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Civic Technology for Social Innovation

A Systematic Literature Review

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Abstract. The recent surge of investment in Civic Technologies represents a unique opportunity to realize the potential of Information and Communication Technologies (ICTs) for improving democratic participation. In this review, we study what technologies are proposed and evaluated in the academic literature for such goal. We focus our exploration on how civic technology is used in the collaborative creation of solutions for social issues and innovations for public services (i.e., social innovation). Our goal is to provide researchers, designers, and practitioners a starting point to understand both the academic state of the art and the existing opportunities for ICT in a democracy.

Keywords: Civic technology, Participatory democracy, Public service innovation, Social innovation

1. Introduction

Information and communication technologies (ICT) for governance and democracy is an emerging trend, with a growing focus on facilitating citizens' influence on government decisions (Desouza and Akshay Bhagwatwar 2014; Peixoto 2009), policies (Aitamurto 2012; Farina et al. 2013), and laws (Aitamurto et al. 2016a). Although not new —terms like e-government have been around since the mid 1990s (Ronaghan 2002)—, up until recently the primary focus of these technologies was on optimizing the functioning of public sector organizations and improving the delivery of government services. This new trend of "Civic Technology" focuses on participation and has attracted more than $400 million of investment between 2011 and 2013 (Patel et al. 2013)[1]. Recent CSCW research have also started to pay attention to this field using terms like "digital civics" (Vlachokyriakos et al. 2016; Olivier and Peter Wright 2015) or "crowd-civic systems" (McInnis et al. 2017), exploring its design, implementation and usage in community engagement and policy-making (Mosconi et al. 2017; Johnson et al. 2016; Hou 2016).

Academic and non-academic literature has referred to "Civic Technology" from both government-centric and citizen-centric perspectives. A government-centric

[1] For more, see http://www.slideshare.net/knightfoundation/knight-civictech

definition presents it as the "use of technology by cities for service provision, civic engagement, and data analysis to inform decision making" (Living Cities 2012).

A citizen-centric definition presents it as "platforms and applications that enable citizens to connect and collaborate with each other and with government" (Suri 2013).[2]

What is common to both perspectives is the objective of civic technology: enabling participation in democratic governance (i.e., the many activities citizens undertake to negotiate living together in society). We therefore define *"Civic Technology"* as *technology (mainly information technology) that facilitates democratic governance among citizens*.

Democratic participation and citizenship have taken many forms throughout history. For the ancient Athenians, democratic citizenship meant direct participation of all the citizenry in all major issues through public debates (Held 2006): a radical but not fully inclusive democracy as the political franchise was limited to adult males. In our modern *representative* democracies, inclusion is universal but participation is limited to the casting of a ballot every number of years. Both ancient direct and modern representative forms of democracy share the need for an active participation of citizens "able to take part in the decision-making processes of the state" (Knowles 2001). In our modern democracies, this active participation is in deficit: there is less engagement, trust, and empowerment for the people (Lerner 2014). The response to this deficit might come from a revival of participatory democracy (Pateman 2012), a model that extends participation beyond voting and which, according to recent empirical evidence, is welcomed and enjoyed by citizens under certain circumstances (Pateman 2012; Goodin and John S Dryzek 2006). Motivated by the potential of ICTs for enabling new and innovative processes of participatory democracy, we study what technologies are proposed and evaluated in academic literature to further its ideals.

Facilitating more participation in democracy is a broad topic. A wide range of activities and processes count as participation (Rowe and Lynn J Frewer 2005). We focus our exploration on *how civic technology can be useful in facilitating processes of collaborative creation of solutions for social issues, or innovations for public services*, or in more simple terms, *facilitating social innovation*.[3]

Our goal with this review is to provide researchers, designers, and practitioners, a starting point to understand the state of the art in academic literature, and the existing opportunities to design and evaluate ICT that can help to improve our democracies. In concrete, we contribute to CSCW scholarship by systematically

[2] For a discussion on the term, see https://medium.com/@emilydshaw/debugging-democracy-bfa68e37967b

[3] Defining social innovation: https://www.gsb.stanford.edu/faculty-research/centers-initiatives/csi/defining-social-innovation

identifying relevant research that, along with an analysis framework we introduce in this review, and coupled with our in-depth discussion of the insights that arise from the selected articles, provide a conceptual framework for computing research that is based on previous fieldwork and evaluations. The scope of our review is limited to the following research questions:

- RQ1. What technologies are proposed to support civic engagement in the processes of collective construction of solutions for public-interest issues?;
- RQ2. For technologies identified in RQ1, what level of engagement do they support? (e.g., do they enable citizens to make decisions?, do they allow citizens to get involved throughout the process?, or are they primarily intended to listen to citizens' feedback but not necessarily acting on them?);
- RQ3. What are the benefits of applying the technologies identified in RQ1? (e.g., increased participation, enhanced community engagement, increased awareness, etc.)

As part of RQ1, we placed a particular emphasis in investigating:

- RQ1.a. Intended target users (e.g., young adults, senior adults, general population, activists groups, city residents, etc.);
- RQ1.b. Location and scale of use (e.g., cities, countries, local districts or communities, regions, national states, etc.)

In what follows, we start by describing the methodology we used to construct this review, followed by the results and implications that arise from it.

2. Method

Our systematic literature review consisted of the following steps: (1) we started by formulating our research questions about *Civic Technology* for facilitating social innovation; (2) based on these questions, we established a search protocol that defined where (online repositories) and how (search strings) to find relevant academic literature; (3) we also defined inclusion and exclusion criteria to limit the scope of our review; (4) conducted the search and obtained the resulting academic abstracts; (5) and coded and evaluated these abstracts based on the exclusion and inclusion criteria, producing a pre-selection of research articles to read in full; (6) we applied the same set of criteria to the pre-selection, after reading them at length, to produce the final list of selected articles; (7) we complemented our selection, following a Delphi-like approach, by including recommendations from experts in the domain with the objective of including also emergent work that experts would view as potentially influential; (8) and finalized our process by coding and analyzing the final selection in terms of the dimensions we presented in the background. What follows explains this method in detail.

2.1. Search protocol and terms

Since our focus is on *proposed and evaluated* ICTs, the first criterion was to select sources that contain computer science research articles. The second criterion was to select sources that have a high coverage of this field by indexing a large number of journals and conference proceedings. Following these criteria, we selected nine repositories of computer science research articles, which are listed in Table 1, in alphabetical order.

After selecting our sources, we defined a list of terms to search based on our research questions. The logical operator OR was used in the search string to include related terms, for instance, civic and citizens; engagement and participation; collaboration and discussion. We further employed the logical operator AND to join together different sets of related terms. The resulting search string that contains all the search terms and logic operators is the following:

(civi* OR citizen*) AND (engagement OR *participation) AND (technology OR internet OR online OR application OR crowdsourc* OR platform OR web) AND (*deliberati* OR collaboration OR consult* OR discuss* OR ideation OR *making OR planning OR budget* OR "public service innovation")

In some repositories, the search functionality supported the use of wildcards like "*" to represent zero or more alphanumeric characters at the beginning or end of a term. We used this functionality when available to include multiple variations of the same term, for instance, "*" at the end of "citizen" includes citizen, citizens, citizenship, and citizenry. In all sources but one, we searched the terms within the abstracts of articles. SpringerLink, however, does not support searching within abstracts, and therefore, we used full text search in this source.

Our search was limited to articles written in English and represented recent research. We defined recent as published since 2009 as some important events about technology and democracy happened that year: Iceland conducted the first constitution reform process to include online citizen participation (Landemore

Table 1. Electronic literature sources in alphabetical order.

Source	URL
ACM Digital Library	http://dl.acm.org/advsearch.cfm
Elsevier ScienceDirect	http://www.sciencedirect.com
Emerald	http://www.emeraldinsight.com
IEEE Xplore	http://ieeexplore.ieee.org
ISI Web of Knowledge	http://www.isiknowledge.com
SAGE	http://online.sagepub.com
SpringerLink	http://link.springer.com/advanced-search
Taylor and Francis	http://www.tandfonline.com
Wiley InterScience	http://www3.interscience.wiley.com

2015) and the US government published the Open Government Declaration[4], which is referenced by Lathrop and Laurel Ruma (2010) as the event that allowed civic technologies to get momentum.

2.2. Inclusion and exclusion criteria

Two other criteria were taken into consideration: (1) we only included articles that proposed tailor-made ICT solution (e.g., websites, mobile apps, APIs, combination of platforms, etc.) or the novel use of existing platforms (e.g., social networking sites) to engage the public in processes of social innovation, and (2) we only included articles that validated their proposals through use of cases, field studies, controlled experiments, or other research evaluation methods.

Observational studies about the impact of technology in various democratic practices, or discussions on the ethical aspects of employing technology to engage citizens, were excluded from the review as their analysis, although often rich and thorough, is beyond the scope of our research questions.

2.3. First stage selection process

Our search resulted in 1,246 unique articles[5], which we evaluated and selected through the following selection process:

1. We distributed the articles among the first four authors of this paper (from here on reviewers), resulting in approximately 300 articles per reviewer;
2. Each reviewer read the abstracts of each article, and then applied both inclusion and exclusion criteria. This led to 58 being marked as "relevant"[6];
3. To ensure the quality of our selection process, we cross-validated the result of the previous step. Each reviewer (appraiser) was asked to repeat step 2 on 30 randomly selected articles from the set assigned to another reviewer (appraisee). After cross-validation, an agreement of 98% was found between reviewers. In case of disagreement, appraiser and appraisee met and reached consensus about the final classification;
4. We redistributed the 58 relevant articles among the reviewers, who were asked to read the full text of the papers to confirm the decision taken in step 2. After reading the articles, 29 of them were excluded for not satisfying the selection criteria, particularly, the validation requirement.

The first stage of the selection process resulted in 29 papers (2.3%) being selected for inclusion and analysis from the initial 1,246 papers that resulted from

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[4] Transparency and Open Government declaration: https://obamawhitehouse.archives.gov/the-press-office/transparency-and-open-government

[5] The full data set of articles can be accessed at https://goo.gl/gJ1nnb

[6] The full list of pre-selected articles, along with the justification of exclusion, is available at https://goo.gl/gJ1nnb

our search. The result of the previous four steps were later complemented by a second stage selection, in which we invited experts to suggest potentially relevant research that was not identified by our initial process. The same selection criteria and process was applied to the suggestions we collected in this second stage, which is described in the following section.

2.4. Second stage selection process: recommendations

Using a Delphi-like approach (Delbecq et al. 1975), we further enriched our dataset with literature that was recommended by domain experts. This second-stage selection followed three steps:

1. We contacted researchers of our network, who have previously conducted and published research about civic technologies, introducing our research questions, objectives, and criteria, along with our request for recommendations that could fit the goals of this literature review.
2. We shared the first version of our manuscript with each researcher, inviting them to use this version as an input to better understand the scope of this review.
3. Upon reception of the recommendations, we applied the same selection criteria and process described in Sections 2.2 and 2.3 to the list of recommendations.
4. After our analysis, we followed up with experts, sharing our selection results, including the corresponding exclusion justification in the case for excluded articles.

Three researchers were contacted, and two researchers replied to our request for recommendations, sharing (8) recommendations in total. After reading each new abstract to validate their relevancy (Section 2.3), six (6) articles were selected and read in full for analysis, three (3) recommended by Expert 1, and three (3) by Expert 2. The two articles we excluded did not comply with our second criterion (i.e., evaluating the proposed technology in a participatory process). Both experts agreed with our selection after we shared our selection results with them.

Using this approached, we have expanded our initial selection of 29 articles to include an additional six (6) recommended references, totaling 35 articles in this review. See Appendix A for the full list of references[7].

2.4.1. About the experts

Both experts that contributed to our article were postdoctoral researchers at the time of this review, one at Standford University and the other at the University of California, Berkeley. *Expert 1* has an extensive publication record on crowdsourcing for democracy and policy-making, with over 20 publications during

[7] An interactive web site to navigate through all 35 articles in our study is available at https://participa.org.py/civic-technologies

2016 and 2017, studying users' interaction with civic technologies, and analyzing the impact of people's behavior on society. *Expert 2* has worked extensively on telecommunications policy, with over 10 publications during 2015-2017, studying the dynamic interconnections between law, policy, and emerging technologies, particularly, the role of non-binding multi-stakeholder policy networks on stakeholder participation and influence in internet governance and information and communication technology (ICT) policymaking.

2.5. Data extraction

We use a matrix of 16 different characteristics to analyze our final dataset, including publication metadata (i.e., *title*, *authors*, *year of publication*, *publication source*, and *type*), and other important features that we identify as relevant to the answers of our research questions.

In relation to RQ1, we analyze what *democratic process* is facilitated by the platform that each article presents, particularly focused on processes that facilitate the co-creation of solutions for social problems. For classification purposes, we used (Aitamurto 2012) report, which explains that current civic technologies facilitate participatory *policy-making*, *urban planning*, *innovation of services*, and *budgeting*. In these processes, citizens participate to create and discover new knowledge, integrate different perspectives to the process, diffuse knowledge and information among citizens, and ensure that policies, plans, services, and public expenditure fit people's need (Van Herzele 2004). Alongside these four processes, our analysis of the literature added a fifth, which we named *community engagement*, as it benefits and empowers local communities by building structures of participatory democracy[8] beyond the established representative institutions (Andrews and David Turner 2006).

In addition to the process, we analyze who the *actors* in these processes are, and how *information flows* between them. The four archetypes of civic technologies introduced by Desouza and Akshay Bhagwatwar (2014) —(1) citizen-centric and citizen-sourced data, (2) citizen-centric and government open data, (3) government-centric and citizen-sourced data, and (4) government-centric and citizen-developed solution— are used to identify who interacts with who, and how information flows through technological means. Individuals and organizations, e.g., public institutions, companies, NGOs, represent different actors in the democratic process, and the information and knowledge flow can connect citizens with other citizens, or connect citizens with government. In citizen-centric archetypes, citizens lead the development of the technology and are the key actors while public agencies play a passive role. Civic technologies in archetype (1) heavily

[8] Participatory democracy is a democratic model that envisions the broad participation of citizens in "their self-governance" (Pateman 2012)

depend on information generated by citizens while technologies in the archetype (2) are built on official information released by public agencies. In government-centric archetypes, the opposite occurs: government invites citizens to provide information, ideas and suggestions (archetype 3) or to implement actual solutions (archetype 4).

Continuing with RQ1, we analyze what the technical contribution of the articles are, and what are the features of these contributions. Each article is classified according to the mode used to deploy the proposed technology. Three different *modes of deployment* were identified in the dataset: *personal desktop*, *personal mobile*, and *situated* or shared (as in public displays). We use the term *personal desktop* here to categorize systems that are used through a desktop software or from a web browser in a non-mobile device like a laptop. It is important to notice, however, that not all articles we have reviewed contained enough information to ensure that the participants of their evaluation did not use a browser in a mobile device to access a platform deployed through web technologies. So the divide between personal desktop and personal mobile, or situated, means really that the latter represent contributions that were designed with the mobile or situated setting as the primary intended mode of deployment.

Because the platform tells only one part of the story, we also annotate each article with what we understand is their *featured technology*, i.e., the salient or most important technology of the platform that is used to support the process, as per our analysis of the description that the article provides of its proposed technology. Some of these featured technologies include the use of interactive maps, social network services, and SMS. When there is no specific salient technology, we use categories like "interactive web or mobile app".

In addition to the more technical aspects, we also analyze what is *evaluation method* used to assess the impact of the introduced technology, e.g., real case study, controlled experiment, usability tests; the *location* (country) where the technology was tested; and the target audience or *population* of the technology.

To answer RQ2 we use the Spectrum of Public Participation developed by the (International Association of Public Participation (IAP2) 2014). Through its five *levels of citizen participation*, the Spectrum specifies the role of the public in the processes, and the degree of influence they have on the outcome. Nelimarkka et al. (2014) adapted the Spectrum to study how civic technologies enable the different levels of engagement proposed by the IAP2. In the lowest level of engagement, technology is used to *inform* citizens about participatory and decision-making processes, without directly involving them. In the next level, technologies are used to *consult* and obtain feedback from the citizenry on ideas or solutions to be implemented, but there is no commitment of incorporating these opinions into the final decision. The third level corresponds to technologies that actively *involve* citizens in proposing ideas and solutions, with a commitment for taking them into consideration. The next level of engagement entails *collaboration* among citizens, and between government and citizens. In this level, the ultimate decision still remains

with the government, however, there is a guarantee to include into the outcome ("to the maximum extent possible") the input of the citizenry. In the last level of the Spectrum, there are technologies used to *empower* citizens to make actual decisions in participatory processes.

While coding our dataset, we encountered an additional element related to the *strategy to motivate engagement*. Examples of strategies include motivating engagement through games or leveraging on the location of technology to lower the barriers of participation, e.g., public displays in a public square that is frequently visited by residents of a city.

Finally, to answer RQ3, we include in our matrix a dimension to keep a record of the *benefits* that were reported after testing the technology. Here, we wanted to understand how the application of the proposed technology has benefited the democratic process, e.g., increased participation, influenced decision, enhanced collaboration. See Table 2 for a summary of our analysis matrix.

We understand that this framework can help future research in civic technologies for social innovation processes, helping to systematize its analysis, and therefore constitutes an additional contribution of our review.

3. Results

Our final dataset contains 35 studies that propose ICT tools for engaging civil society in the creation of solutions for social problems regarding policy-making, urban planning, and public sector innovation. The studies we selected, along with a summary of their characteristics, are listed in Table 3, which summarizes the data we describe in this section, before discussing its implications.

3.1. Summary of selected studies

Based on the dataset of selected articles we see in Table 3, research on this topic vary in ripeness, quality of research, and approaches. The research area appears to be quite ripe considering the type of publications found in this review, and assuming that journal papers are often riper that conference articles. A majority of 65% (19 out 29) was published in journals and the remaining 10 in conferences. Figure 1a shows that the number of publications in the domain of civic technology has increased steadily over the recent years, with a fairly similar trend in the narrower domain of civic technologies for social innovation (i.e., the papers in our pre-selected and final data sets), as depicted in Figure 1b. In the final dataset, however, the evolution of publications alternated between peaks and valleys. A noticeable increment in publications can be seen between 2009 and 2010. Then, the number of studies dropped off until 2013 when it increased until reaching the highest peak in 2015. Considering the time in which we conducted this review, during the first months of 2016, it is reasonable to expect that publications from 2016 were not yet indexed by electronic sources, therefore producing a drop in

Table 2. Data extraction dimensions.

Dimension	Description	Research Question
Title	Title of the paper	RQ1
Authors	Paper authors	RQ1
Year of publication	Year when paper was published	RQ1
Publication source	Name of journal or conference where the paper was published	RQ1
Publication type	Is the article a journal paper or a conference paper?	RQ1
Democratic process	Process in which the technology was used (e.g., urban planning, policy making, public sector innovation)	RQ1
Level of participation	What level of engagement is supported by the technology? (i.e., inform, consult, involve, collaborate, empower)	RQ2
Actors and information flow	Who generates the data and what are the roles of citizens and government (i.e., citizen-centric and citizen-sourced data, citizen-centric and government open data, government-centric and citizen-sourced data, government-centric and citizen-developed solutions	RQ1
Technical contribution	Does the article propose a new technology or the novel use of current platforms?	RQ1
Mode of deployment	Technology used to deploy the proposed technology (e.g., personal desktop, personal mobile, situated)	RQ1
Featured Technology	Most important technology of the platform that is used to support the process	RQ1
Strategy for engagement	Strategy proposed for citizen engagement apart from advertising (e.g., games, situatedness of technology)	RQ2
Target population	Target audience of users of the proposed technology to (e.g., senior adults, youth, general population)	RQ1.a
Evaluation method	Method used for assessing the proposed technology (e.g., controlledexperiment, real case study)	RQ1
Reported benefits	Reported benefits after testing the technology (e.g., increase participation, awareness, adoption)	RQ3
Location	Country where the technology was tested	RQ1.b

Table 3. Selected studies, see Appendix A for bibliographic details.

Study	Democratic Process	Level of Part.	Actors and Information Flow	Mode of Deployment	Featured Technology	Strategy for Engagement	Evaluation (scale)	Reported Benefits
[S1]	Urban planning	Consult	CCGO	Situated (public screen)	Common web app features	None	Controlled experiment (city)	Enhanced collaboration
[S2]	Urban planning	Consult	GCCS	Personal desktop (desktop software)	GIS	None	Controlled experiment (city)	Increased participation
[S3]	Policy-making	Empower	GCCS	Personal desktop (web)	Common web app features	None	Real case study (region)	Influenced decisions
[S4]	Community engagement	Consult	CCCS	Personal desktop (web)	Common web app features	Use it within high-school classes	Real case study (community)	Increased participation
[S5]	Urban planning	Consult	CCCS	Situated (public screen)	Native mobile app	Technology situatedness	Field study (community)	Increased awareness and participation
[S6]	Policy-making	Consult	CCCS	Personal desktop (web)	Common web app features	None	Real case study (state)	Improved the quality of political discussion

Table 3. (continued)

Study	Democratic Process	Level of Part.	Actors and Information Flow	Mode of Deployment	Featured Technology	Strategy for Engagement	Evaluation (scale)	Reported Benefits
[S7]	Community engagement	Consult	CCCS	Personal mobile	Wiki, Maps	None	Field study (community)	Enhanced community engagement
[S8]	Participatory budgeting	Empower	GCCS	Personal mobile	SMS	Use of popular technology (cell phone)	Real case study (city)	Influenced decisions
[S9]*	Participatory budgeting	Empower	GCCS	Personal desktop (web)	Common web app features	Partnered a public institution	Real case study (community)	Do not report
[S10]	Urban planning	Inform	CCCS	Personal desktop (web)	Common web app features	Gaming	Real case study (city)	Increased participation
[S11]	Urban planning	Collaborate	CCCS	Personal desktop (web)	Virtual Reality	Gaming	Focus group (city)	Engaged young citizens
[S12]	Community engagement	Consult	CCCS	Personal desktop (web)	GIS	None	Focus group (city)	Do not report

Table 3. (continued)

Study	Democratic Process	Level of Part.	Actors and Information Flow	Mode of Deployment	Featured Technology	Strategy for Engagement	Evaluation (scale)	Reported Benefits
[S13]	Community engagement	Inform	CCCS	Personal Mobile	Social network service	Use of familiar technology (Twitter)	Lab Study (community)	Increased awareness
[S14]	Urban planning	Consult	GCCS	Situated (public screen), Personal mobile	Social network service, SMS	Technology situatedness	Field study (city)	Increased participation
[S15]	Urban planning	Empower	GCCS	Personal desktop (web)	Virtual Reality	None	Usability test (city)	Do not report
[S16]*	Policy-making	Consult	CCCS	Personal desktop (web)	Common web app features	Public events ads in newspaper social media mailing lists	Real case study (country)	Do not report
[S17]*	Community engagement	Consult	CCCS	Personal desktop (web)	Common web app features	Partnered a local initiative that works on participatory processes	Real case study (state)	Enhanced community engagement

Table 3. (continued)

Study	Democratic Process	Level of Part.	Actors and Information Flow	Mode of Deployment	Featured Technology	Strategy for Engagement	Evaluation (scale)	Reported Benefits
[S18]*	Policy-making	Consult	CCCS	Personal desktop (web)	Common web app features	Partnered local organizations	Real case study (community)	Involved citizens in defining urgent issues
[S19]*	Policy-making	Collaborate	CCCS	Personal desktop (web)	Common web app features	Partnered federal agencies	Real case study (country)	Involved citizens who usually do not participate in policy making
[S20]*	Policy-making	Consult	CCCS	Personal desktop (web)	Common web app features	Partnered local organizations	Real case study (state)	Involved citizens in discovering public interest issues

Table 3. (continued)

Study	Democratic Process	Level of Part.	Actors and Information Flow	Mode of Deployment	Featured Technology	Strategy for Engagement	Evaluation (scale)	Reported Benefits
[S21]	Urban planning	Empower	GCCS	Personal desktop (web)	Map	None	Real case study (city)	Influeced decisions
[S22]	Participatory Budgeting	Consult	GCCS	Personal desktop (web)	Common web app features	None	Real case study (city)	Involved people in binding decision-making processes
[S23]	Policy-making	Inform	CCCS	Personal desktop (web)	Map	Gaming	Field study (community)	Increased civic skill on young people
[S24]	Urban planning	Collaborate	GCCS	Personal desktop (web)	Common web app features	Gaming	Usability test (city)	Do not report
[S25]	Urban planning	Collaborate	CCCS	Personal desktop (web)	GIS	None	Real case study (community)	Increased participation
[S26]	Policy-making	Empower	GCCS	Personal desktop (web)	Common web app features	None	Field study (city)	Do not report

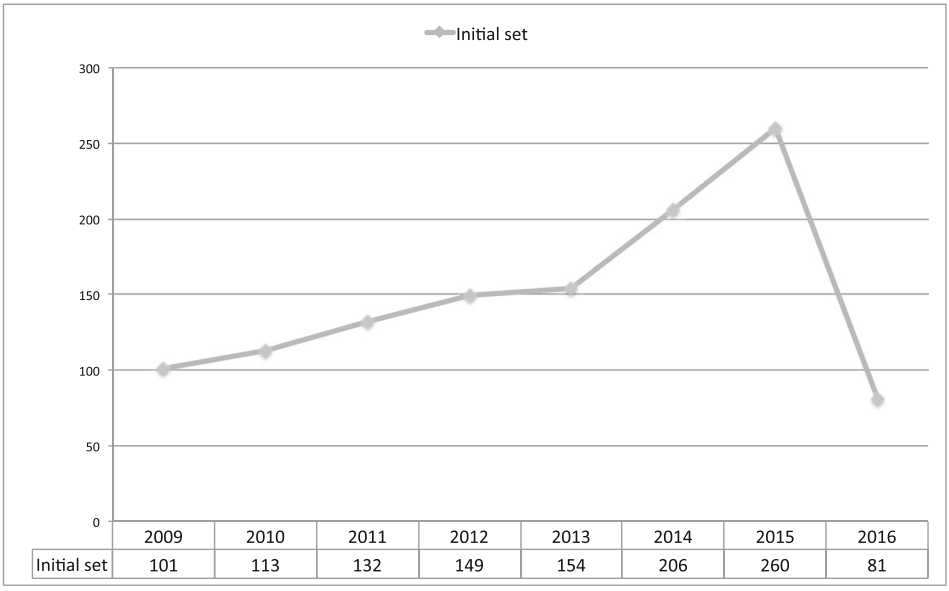
Table 3. (continued)

Study	Democratic Process	Level of Part.	Actors and Information Flow	Mode of Deployment	Featured Technology	Strategy for Engagement	Evaluation (scale)	Reported Benefits
[S27]	Urban planning	Collaborate	CCCS	Personal desktop (web)	Common web app features	None	Focus group (city)	Do not report
[S28]	Urban planning	Consult	CCCS	Situated (public screen)	Common web app features	Technology situatedness	Field study (city)	Enhance community engagement
[S29]	Urban planning	Involve	CCCS	Situated (public screen)	Social network service, SMS	Use of familiar technology (SMS, Twitter)	Field study (city)	Involved people who are not civically active
[S30]	Community engagement	Consult	CCCS	Situated (public screen)	Interactive sensor	Gaming	Real case study (city)	Increased participation
[S31]	Public sector innovation	Involve	GCCS	Personal mobile	Map	None	Usability test (city)	Do not report
[S32]	Urban planning	Consult	GCCS	Personal mobile	Map	None	Field study (city)	Increased awareness

Table 3. (continued)

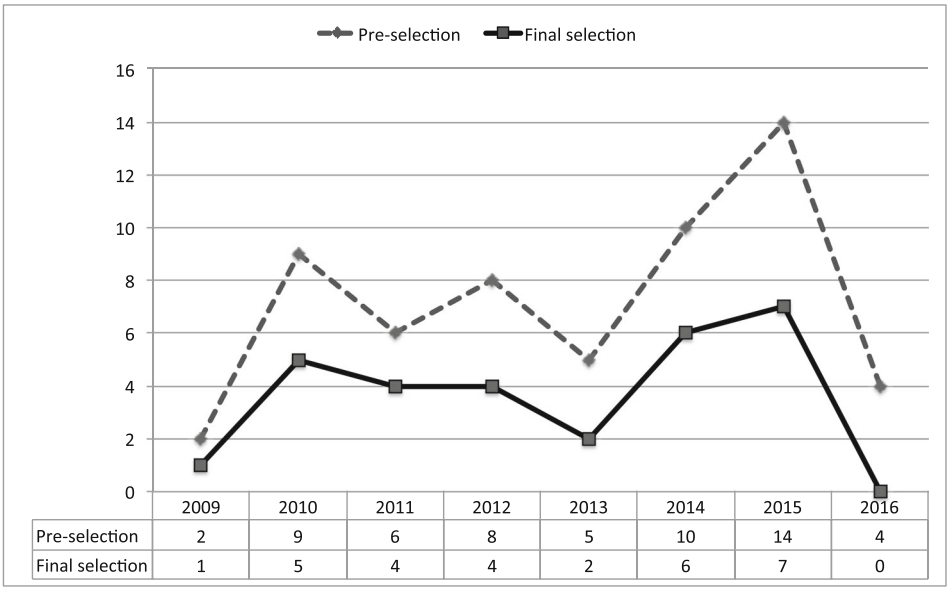
Study	Democratic Process	Level of Part.	Actors and Information Flow	Mode of Deployment	Featured Technology	Strategy for Engagement	Evaluation (scale)	Reported Benefits
[S33]	Urban planning	Collaborate	CCCS	Situated (tabletop)	Augmented Reality	None	Focus group (city)	Do not report
[S34]	Community engagement	Inform	CCCS	Personal mobile	Native mobile app	None	Real case study (city)	Increased awareness
[S35]	Urban planning	Consult	CCCS	Situated (public screen), Personal desktop (browser), Personal mobile	SMS, Native mobile app	Technology situatedness	Real case study (community)	Increased participation

'*': Articles collected through the Delphi process
CCCS: Citizen-centric and citizen-sourced data
GCCS: Government-centric and citizen-sourced data
CCGO: Citizen-centric and government open data
GCCD: Government-centric and citizen-developed solution



	2009	2010	2011	2012	2013	2014	2015	2016
Initial set	101	113	132	149	154	206	260	81

(a)



	2009	2010	2011	2012	2013	2014	2015	2016
Pre-selection	2	9	6	8	5	10	14	4
Final selection	1	5	4	4	2	6	7	0

(b)

Figure 1. **a** Number of publications per year in the initial dataset; **b** Evolution of the pre-selected (dashed line) and final (solid line) publications over time. The drop in the publications from 2016 represent an expected result considering that this review was conducted during the first months of 2016.

the number of publications 2016. Most likely, the growing trend would tend to continue. Through the Delphi process, we collected two more papers from 2012, one from 2015, one from 2016, and two from 2017.

3.2. Proposed mode of deployments and technologies

Technologies that are deployed through a web platform (i.e., used from a browser) dominate our data set. More than half of the reviewed studies (57%, 20 out of 35) make use of web platforms to support processes of civic engagement for social innovation (e.g., [S6], [S9], [S15]). About 20% (6 out 35) use personal mobile devices as the mode of deployment (e.g., [S7], [S13], [S31]) and another 20% employ situated technologies, like public screens, connected to online platforms or standalone systems, to elicit situated feedback in urban settings (e.g., [S1], [S5], [S28]). Bailey et al. (2011) [S2] introduce a desktop-based software. Two articles propose approaches that combine more than one mode of deployment.Woodcock et al. (2012) [S35] present a system that integrates public screens, web, and mobile technology while Hosio et al. (2015) [S14] propose a platform that combines public screens with personal mobile devices.

Concerning the featured technologies, more than 40% of the studies (15 out of 35) propose common web applications features (e.g., [S20], [S3], [S17]). Steinberger et al. (2014) [S30] introduce a tool that employs a sensor that let the users interact with the system through their feet. Solutions that make use of interactive maps, like Google Maps[9] or Open Street Maps[10], are proposed in 14% (5 out 35) of the cases (e.g., [S23], [S31], [S32]), making it the second functionality most used. Among the proposals that employ maps, Ganoe et al. (2010) [S7] propose a mobile solution that integrates map with wiki technologies. Farnham et al. (2012) and Han et al. (2014) introduce systems that are based on popular social networking sites, such as Facebook and Twitter. Situated technologies (public screens) that combine SMS technology with Twitter are suggested in Hosio et al. (2015) and Schroeter (2012). Garcia et al. (2011) and Woodcock et al. (2012) present mobile solutions that leverage on SMS as the means to public participation. Geographic Information Systems (GIS)[11] and Virtual Reality (VR) are functionalities that are present in three (9%) and two (6%) studies, respectively. VR is used to allow citizens to access and suggest changes to planning proposals in an interactive three-dimensional visual interface. GIS, for its part, is employed to visualize information in maps and to enable users to provide feedback referring to geographic objects. Fredericks et al. (2015) and Wilson (2011) use native mobile applications specially developed for civic engagement purposes. A combination

[9] http://maps.google.com
[10] http://openstreetmap.org
[11] Geographic Information Systems (GIS): a system used to report and display spatial and geographical information (Tomlin 1990)

of Augmented Reality (AR) with a tabletop device is the proposal of Wagner (2012). In 83% (29 out of 35) of the studies, authors present new civic technologies (e.g., [S3], [S15], [S19]) while the remaining articles introduce new usages of existing ICT solutions (e.g., [S2], [S4], [S10]).

3.3. Democratic process, level of participation, actors and information flow

Solutions to facilitate urban planning dominated our final dataset: 46% of the studies (16 out of 35) propose technologies that engage citizens in the urban development of their communities (e.g., [S1], [S10], [S25]). About 23% (8 out 35) of the publications aimed at involving civil society in policy-making (e.g., [S3], [S17], [S26]). Among the remaining, seven articles (20%) proposed approaches to strengthen engagement between community members (e.g., [S4], [S13], [S30]); and three (9%) to support participatory budgeting and one last to facilitate processes of public sector innovation ([S8], [S9], [S22]). Thiel et al. (2015) introduce a tool to facilitate processes of public sector innovation.

Almost half of the technologies (49%, 17 out of 35) support a consultive level of engagement (e.g., [S18], [S20], [S28]). Technologies that enables collaborative process of social innovation account for 17% (6 out of 35) as well as those solutions that are geared toward actually making decisions (e.g., [S11], [S24], [S27] and [S8], [S15], [S21]).

Four articles (11%) present technologies to help citizens in learning public interest issues (e.g., [S10], [S13], [S23]). Schroeter (2012) [S29] and Thiel et al. (2015) [S31] introduce approaches that aim at involving citizens' feedback, ideas and comments into social innovation processes but without facilitating opportunities of collaboration among them.

Almost all studies (97%, 34 out of 35) propose civic technologies that depend on data sourced from citizens' creativity, knowledge, opinion, and judgment. Only Anwar et al. (2015) [S1] based their approach on official open data. In the majority of studies (66%, 23 out of 35), the implementation and deployment of the tools are led by the civil society (e.g., [S5], [S12], [S17]), in the remaining 34% of the articles, authors partner with public institution to deploy the solution in real case scenarios (e.g., [S3], [S15], [S22]).

Figure 2 illustrates the emerging relationships between the dimensions of our frameworks. In the chart, we can see that urban planning processes are mainly supported by tools deployed in personal desktop and situated modes through web applications, maps, GIS, augmented and virtual reality, and social networking services. Technologies used for planning serve primary a consultive level of participation. Processes of policy-making are entirely facilitated by solutions deployed in a personal desktop mode through web applications and maps. In policy-making technologies enable mainly consultive and collaborative levels of engagement. Half of the processes that aim at strengthening the engagement between community members are supported by native mobile apps integrated

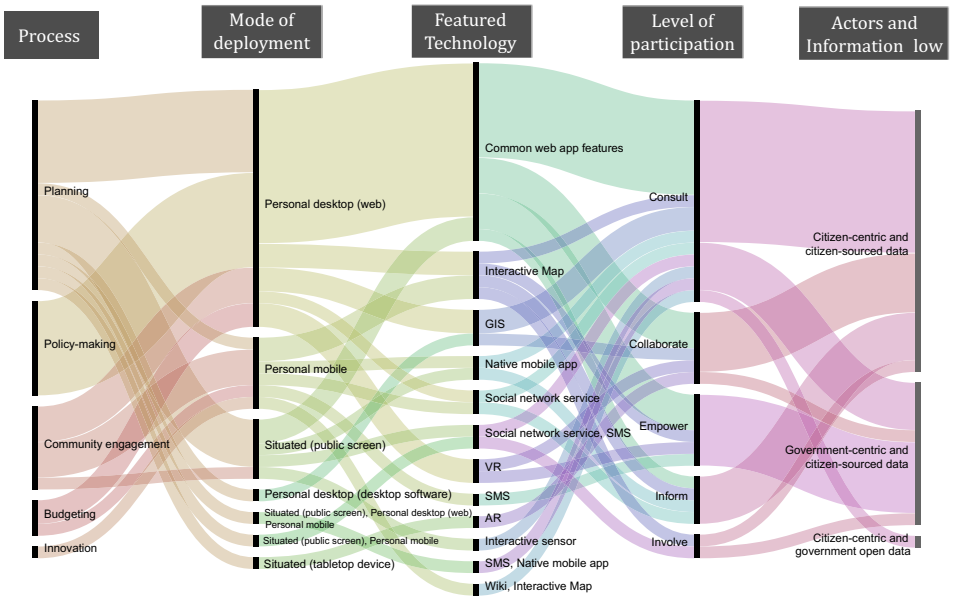


Figure 2. Alluvial chart illustrating the relationship between the dimensions of our framework.

with social network services, SMS, wiki, and maps. Although, we found that web platforms and interactive sensors are also used for this purpose. Consult and, to a lesser extent, inform are the primary levels of engagement enabled by technologies in processes of community engagement. Web and mobile platforms with SMS functionalities are the preferred means to engage the citizenry in participatory budgeting processes. A mobile platform equipped with interactive maps, which enable an involved level of engagement, facilitates the only case of public sector innovation available in our final data set.

Citizens take the lead in the deployment of the majority of tools that facilitate consultive and collaborative level of engagement. Figure 2 shows also that citizens are the leaders of processes in which technologies are employed for informative purposes. On the other hand, governments play a central role in the implementation of technologies for decision-making (empower). Not all of the actors and information flow archetypes defined in Table 2 are present in our dataset. We did not review studies that propose approaches in which government asks citizens to actually implement complete solutions (government-centric and citizen-developed solutions archetype, see Table 2).

3.4. Strategies of engagement, target population, evaluation methods, and reported benefits

Almost half of the studies (43%, 15 out of 35) report of having used techniques to engage citizens. In five articles games are used to create entertaining environments

where users can be informed, learn and get involved in democratic processes (e.g., [S10], [S23], [S24]). Four studies leverage on the attractiveness and location of technology to promote civic engagement within planning and ideation processes in urban settings (e.g., [S5], [S14], [S35]). The use of popular, and well-known technologies, such as mobile phones and general purpose social networking sites, like Facebook, YouTube, Twitter, is proposed in six studies to lower barrier of entry and give users the opportunity to participate through familiar technologies (e.g., [S13], [S20], [S29]).

In the majority of cases (74%, 26 out of 35), the target is the general population (e.g., [S7], [S24], [S25]). Some studies aim at involving specific groups of citizens such as university students or senior adults (e.g., [S29], [S32], [S35]). More than half of the publications (57%, 20 out of 35) propose technologies that were tested at a city scale (e.g., [S22], [S33], [S34]), nine are validated at a community level (e.g., [S5], [S18], [S35]), and the rest at region, state, and country levels (e.g, [S3], [S6], [S20]), with one explicitly designed to be used at a continental level (Sånchez-Nielsen and Lee 2013). Almost half of the studies (43% ,15 out of 35) were conducted in cities and communities of the United States (e.g., [S11], [S13], [S23]), and eight were done in Australia and Italy, four in each of these countries (e.g., [S3], [S28], [S30]).

Close to 50% of the approaches (16 out of 35) were tested through real-life case scenarios (e.g., [S6], [S8], [S29]). In a quarter of the cases (23%, 8 out of 35), the author employed field studies on validating their proposals (e.g., [S14], [S26], [S32]). Focus groups, lab studies, controlled experiments, and usability tests were used in the rest of the publications (e.g., [S7], [S15], [S23]).

Studies report that the deployment of the civic technology benefited democracy in different ways. One-third increased (31%, 11 out of 35) the level of public participation (e.g., [S2], [S25], [S29]) while 11% (4 out of 35) reported of having enhanced community engagement and collaboration (e.g., [S1], [S7], [S28]). Improvements in citizens' civic skills, i.e., identifying community problems and collaborating on solutions was the benefit reported by 11% of the studies (e.g, [S6], [S11], [S23]). Five articles found that the technology proposed increased awareness and concern in public-interest topics (e.g., [S5], [S13], [S32]). Three studies highlighted that their proposals enabled the citizenry to participate directly in decision-making ([S3], [S8], [S22]). Approaches that used games as their motivation strategy reported of having achieved more engagement and of having improved the civic skills of the participants. The use of public display has helped to increase the levels of public participation and enhance community engagement. Mobile technologies and social networks have contributed to raising awareness on public-interest topics.

In reviewing the articles, we found that six publications use well-established and formal procedures of participation to organize and guide citizens toward a more effective participation. These include the Delphi and CoRes methods (Delbecq et al. 1975; Khan et al. 2013), the inform-consult-empower process (Lee

et al. 2011), argumentation maps (Rinner and Michelle Bird 2009), the SPI methodology (Grossardt et al. 2003), and the mDSS framework (Giupponi 2007) (e.g., [S3], [S8], [S15]). It was reported that the application of formal engagement methods, such as argumentation maps and structured public involvement (SPI) methodology, resulted in more public participation.

4. Discussion

Our systematic review identified 1,246 potentially relevant articles of which only 2.3% fit the criteria we had set for this review: to propose a new technology (or the innovative use of an existing one), and to evaluate its impact.

In what follows, we discuss the answers to each of our research questions as informed by our findings, presented in the previous section, using our analysis framework as the guiding thread.

It is important to make notice that our analysis framework is itself a contribution of this review. Together, the analysis framework and the insights we discuss here can serve as a conceptual framework for future computing research, based on previous fieldworks and evaluations available in literature. This discussion and the subsequent conclusion seek to provide a more in-depth synthesis of the research opportunities that civic technology for social innovation holds for CSCW scholarship.

4.1. RQ1: What technologies are proposed?

In terms of technologies, the web reigns this academic field, with more than half of the articles focusing on solutions deployed in this type of platform (e.g., [S1], [S24], [S35]). The web is an accessible and affordable technology to develop, which might explain this result. Tools deployed in web technologies, when used from a resourceful device like a laptop, can also offer additional affordances that mobile and situated devices might not provide (e.g., rich text collaborative editing and more computing resources). We can support this argument by looking at what processes are supported by which platform, with policy-making solely relying on the web, as Figure 2 shows. As a process, policy-making usually entails deep and thoughtful deliberation around complex documents, something that mobile devices or situated technologies might not support with enough richness, at least not yet.

Tools deployed in personal mobiles and situated technologies have equivalent importance in our dataset (e.g., [S5], [S8], [S28]), and are correspondingly leveraged upon in processes that might benefit more of direct and lighter communication patterns with citizens. This is, for example, the case of community engagement processes, or planning processes in stages where situated and succint feedback is needed. Since articles in our review did not always offer information to know if their evaluation included the use of a web platform from a personal

mobile device, the distinction here for mobile and situated must be read as technologies that were designed to be deployed with these settings as their main or only usage setting.

The choice of a technology platform is very important for the citizen's engagement and the process facilitation. *Civic technology* is particularly challenging because it justifies itself as a means for increasing participation (both in scale and, hopefully, also quality), while at the same time it can potentially exclude people if it does not consider the capabilities and resources available to all citizens. In democratic processes like participatory budgeting, there is often a concerted effort to reach excluded communities (Carolin Hagelskamp et al. 2016), which entails reaching out to them where they live. In this sense, we find it interesting that our data shows how public displays are informing processes of participatory planning and community engagement, but are still absent from academic research on participatory budgeting, policy-making, and public service innovation. Situated technologies hold a potential to improve inclusion as they can be placed in selected locations to address specific inequalities in terms of access to technology. Researching cooperative uses of situated technologies in the processes where they have not yet been used is an interesting opportunity for CSCW scholars.

Another interesting missing link in our data set is that of mapping and Participatory Budgeting. We know from experiences like the PB process of New York[12] or the analysis made by organizations like the Participatory Budgeting Project [13], mapping plays an important role in this type of ideation-heavy process, but it somehow does not register in the resulting academic literature for this review. This represents a disconnect between research and practice that we see as an opportunity for future CSCW research.

In addition to this, there is still room for *civic technologies* to improve its use of multiple channels of participation. In this regard, only a fraction of our dataset used social networks (e.g., [S13], [S14], [S29]) , and there was only one study to include all three modes of deployment to engage citizens [S35]. It is unclear from these research articles why so few of them leveraged upon social networking sites considering how pervasive they are today. Exploring and evaluating the benefits of social networking sites to facilitate civic engagement therefore represents another open opportunity for academia that has, in fact, already been leveraged in some non-academic instances.

Governments and citizens of US, UK, and Canada, for example, used social networking sites, like Facebook, to support asynchronous and ongoing dialogs about

[12] See http://ideas.pbnyc.org/

[13] See https://www.participatorybudgeting.org/mapping-data-driven-community-decisions/

neighborhood and community development plans in *urban planning* (Evans-Cowley 2010), but they have not designed new platforms on top of these networks or published in computer science literature. CSCW research that was published after the time frame considered for this review, for example (Mosconi et al. 2017), does explore the use of popular social networking sites for community engagement, and it might very well be that more research and design is already being conducted in this space. Beyond these cases, data privacy laws might be playing a role in limiting the use of social networking sites in initiatives connected to governments, as the latter might be less inclined to share data with big social networking companies.

Another interesting point is that there is almost no use of open data in this literature. Repositories that make all kind of public data available are on the rise, promoted by the international *Open Gov Partnership*[14]. *Civic Technology* in academia, and particularly CSCW research, might benefit from exploring how to design tools that make effective use of this data to improve the quality of online deliberation, beyond the level of informing and consulting citizens that are usually the ones supported by open data initiatives.

Also of note in relation to technology is how the articles we have reviewed include usage of VR and AR, two technologies that are the forefront of innovation nowadays, but not commonly associated with civic life. In all the three articles that make use of VR or AR (e.g., [S11], [S15],[S33]), these technologies tap into the visual imagination of citizens to support participatory planning, and we wonder how they might play in supporting cooperative practices among participants. Other frontier technologies are noticeable by their absence in this review, as is the case of AI and Blockchain, to name two. AI technologies, like machine learning and natural language processing, might prove useful in the process of analyzing the data that is generated by a participatory process (Aitamurto et al. 2016b). Blockchain technologies are already being billed by some in the industry and academia as the enabler of the next generation of voting systems for democracy (Swan 2015; Berg 2017), and it is also missing in this research. CSCW scholarship research is needed to help in evaluating and informing how much these new technologies truly improve the quality of our democratic experiences.

Other problems we have not seen in our selected literature, and that we see as relevant to CSCW research, include idea management, and what we might call the backoffice administration of civic engagement. Idea management, for example, has been extensively explored in business innovation related research (Saldivar et al. 2016). As noted before, AI could be explored in this space. Another problem that is not explored enough in the articles of our dataset is how IT can facilitate and

[14] http://www.opengovpartnership.org/

integrate the face-to-face or offline experiences that are so often a fundamental part of these democratic processes. CSCW research can certainly help lead the way in both these problems.

4.2. RQ2: What levels of participation do these technologies enable?

Before analyzing the specific roles of technology, it is interesting to see how academic research has paid extensive attention to *participatory planning* (e.g., [S1], [S10], [S14]) and *community engagement* (e.g., [S4], [S7], [S12]) while almost neglecting others like *participatory budgeting* [S8] and *public service innovation* [S31] [15] (represented only by about 10% of the articles). This, apart from indicating opportunities for CSCW research, suggests that either the under represented cases employ already well-established technologies so no new civic technologies are proposed to support them or there is a lack of interest in designing and understanding how technology can be used in innovative ways to facilitate these processes.

While computer science (CS) literature neglects these two processes, there are high profile cases of civic technology for *public service innovation* and *participatory budgeting* in practice. *Public service innovation* is the goal of Challenge.gov[16], a platform developed by the White House during president Obama's administration (Mergel and Kevin C Desouza 2013) with the goal of harnessing the collective intelligence of citizens for solving public administration problems. Similarly, social media tools, like Facebook, Twitter, and Youtube, as well as specially-designed technology, has been used to facilitate participatory budgeting processes in the city of Chicago, USA (Aitamurto 2012) and the Brazilian region of Rio Grande do Sul (Spada et al. 2016), among many more examples (Carolin Hagelskamp et al. 2016).

A reason for this limited coverage might be that CS literature, incorporating both design and evaluation in these processes, has simply not been published or achieved recognition yet. For example, a platform designed at the University of California, Berkeley, was used by Vallejo residents to develop proposals, but only a preliminary publication about the platform has been published, with no evaluation (Holston et al. 2016; Parra et al. 2017)[17]. Like in this case, evaluation of civic technology within CS literature might still be forthcoming for most cases. It

[15] We use the OECD definition, "innovation in the public sector refers to significant improvements to public administration and/or services". In this case, we refer to the involvement of citizens in the processes that lead to this kind of improvements. For more, see http://www.oecd.org/gov/innovative-government/a-framework-for-public-sector-innovation.htm

[16] https://www.challenge.gov

[17] https://vallejopb.appcivist.org

is also the case that studying civic technology through real cases are often difficult to accomplish, as they heavily depend on political commitments from public officials, which are not easy to attain. In the case of Participatory Budgeting, the lack of willingness from some governments to outsource part of the budget might also play a role in the limited number of tools for this process.

In the case of *Policy-making*, while still limited in relation to planning, it has been subject of more research according to our review. Practice, however, showcases high profile examples, which indicates another example of the disconnect between research and practice in this field. For example in Finland, citizens used an online platform to submit ideas for reform and improvement of off-road traffic laws (Aitamurto and Hélène Landemore 2016), and in Iceland, online tools were used for the participatory writing of the country's new constitution (Landemore 2015).

Regarding the levels of participation we found that technologies fulfill mainly consultative roles. In this sense, we can see that research has mostly studied *civic technologies* that do not have a deliberative or binding outcome. This represents a risk in terms of practice, as citizens tend to lose interest in processes that do not have a measurable outcome (Lerner 2014). In accordance, a highly deliberative processes, participatory budgeting, is one of the least studied[18]. As shown in Figure 2, the processes with stronger connections to the Collaborate and Empower levels of participation are participatory budgeting and policy-making.

An open challenge for academia is therefore to explore effective technologies for substantive deliberation, which allows residents to consider the problems facing the cities and to engage in deep and productive deliberations that result in solutions being implemented. This type of processes require partnering with government. Only one-third of the articles included government participation, and all of the articles that proposed technologies to support making decisions were government-centric (e.g., [S21], [S26], [S32]). As shown by Figure 2, almost all the articles connected to the Empower level of participation are also government-centric with citizen-sourced data. Here again, practice is ahead of research. Four thousand citizens of Geraldton-Greenough, Australia, for example, participated in large-scale decision-making about the future of their city through the platform CivicEvolution sponsored by the city government (Sullivan 2008).

A future in which technology is the enabler of evidence-based and participatory governance depends on academia partnering more and more with governments to link *civic technologies* to actual outcomes.

Another interesting and encouraging result is that most articles that are citizen-centric rely on citizen-sourced data (e.g., [S10], [S23], [S27]). This suggests that, even if only for consultative purposes, public administrations are still reluctant to

[18] Participatory budgeting often features several phases of proposal development, where volunteer residents spend several months researching, discussing and deliberating on project proposals, before reaching the final voting phase

embrace open government practice, and it is citizens who take the lead at promoting opportunities of technology-mediated civic engagement. Future research should explore how this is impacting the life of regular citizens, what new obligations are being created, and how to reward citizens accordingly to maintain their engagement, motivation and empowerment. Moreover, the fact that none of the articles we reviewed supported a government-centric process with citizen-developed solutions represents an interesting design research exploration opportunity. There is a design research opportunity for CS with technologies like FixMyStreet[19], but with the solution side driven by citizens, who themselves come up with ideas and implement them.

A final note has to do with the supported magnitude of these processes. The overwhelming consensus in literature is that, as Buchanan and Tullock put it, "direct democracy becomes too costly in other than very small political units when more than a few isolated issues must be considered" (Matsusaka 2005).

Our review indicates that *civic technology* might be breaking this consensus as more than half of the studies (20 out 35) in this review tested their application at the city scale (e.g., [S8], [S11], [S30]) and around 20% (7 out 35) did so at an even larger scale (e.g., [S3], [S6], [S19]), one was tested a city level but designed to be used at the continental scale [S26]. From this data, there seems to be a resurgence of the city as the principal space of democratic endeavor, as it was in ancient Greece.

4.3. RQ3: What is the reported benefit of these technologies?

The third and final question is also the hardest to answer, as even when all finally selected studies have validated their proposal through field studies, real case pilots, or controlled experiments, these evaluations vary in quality and consequently the inferred conclusions can be weak. In some cases, studies do not include in their evaluations the target population of the proposed tools. In other cases, they evaluate the users that are not representative; for instance, applications built for senior adults were tested by students [S32] or platforms intended to be used by ordinary citizens were validated by technically skilled students [S24].

The fact that only 28 out of 58 (around half) of the potentially relevant papers included evaluation is a testament to how challenging it is to measure the benefit of *civic technologies*. Academic evaluation is still lacking in this field and represents an opportunity for research and there seems to be a gap with respect to practice, with many important real use cases of civic technology not coming from academia but anchored in the work of practitioners.

We find interesting that several articles that do evaluate their proposals, also explored the pedagogical impact of their proposals, citing benefits such as

[19] https://www.fixmystreet.com/

improved civic skills (Poole et al. 2010), enhanced collaboration [S1], improved quality of political discussion [S6] , and increased interest in public issues [S32] [S34]. *Civic technology* can therefore become the channel for learning by doing for future generations of citizens.

4.4. Limitations of this review

Civic technology represents an emerging field of research, design and practice. To map and analyze the field in its full extent is beyond the scope of this review, whose main purpose is to present and analyze a systematically constructed dataset of academic research incorporating both design and validation elements. This focus on academic research is the first limitation of our review, which can be complemented by other perspectives (Patel et al. 2013).

A second limitation is our focus in the computer science discipline and, particularly, in ICTs. Other disciplines like Political and Information Sciences, Industrial Design or Urban Planning might also host research that incorporate both design and validation of technologies for social innovation (Ratto and Megan Boler 2014). The use of digital libraries that index a large set of journals and conference proceedings, however, ameliorates this limitation, as online libraries like ACM and IEEE often include also interdisciplinary collaboration between computer scientists and other disciplines.

A third limitation is our focus on literature indexed by online digital libraries. While this ensures a wide coverage of the field, we might be losing interesting but not widely known contributions that are published in self-indexed venues, often focused on practice more than research. Conferences like the TICTeC (The Impacts of Civic Technology Conference[20]) or CIRN (Community Informatics Research Network[21]) often include among their accepted publications interesting pieces of academic research that have high local impact but low academic recognition.

A fourth limitation is that the studies obtained are limited by the range of time considered for our searches, i.e., from 2009 to January 2016. Also, the results of the queries are restricted to the defined search strings, which might omit relevant papers. Moreover, it could be possible we missed studies when conducted our search in sources that did not accept our entire search string (i.e., IEEE Xplore and SAGE), which forced us to split the search string into a series of more compact versions.

5. Conclusions

In this literature review, we have constructed a dataset of academic articles that study the challenge of supporting participatory social innovation with new and

[20] http://tictec.mysociety.org/
[21] http://cirn.wikispaces.com

innovative ICTs, or *civic technologies*. Using a systematic approach, we have identified relevant research that, along with our analysis framework and discussion, provides a conceptual framework for computing research, using previous fieldwork and evaluations as the baseline. This overarching overview shows what this field currently looks like, and what the future might hold for CSCW research.

In our analysis, there is a paradoxical emergence (and even thriving) ecosystem of civic technologies while democracy seems to be facing a crisis around the world (Lerner 2014). This ecosystem seems to thrive especially in practice, with cities and civil society organizations increasingly organizing experiments of participatory and direct democracy, with the help of technology, while academia is still somewhat behind this trend, not having fully explored the spectrum of technologies that are currently being explored in practice (e.g., mapping in participatory budgeting, blockchain for voting, social networking services for all processes, etc.). This disconnect between research and practice represents a unique opportunity for CSCW scholarship, which can help to uncover innovative ways of improving the quality of our democracy by designing and evaluating better platforms for collaborative and empowering citizen engagement.

Some recent CSCW research (i.e., articles published after the time window of our analysis) are already taking the turn toward this field. Hou (2016) is exploring the socio-technical factors that influence design and implementation of civic technologies. Johnson et al. (2016) present a similar work to this review, highlighting challenges for civic technology research going forward. Mosconi et al. (2017) experiment with using Facebook to support local community engagement, and McInnis et al. (2017) collect a number of workshop papers around the topic of crowdsourcing and policy making, naming them "crowd-civic systems".

Still, CSCW research has plenty of room to grow. Civic technologies, or digital civics as some call it Vlachokyriakos et al. (2016) and Olivier and Peter Wright (2015), "aim to create relational rather than transactional public services", which falls in line with the vision of engaging citizen beyond consultation, enabling collaboration and empowerment. We are not yet there in terms of this vision as technology is still mostly used for consulting citizens, and not so much for enabling a full collaboration in governance between citizens and governments that would empower citizens with more direct mechanisms of decision making. This literature review points to the following list of challenges where CSCW scholarship can play a pivotal role:

- Addressing the disconnect between research and practice by paying more attention to the experience of cities, civil society organizations and some startups that are actively engaged in the development and use of civic technologies.
- Design and experiment with multi-modal platforms that combine multiple modes of deployment to accommodate multiple modes of participation. Particularly, deepen the research in how can technology contribute to increase the scale of deliberative processes without losing the depth and quality of

the arguments within. Different stages in a participation process (e.g., participatory budgeting) could benefit from different modes of deployment and featured technologies, in a process-oriented research agenda that would weaved together custom made technologies with other platforms that are more general in their purpose (e.g., social networking services).
- Expand research on how situated or shared technologies can contribute to civic collaboration patterns that typically benefit from face-to-face interactions. Particularly, explore the limits of this mode of deployment in terms of how much can they support more meaningful interactions. In the same line, explore what role could state of the art technologies (e.g., machine learning, natural language processing, VR/AR, blockchain, etc.) play in facilitating or improving the quality of social innovation processes. AI technologies might prove particularly useful in improving idea management and the backoffice administration of civic engagement. VR/AR could enhance the quality of information for participatory planning processes. Blockchain technologies could facilitate voting and open contracting.
- Addressing the current lack of evaluation by engaging more closely with institutions and organizations that have a real influence on decisions of cities and states.
- Leverage upon existing networks of social innovation that are heavily invested in civic technologies, such as the open data and government partnership (particularly relevant in Latin America), as way to improve the connection between academia and government.
- Expand research on how to ensure inclusion when technologies are involved in participation processes. This might entail learning from the experience of cities that purposely design their participation strategies with the goal of reaching vulnerable or minority communities.
- Explore how technologies can contribute to enhance the pedagogical dimension of participatory democracy, helping to educate for citizenship through practice.

In ancient Athens, our original blueprint for democracy, democratic citizenship was understood as the direct participation of citizens in all aspects of governance: from the occasional vote to the everyday activities of juries, councils, and assemblies. When Aristotle famously declared that ”citizens in the common sense of the term are all who share in the civic life of ruling and being ruled in turn” (Newman 1902, p. 1275), he was talking about both the legislative (i.e., making and obeying laws) and the executive functions of citizenship (i.e., to direct an unmediated decision-making in the execution of government and the administration of justice). Aristotle also argued that this kind citizenship could only or best be achieved in small-scale communities, in which people knew each other and could deliberate face to face as a means of evaluating moral character and building

trust. Experiences like the Regulation Room (Farina et al. 2013) or the Iceland Constitutional experiment (Landemore 2015) are showing us that this type of citizenship, with meaningful and deep deliberation moments, is also possible at large scale, and technologies can play a beneficial role.

This is the most important insight from this review: that these deeper and more meaningful levels of participation could now finally be accomplished beyond the scale of small communities. This literature review offers a research agenda toward this goal, and CSCW is an ideal space for this effort.

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Appendix A: Selected Studies

[S1] Anwar, Afian; Bernhard Klein; Matthias Berger; and Stefan Muller Arisona (2015). Value lab Asia: A space for physical and virtual interdisciplinary research and collaboration. In: *iV '15. 19th International Conference on Information Visualization, Barcelona, Spain, 2015*. pp. 348–353.

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