2003. Real-time information: Now arriving. Metro 99 (3).

Chahine, T., Tomitsch, M., 2013. What the bus and why should i bother: Designing for user participation in a public transport information system.

Chamberlain, A., Crabtree, A., Rodden, T., Jones, M., Rogers, Y., 2012. Research in the wild: understanding "in the wild" approaches to design and development. In: Proceedings of the Designing Interactive Systems Conference. ACM, pp. 795–796.

Coleman, E. G., 2013. Coding Freedom: The Ethics and Aesthetics of Hacking. Princeton University Press.

Dalsgaard, P., Halskov, K., 2010. Designing urban media façades: cases and challenges. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, pp. 2277–2286.

Dalsgaard, P., Hansen, L. K., 2008. Performing perception – staging aesthetics of interaction. ACM Transactions on Computer-Human Interaction (TOCHI) 15 (3), 13.

De Angeli, A., Bordin, S., Blanco, M. M., 2014. Infrastructuring participatory development in information technology. In: Proceedings of the 13th Participatory Design Conference: Research Papers-Volume 1. ACM, pp. 11–20.

De Angeli, A., Lynch, P., Johnson, G. I., 2002. Pleasure versus efficiency in user interfaces: Towards an involvement framework. Pleasure with products: Beyond usability, 94.

Dewey, J., 1927. The role of philosophy in the history of civilization. The Philosophical Review, 1–9.

DiSalvo, C., Lukens, J., Lodato, T., Jenkins, T., Kim, T., 2014. Making public things: how hci design can express matters of concern. In: Proceedings of the 32nd annual ACM conference on Human factors in computing systems. ACM, pp. 2397–2406.

Dittrich, Y., Eriksén, S., Hansson, C., 2002. Pd in the wild; evolving practices of design in use. In: PDC 2002 Proceedings of the Participatory Design Conference, Malmö, Sweden. pp. 124–134.

Dourish, P., 2004. Where the Action is: The Foundations of Embodied Interaction. MIT Press, Cambridge, MA.

Dourish, P., 2006. Re-space-ing place: "place" and "space" ten years on. In: Proceedings of the 2006 20th Anniversary Conference on Computer Supported Cooperative Work. CSCW '06. ACM, New York, NY, USA, pp. 299–308.

Dourish, P., Anderson, K., Nafus, D., 2007. Cultural mobilities: Diversity and agency in urban computing. In: Human-Computer Interaction–INTERACT 2007. Springer, pp. 100–113.

Forlano, L., 2013. Making waves: Urban technology and the co–production of place. First Monday 18 (11).

Foth, M., Choi, J. H.-j., Satchell, C., 2011a. Urban informatics. In: Proceedings of the ACM 2011 conference on Computer supported cooperative work. ACM, pp. 1–8.

Foth, M., Forlano, L., Satchell, C., Gibbs, M. (Eds.), 2011b. From Social Butterfly to Engaged Citizen: Urban Informatics, Social Media, Ubiquitous Computing, and Mobile Technology to Support Citizen Engagement. MIT Press, Cambridge, MA.

Fritsch, J., 2009. Understanding affective engagement as a resource in interaction design. Nordes (3).

Greenfield, A., 2013. Against the Smart City. Do Projects, New York, NY.

Haraway, D., 1988. Situated knowledges: The science question in feminism and the privilege of partial perspective. Feminist studies, 575–599.

Hardt, M., Negri, A., Jul. 2005. Multitude: War and Democracy in the Age of Empire. Penguin.

Hardt, M., Negri, A., 2009. Commonwealth. Harvard University Press.

Harrison, S., Dourish, P., 1996. Re-place-ing space: the roles of place and space in collaborative systems. In: Proceedings of the 1996 ACM conference on Computer supported cooperative work. ACM, pp. 67–76.

Hassenzahl, M., Tractinsky, N., 2006. User experience-a research agenda. Behaviour & Information Technology 25 (2), 91–97.

Hassenzahl, M., 2014. User Experience and Experience Design. In Soegaard, Mads and Dam, Rikke Friis (eds.). The Encyclopedia of Human-Computer Interaction, 2nd Ed. Aarhus, Denmark: The Interaction Design Foundation.

Hess, C., Ostrom, E. (Eds.), 2007. Understanding Knowledge as a Commons: From Theory to Practice, 1st Edition. The MIT Press, Cambridge, Mass.

Hollands, R. G., 2008. Will the real smart city please stand up? intelligent, progressive or entrepreneurial? City 12 (3), 303–320.

Kelty, C. M., Jun. 2008. Two Bits: The Cultural Significance of Free Software. Duke University Press.

Latour, B., Sep. 2005. Reassembling the Social - An Introduction to Actor-Network-Theory. Oxford University Press, Oxford.

Le Dantec, C. A., DiSalvo, C., 2013. Infrastructuring and the formation of publics in participatory design. Social Studies of Science 43 (2), 241–264.

Marres, N., 2007. The issues deserve more credit pragmatist contributions to the study of public involvement in controversy. Social Studies of Science 37 (5), 759–780.

Marttila, S., Botero, A., Saad-Sulonen, J., 2014. Towards commons design in participatory design. In: Proceedings of the 13th Participatory Design

Conference: Short Papers, Industry Cases, Workshop Descriptions, Doctoral Consortium papers, and Keynote abstracts-Volume 2. ACM, pp. 9–12.

Memarovic, N., Langheinrich, M., Alt, F., 2012. The interacting places framework: conceptualizing public display applications that promote community interaction and place awareness. In: Proceedings of the 2012 International Symposium on Pervasive Displays. ACM, p. 7.

Nielsen, J., 1994. Usability inspection methods. In: Conference companion on Human factors in computing systems. ACM, pp. 413–414.

Oldenburg, R., Brissett, D., 1982. The third place. Qualitative Sociology 5 (4), 265–284.

Ostrom, E., Nov. 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge, UK.

Paulos, E., Jenkins, T., 2005. Urban probes: encountering our emerging urban atmospheres. In: Proceedings of the SIGCHI conference on Human factors in computing systems. ACM, pp. 341–350.

Rogers, Y., 2006. Moving on from weiser's vision of calm computing: Engaging ubicomp experiences. In: UbiComp 2006: Ubiquitous Computing. Springer, pp. 404–421.

Rogers, Y., 2011. Interaction design gone wild: striving for wild theory. Interactions 18 (4), 58–62.

Schmidt, K., Bannon, L., 1992. Taking cscw seriously. Computer Supported Cooperative Work (CSCW) 1 (1-2), 7–40.

Sengers, P., Gaver, B., 2006. Staying open to interpretation: engaging multiple meanings in design and evaluation. In: Proceedings of the 6th conference on Designing Interactive systems. ACM, pp. 99–108.

Shneiderman, B., 1980. Software psychology: human factors in computer and information systems. Little, Brown.

Smith, C. P. (Ed.), 1992. Motivation and Personality: Handbook of Thematic Content Analysis. Cambridge University Press, Cambridge, UK.

Suchman, L., 2002. Located accountabilities in technology production. Scandinavian journal of information systems 14 (2), 7.

Tkacz, N., Dec. 2014. Wikipedia and the Politics of Openness. University of Chicago Press, Chicago, IL.

Townsend, A. M., Oct. 2013. Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia. W. W. Norton & Company.

Wiener, N., 1954. The Human Use of Human Beings: Cybernetics and Society. Hougthon Mifflin, Boston, MA.

Williams, A., Dourish, P., 2006. Imagining the city: The cultural dimensions of urban computing. Computer 39 (9), 38–43.

Zimmerman, J., Tomasic, A., Garrod, C., Yoo, D., Hiruncharoenvate, C., Aziz, R., Thiruvengadam, N. R., Huang, Y., Steinfeld, A., 2011. Field trial of Tiramisu: crowd-sourcing bus arrival times to spur co-design. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, pp. 1677–1686.

Zito, P., Amato, G., Amoroso, S., Berrittella, M., 2011. The effect of advanced traveller information systems on public transport demand and its uncertainty. Transportmetrica 7 (1), 31–43.