Tackling Challenges in the Engagement of Citizens with Smart City Initiatives

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ABSTRACT
Smart City (SC) initiatives offer best possible outcomes to citizens and other stakeholders when those people are involved centrally in all stages of the project. However, undertaking design processes that facilitate citizen engagement often involves prohibitive challenges in cost, design and deployment mechanisms, particularly for small cities that have limited resources. We report on a project carried out in Cork City, a small city in Ireland, where a method inspired by *crowdsourcing* was used to involve local participants in decisions regarding smart city infrastructure. Academics, local government, volunteers and civil organisations came together to collaboratively design and carry out a study to represent local interests around the deployment of smart city infrastructure. Our project demonstrates a new way of translating crowdsourcing for use in government problem-solving. It was comparatively inexpensive, creative in design, and flexible but collaborative in deployment, resulting in high volume of reliable data for project prioritisation and implementation.

Author Keywords
Smart cities; engagement; participation; crowdsourcing

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
The Smart City (SC) is a new urban management practice using information and communication technologies to boost cities' competitiveness, promote sustainable development, and enhance the quality of life of citizens/residents. Such initiatives frequently involve the building of infrastructures and procedures for sharing and integration of data between public service departments, and between public and private sectors, in order to improve the quality and resolution of decision making about city services and development.

While there are many elements underpinning successful implementation of SC initiatives and/or programmes, resident engagement and participation appear to be critical success factors for those programmes [13]. Resident engagement refers to the process of informing residents, getting them excited, and their subsequent participation in decisions from early stage of design to implementation and expansion [6]. However, each of these activities involve costs in both time and money, and are frequently beyond the means of small cities. Indeed, large cities frequently hire consulting companies to carry out this work, or assign a full time in-house team. In order for small cities to engender the same levels of participation, more creative methods must be developed.

In this paper we describe a project in which academics, local government, volunteers and civil organisations came together to collaboratively design and carry out a study to represent local interests around the deployment of smart city infrastructure. We first provide a brief introduction to smart cities, and current scholarship on the importance of community participation and engagement with such projects. We present crowdsourcing as a method that can provide inspiration for the design of low cost smart city data gathering projects. We report on the process of carrying out and managing a crowdsourcing-inspired smart city project in Cork City, a small city in Ireland and present some initial results regarding the implementation of this project.

BACKGROUND
Early Smart City projects have aimed to address urban challenges including traffic congestion; energy services; housing allocation and development; food supply; noise and air pollution; water supply; waste water treatment and social disparities [4]. Typically, these projects involve the use of IT services to share and integrate data coming from different sources relevant to the city, in order to improve the quality of decision making. Often, data visualisation is a key part of this process. Increasingly, citizen consultation and participation is also seen as a necessary part of this process.

Citizen Participation and Engagement

The European Union (EU) emphasises the importance of citizen engagement in SC projects, to empower EU citizens at the local level, to improve success rates and foster citizen ownership of programmes [15] and to improve quality of life for citizens. It is considered that residents' engagement will more readily invite residents within the project boundaries to become strong advocates for the project.

More generally, there has also been a growing recognition in recent years of the importance of collaboration and dialogue between design teams and stakeholders at all stages (design, development, testing, implementation, evaluation) of projects that have the potential to affect those stakeholders [20]. This is the case with SC projects, but also in any context where IT is introduced in order to improve services, from work design [7] to mental health services [9]. The practice of designing products and services in close collaboration with potential users is referred to as Participatory Design.

Research is also increasing in an area called "digital civics", which aims to understand how technology can be used to promote and improve community participation, political engagement and democracy [14]. For example, projects have examined how data can be gathered [18] and displayed [11] on a hyper-local scale to improve participation in local decision making. Research in this area often follows participatory design principles, where the community is encouraged to not only engage in dialogue with designers, but to drive decisions about how technology is designed and implemented [21].

In contrast with the participatory community focused design studies mentioned above, it is often the case that existing SC initiatives focus on technology testing rather than directly addressing practical and immediate problems with the information infrastructure of a city. While these studies aim to prove that certain technologies could work in real world and scaled-up settings, such an approach rarely takes advantage at the outset of the potential contribution of resident engagement in ensuring the success of initiatives when real-time adoption of the solutions is proposed [8].

In its pursuit of SC initiatives, Cork City faced a challenge in how to effectively engage with its residents and involve them in consultation, feedback, decision-making, and implementation processes. The decision was made to pursue a strategy, inspired by crowdsourcing, in order to best make use of local expertise, collaborating with academics, industry and social organisations to resolve the challenges.

Crowdsourcing

Crowdsourcing refers to a method of gathering and/or analysing data that is led by non-experts. It is used in situations where the amount of data that must be dealt with is so large that it is not feasible or economical to employ experts, but which the task also cannot feasibly be automated. It has been used successfully in many different areas, for example, gathering of data on habitats of insects and animals [16], classifying high fidelity photos of deep space [19], and DNA analysis [10].

Researchers that have successfully used crowdsourcing to gather useful and valid data emphasise the importance of designing and managing the process through which data is gathered. People will engage willingly and usefully in crowdsourcing if the task assigned to them is simple and clear, and they can see how their work is contributing to science [19].

METHOD

Participation through Crowdsourcing

In the Cork Smart City project, we needed high fidelity information, from a breadth of city residents, but had very little budget. We adopted a data collection method inspired by crowdsourcing, in which interested local academics, industry, volunteers and social organisations collaborated in the study design and data collection. The strategy followed formal guidance to define and design relevant indicators for resident engagement, sample data, and experiments [1].

The guidance included step-by-step tutorial to put the selected crowds to work for specific tasks.

The first step was defining overall aims of the project with actionable objectives. This also involved the defining and designing exercises of what to assess in citizens/residents engagement in this data collection stage. Apart from literature review in citizen participation and engagement, the project had the opportunities to incorporate inputs from relevant experts and practitioners. After series of discussions and critical reviews, the project was approved to measure initial three key aspects of public participation, digital skills, and public infrastructure access and usage. An additional aspect was the regular updated demographical data. The three aspects comprised of ten indicators, which were later on measured by 20 questions in a questionnaire.

The second step was designing the questionnaire and calculating samples. This was a crucial stage for the project to get the right expertise from its crowd. The Managing the crowd section below describes the expertise involved and what they would benefit from the project.

The third step was designing the survey deployment strategies. The project aimed at collecting a holistic picture of Cork's citizens/residents, including children, seniors, local authorities, and general public, therefore, multiple strategies were employed according to the project's crowd capabilities and authorities. For instance, city and county were responsible for the survey targeting local authorities via an online survey to be sent through their email systems. Clarification of this step is in the below section of Facts to Formation.

The fourth step was running the survey research. The deployment plans were in place including specific time

frames for each of the survey sets. Access channels to potential survey respondents and specific names of the tasks' champions from the crowd were provided to the involved people. This ensured transparency and authorities of the project, helping each participants to be sure about their parts in a complete picture of the project.

The fifth and final step was collecting data and analysing results. The data collection task in this project varied because of the different deployment strategies. The data from most representative sample of general public were collected using student volunteers. More on this can be found in the following section of Managing the crowd.

Quality control was employed throughout the second step to the final stage of analysing results. The quality control for the questionnaire design, for example, was reviewed with experts, through pilot testing (twice for the survey targeting the general public), and continuous inputs from early survey respondents.

Facts to Formation

Prior to the project's formation, it was necessary to understand who are we working with, what are the resources we can access, how are we going to make the project relevant to those who would involve, impact, and benefit from it. All of those facts would have affected to costs, design, and deployment mechanism of the project. The crowdsourcing action rules [1] provide guiding principles for the project formation with crucial considerations including picking the right crowdsourcing model, picking the right crowd, offering incentives, and identifying decision makers. The lead researcher analysed the rules and decided that the project should be a combination crowdsourcing model, which included a collective intelligent/crowd wisdom [17], a crowd creation, and a crowd funding model. The decision came natural because of the project's stakeholders, their demands, and commitments as described in the Managing the crowd section below. This was where the project got to be innovative in the way it picked the right crowd. The stakeholder exercise arose with specific actions including cultivating, stewarding, sustaining, and requiring interactive participation of the each and every stakeholders in the selected crowd. Other action rules were explained in more details in the Managing the crowd section.

First, the lead researcher looked at the establishment and initiators of the Cork Smart Gateway: The initiative was originated by four key institutions of City Council, County Council, NIMBUS (a technology centre) in Cork Institute of Technology, and Tyndall National Institute, a technology research hub in University College Cork (UCC). These are established organisations with authorities, international reputations, and local familiarity. Therefore, the project should utilise those formal channels in accessing its target audience (i.e. survey respondents), in sharing and sponsoring of responsibilities, whether it's financial or non-financial contributions.

Besides the upfront and ongoing commitments, the key initiators also have their wider expertise resource and networks that the project can tap in. These factors allowed the project to follow a combination crowdsourcing model, which includes collective intelligent (crowd wisdom), crowd creation, and crowdfunding. The project's framework was shaped with a projection of high success chance for reaching and engaging many people that resulted in good turn-out of survey respondents. The projection would work if the deployment methods were innovative and nimble. Since the project and its content were multi-disciplinary by design, it required lots of inputs from expertise and people familiar with subjects. A stakeholder mapping exercise came in to address the cross-cutting approach.

Managing the crowd

The crowd of the project was diverse. It involved local government, academics, citizens/residents, communities, industries, social organisation and many more (see Figure 1). They were identified and analysed to locate their shared responsibilities and interests in local context. Accordingly, the researcher engaged and sold the project to the stakeholders, offering benefits and seeking resources, access permission, and other help needed from each of the stakeholders. The stakeholders were pitched with outcomes and impacts that the project could contribute and/or compliment to their organisations or to individuals.

The stakeholder mapping was crucial prior to running the study and expertise was utilised from local academic pools and numerous practitioners. The mapping enabled the right expertise for the specific tasks, meanwhile locating expertise required homework to be done for identifying potential similar interests. The tactic worked for Cork because the presence of two universities that have dozens of relevant academics. The expertise contribution was on merit basis and mutual benefits including access and resources for future research.

The strategy also composed series of surveys to collect relevant city residents' data and produce a baseline and analysis for Cork. Survey and questionnaire designs received quality inputs from UCC experts. Another layer of crowdsourcing for survey deployment was applied: using student volunteers from UCC and Cork Institute of Technology to carry out door-to-door interviews. The involvement of the student volunteers incorporated key instructions, trainings with household interviewers from Central Statistics Office, academic credits, token incentives, and volunteering recognitions.

All of the employed tactics followed the crowdsourcing wisdoms and motivations including the opportunity to make money, the opportunity to develop skills (communication and interpersonal), the potential to leverage freelance work

for students [1]. The professionals also benefitted from new approaches, networks, and recognitions within and outside their own organisations for community contributions. Other Web-based survey sets were designed to harness the greater contribution of the public. The survey distribution itself also leveraged the Web medium, email lists, and newer applications including Twitter, Facebook, and LinkedIn.

Figure 1. The Stakeholders mapping was time a consuming and challenging exercise. It required economic, political, social, and cultural understandings of the city. Layers of policies (i.e. EU, regional, national, local) enabled identification of responsibilities' boundary and overlapping or mutual areas of stakeholders, thus involving them at different tasks of the deployment plan.

FINDINGS

The crowdsourcing approach was demonstrated as a useful strategy for interested local people engage constructively with local government around important infrastructure decisions. The process of local interested experts collaboratively crafting the strategy and implementation plans, by itself, showed a new way of addressing the cost, design, and deployment challenges for effective local engagement. For instance, the informed residents would become more engaged if a relevant tool, such as a local mobile application, is available. They were asked to contribute at the beginning of the SC initiatives, they would tend to keep track on progresses. This motivation would help local authorities to sustain the public involvement not only in SC programmes but also in other public issues.

In Cork City's crowdsourced studies, the solution produced the following results to the stakeholders:

- A sizable baseline data of more than 2% of the city's total population
- Lower costs: from 3 to 10 times cheaper than using a service provider for the door-to-door survey
- Large amount of residents and citizens become aware of the Cork Smart Gateway (20K on Twitter; 14K on LinkedIn, 2K+ face-to-face; 35K+ students and universities' staff)
- Series of data-driven analysis for project prioritisation and planning
- Almost 200 trained students for household survey interviewers
- New networks of authorities, academics, practitioners, and industries for research and business collaborations

Respondents	No
Seniors	400
General Public (non-representative sample)	1000
General Public (representative sample)	950
Youth	767
Officials	352

Table 1: Five sets of surveys (25 to 30-questions) collected a holistic view of all Cork residents. The surveys were the first systematic and widespread assessment for Cork in any local development initiatives. Crowdsourcing worked for all Web-based and face-to-face surveys. What works and what do not work within each of the mediums was great learning experience.

With the inputs from 3000+ respondents in the survey sets, Cork SC initiatives can now plan for the projects that would attract business and residents' participation in their roles as service providers, users, and/or co-managers [8], [13]. This would enable the ideal form co-creation and co-delivery of SC solutions for risk sharing and co-benefitting which the SC initiatives could offer [3]. While the benefits for Cork and its stakeholders are obvious, the crowdsourcing method generated lessons learned for other cities of similar size, SC oriented, and resource-constrained like Cork. The crowdsourced strategy was at least three times cheaper than the traditional way of contracting the job to service providers. The method was also fast turnaround, high quality, and flexibility [2]. Since it's a crowdsourced strategy, key stakeholders shared financial resources at much smaller portions [12]. This enabled the strategy to move faster than other projects that hit finance thresholds. The strategy identified relevant expertise to utilise at every stage of design, planning and implementation, thus quality

of each tasks received multiple professional and experienced eyes.

The employed crowdsourcing had really high flexibility in its deployment such as the recruitment of door-to-door interviewers, incentives, participation of many social and community groups [5]. This has worked particularly well in the data collection stage for the SC initiatives. It enabled local residents to learn about what's involve locally in a near future and to choose how they are going to be a part of it. This large, ambitious and successful project has raised many interesting issues that deserve further discussion at the workshop:

- Through its focus on crowdsourcing, this project demonstrates constructive, collaborative and citizen-led methods for participating in decisions around local infrastructure. This stands in contrast with the approach of many cities, which merely attempt to make decisions more acceptable to citizens.
- It gave the cities options to cope with their current challenges of cost, design and deployment mechanism for this important mission.
- Leading the crowdsourcing solution, the researcher would be able to share key findings of the surveys, their implications and usages by stakeholders. Lessons about what work and what does not work can be discussed in the stages from designing, planning, and implementing.
- The research method was employed in the SC-motivated small city, however, questions remain for the method to be used in other government problem-solving.

The crowdsourcing method proved the real values of the collective intelligence and crowd wisdom of experts and general public. It also gave the crowd a chance to validate itself from emerging trend of SC, which facilitates the crowd contributions in many more ways that didn't exist in the past.

While resident engagement and participation appeared to be critical success factors for the SC programmes, crowdsourcing can add as another solution for cities to consider responding to the fundamental question of how to effectively engage with residents and involve them in consultation, feedback, decision-making, and implementation processes.

ACKNOWLEDGMENTS

We thank all the volunteers who participated in the project.

We appreciated all the financial and non-financial supports from Cork Smart Gateway for the completion of the project.

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