Establishing participative Smart Cities: theory and practice

Léo J. PORTAL
Ph.D. candidate in Political sciences at the European University Institute, Fiesole, Italy
leo.portal@eui.eu

Brian FABRÈGUE
Ph.D. candidate in Law at the University of Zurich, Switzerland / Head of Legal Retreeb, Geneva Switzerland
brianfranco.fabregue@uzh.ch

Abstract
In recent years, there have been efforts carried out by international organisations, like the OECD or the EU, to push for smart cities to take inclusion as one of their core pillars. This raises the question of a newly discussed concept: participative (or participation) smart cities. More specifically, it raises the question of whether such a setting or program is feasible , and how passive participants can be transformed into active stakeholder.
Hence, the objective of this article is to investigate whether participative smart cities exist in 2021 and what drives their success. In order to answer the research question, this article intends to assess the level of citizen participation in a sample of selected smart cities. Based on existing knowledge, a framework listing the most common citizen participative practices, and with the help of a case design of each selected cities, we establish how participative smart cities are feasible and whether there are institutional and political characteristics that make them differ from smart cities that lack participative processes.
We find that institutional determinants are key for cities willing to establish participative platforms involving citizens in the city management processes. The article concludes that if smart cities want to follow international organisations recommendations to make cities more inclusive and participatory, institutional reforms must be conducted.

Keywords: adoption, implementation, city management.

1. The concept of a smart city

The Smart Cities (SC) emerge in an environment where population growth and resource scarcity necessitate planned solutions, allowing for the adoption of projects and initiatives that leverage information (and communication) technology (IT/ICT). SC is a term coined by Bollier in reference to his works on intelligent growth. However, in 2005, IT corporations such as IBM, Cisco, and Siemens began to use the phrase to refer to technologies they provided that were expressly developed for cities [1], especially concerning to the delivery of public services [2], [3]. The primary driver of technological progress in the SC industry is the convergence of IT and urbanism [4], [5].

Along with the automation of fundamental and structural operations involving people, buildings, and transportation systems, a Smart city tries to evaluate efficiency, equity, and quality of life has included various monitoring, analysis, and planning services. Making a city 'smarter' is a critical component of current urban agendas, occurring in an era of increased urbanisation and a pressing need for sustainable urban initiatives [6]. As a result of this attitude, knowledge is viewed as an asset, necessitating an intimate interaction between Knowledge Management (KM) and ICT, which requires fine-tuning alignment to ensure that the communication process, which is at the heart of KM, runs smoothly. At this point, it is critical to analyse people's relationships and their willingness to share knowledge in the absence of reward mechanisms

The willingness of individuals to communicate and actively contribute is critical for knowledge management to provide tangible benefits for those concerned [7], [8]. A city becomes intelligent when it invests in human and social capital, as well as in areas such as information technology, transportation, infrastructure, and communication - all of which contribute to sustainability and economic development [9]. Sharing occurs in the context of SC via networks of people, businesses, and technologies [10] Knowledge-based approaches, such as Knowledge-Based Urban Development, are increasingly being applied in SC projects [11] ; there yet is a dearth of awareness of people' responsibilities in smart city efforts, which would highlight the diverse ways in which residents act and engage with ICTs [12], [13].The understanding of knowledge management techniques and the elements affecting their development, such as information technology, become critical considerations for the success of SC projects.

There are fundamental differences over the definition and characteristics of the smart city, and many cities claim to be "smart" without providing data to support their claim [4], [14]–[17]. The debate continues, spurred by a plethora of definitions and solutions in the field of smart cities, none of which are universally accepted. In this perspective, no city can truly claim to have totally conquered smartness; rather, as technologies and societies evolve, the smart city is compelled to redefine itself and experiment with new ways of thinking about technology and its application to the common good.

There are, again, diverse definitions of what a smart city is [2], [18]. Smart cities are a conceptual development model that aims to leverage ICTs to help cities build their human, social, and technological capital, with the ultimate goal of boosting urban sustainability. They provide a vision for the ideal future of a technologically advanced urban settlement. Additionally, they indicate integrated processes for realizing this concept. In the best-case scenario, a city aspiring to be "smart" has an integrated, forward-looking strategic plan that sets a vision and a methodology for capitalizing on digital technology to enhance urban functions and establish knowledge ecosystems. As with any strategy, it is critical that smart city strategic plans are tailored to the demands, priorities, and restrictions of their context. To address the challenges associated with providing a high quality of life for citizens (e.g., environmental protection, efficient public transportation design, and population control), the concept of "smart city" emerges through the integration of information and communication technology (ICT) and the Internet of things (IoT) . Smart city solutions enable us to monitor what is happening in a city, how it is evolving, and how to alter the city's operational processes to improve people's quality of life.

But monitoring by the IoT is not a end by itself, the smart cities actors use the information collected for a whole range of needs and goals. Yet such scopes are to be organised, and such organisation fall right under the public governance. The term 'governance' itself is frequently used to refer to a mode of governance in which private economic actors and segments of civil society participate in policy formulation, administration, and execution [19]–[22] . Governance is described as the interaction and collaboration of various stakeholders during decision-making processes [23], [24] .Governance provides an analytical framework, or at the very least a set of criteria, for observing the urban polity

and appreciating the benefits and drawbacks of collaborative systems of governance [19], [25]. Additionally, the governance method enables the determination of the amount to which individuals participate in the governance process, particularly with regard to the formulation of public policy and decision-making [26], [27]. Scholars have endeavored to understand urban governance patterns and the extent to which diverse social, political, and economic pressures tend to produce distinct urban governance models [28], [29]

Older estimates place the “real” number of smart city initiatives worldwide at between 100 and 400 Due to the continuous extension of the concept, it is difficult to quantify the actual number of smart city initiatives now being implemented in various parts of the world. Current estimates vary between various hundreds (ICM-SO) and thousands. This rapid evolution has been caused by the extremely fast change in the realm of ICT, rapid development of hardware, software, and networks, which has resulted in the availability of ICT for development in the majority of cities worldwide [30]. Without a doubt, smart cities are popular and, indeed, "fashionable" in the policy arena [15], [31], [32]. This condition exacerbates efforts to clarify the true meaning of "smartness" in a municipal setting and to properly identify the features of a smart city.

2. The concept of smart cities : a critical analysis

As previously said, the notion of the smart city is relatively new and is continually evolving as a result of present technological and economic developments and continuing debates. To be able to compare a variety of implemented smart city plans, it is necessary to first define what it means to be "smart" in an urban environment. Based on literature, four main extremely broad characters need to appear for a city to be defined as smart.

The first distinguishing feature of smart cities is the important role of technology in amassing, organizing, and making huge amounts of data accessible to an expanding number of people, with the goal of later using this data to improve urban operations and conserve resources. The Smart City is first and foremost characterized here as a highly technologically advanced city that links people, information, and services. [18], [32], [33]. As technology becomes more accessible and the urban environment becomes increasingly sensorized, real-time data streams and the Internet of Things (IoT) emerge [34], [35]. When we consider the growing interest of individuals and communities in recording their own data about their lives and activities, the volume of data generated becomes enormous. Not only can a city's operations be continuously monitored, but they can also be audited using advanced analytics to discover prevalent patterns and trends, predict incidents before they occur, and change the provision of services and goods based on the circumstances. Public authorities can make more informed and recorded decisions and successfully resolve problems, while the city's population can receive efficient and high-end services in the economic activity, governance, quality of life, and utility management areas [35], [35]. This digitally enabled ecosystem enhances a city's functioning, increasing environmental sustainability and transforming the city into a "smart" metropolis [4], [36]–[39] , for which e-governance becomes standard. Several authors emphasize the critical role of data and information in enhancing the decision-making processes associated with public policies [40].

The second characteristic of smart cities is their ability to enhance human and social capital through knowledge creation and dissemination, increased participation and digital inclusion, and the establishment of new forms of innovation (open, social). In smart cities, a significant portion of available knowledge is generated collaboratively; knowledge is an asset that is created via everyone's input. Existing research on citizen participation in smart city efforts frequently relies on Arnstein's participation ladder and other Arnstein-based models that presume citizens play a differentiated but unchanging role. Usually, these models do not take into account the particular characteristics of urban surroundings when defining and molding people' roles. Contemporary methods of public management emphasize citizen participation in policy and decision-making [41], [42], which is recognized in the literature on urban governance and papers studying citizen participation in smart cities [13], [43]–[45]. Simultaneously, smart city initiatives provide as a platform for engaging residents and stakeholders and evaluating the viability of smart city solutions and services in real-world settings [46]–[49] and includes solutions to make the city life more comfortable, safe, healthier and sustainable [16], [49]–[51]. In aggregate, the city gains significantly from localized knowledge spillovers, collective intelligence functions [52] , and the formation of inclusive communities capable of addressing the difficulties and capitalizing on the opportunities presented by the emerging digital economy [4], [36], [53]. While technology-driven frameworks emphasize the dynamic role of emerging digital technologies , citizen-centric frameworks are built on narratives of open innovation ecosystems with social engagement mediated by ICTs [5]. Citizens are seen as significant actors in both perspectives, albeit to varying degrees, and new ICTs are viewed as a critical transformational medium in both. It is important to point a major stream of literature, where intelligent 'narratives' are deemed to be part of the neoliberal agenda, which reduces citizens to passive consumers of modern digital solutions [27], [43], [54]–[56] . These authors also emphasize the need of viewing technology narratives as part of a neoliberal agenda aimed at controlling the destiny of the city and advancing corporate interests [54], [57], [58]. This disparity of views demonstrates the importance of developing a strong empirically based understanding of the nature of citizen participation and the manner in which these roles manifest themselves in diverse local contexts [44], [59]. Often but not always, this specific point is merged with the general problematic of governance, which we address below.

Thirdly, the smart city movement is also focused on business development, which will be accomplished through a strong track record of entrepreneurial agility, investment attraction, and new business formation. Smart cities are defined by a specific emphasis on business-led urban development and capital recruitment. They seek to create business-friendly settings that provide cutting-edge services to firms and entrepreneurs. Additionally, they assert that they foster the growth of highly professional entrepreneurial settings by creating the optimal conditions for enterprises to succeed, innovate, and network [9], [38], [39], [53]. Because smart cities are open and eager to use technology in productive and new ways, they attract highly qualified people and a competent labour force. They attract creative individuals who encourage the development of creative cultures and companies, which in turn fosters the growth of knowledge ecosystems that contribute to the city's success. Additionally, it is well established that creative, intelligent, and highly

skilled individuals are the most powerful engines of urban development :they generate novel ideas, products, and strategies, either independently or collaboratively through social networks [14]. Examples of such activities include research institutes, innovation incubators, various forms of public-private collaborations, and communication channels for citizen participation [53], [60] . Additionally, under the present EU policy framework – as we'll see later - , policies for smart specialization encourage entrepreneurial actors to investigate potential in existing or new industries and experiment with new activities in order to identify the most viable areas for future regional growth [9], [61]. Both European policies and the smart city movement, overall, place a premium on expanding and diversifying cities' entrepreneurial environments.

Finally, critical thinking about smart cities places a premium on "networking" within and between cities and regions for the purpose of image creation, best practice dissemination, diversification of production bases, and the construction of economies of scale, but also e-governance. In today's information economy and culture, municipal governments under increasing pressure to provide more innovative and high-quality services while maintaining popular support [13]. Cities are focused toward establishing alliances and collaborative networks in order to exchange knowledge and coordinate resources, while highlighting the diversity and unique character of their locus; the majority of cities have already established such alliances. As [62] point out, smart interaction with stakeholders is a bigger area of interest in smart governance research that evolved from traditional e-government research. Authorities communicate their smart city plans to the public through the sharing of concepts (promotional identity and brand), visions, goals, priorities, and even strategic plans [16], as well as the publication of annual reports that include performance data and statistics. [1] define collaboration as the sharing of responsibility and authority for decisions on operations, policies or actions of government for more than one set of stakeholders. According to some authors, the advancement of ICT has the potential to turn urban governance into "smart governance" by enabling municipal governments to perform their functions more effectively and efficiently [63], [64] – for which we express reserves. Social media, the internet, open data, citizen sensors, and serious games are used to bolster collaboration between citizens and urban governments, in particular, to develop novel modes of communication, consultation, and conversation between public organizations and individuals [65] .Today, networking is mostly accomplished via online digital media (websites, social media, wikis, etc.) and, in the European context, via transregional and transnational collaboration, particularly in the field of smart cities. Such characters, as we'll see in the next section, are to be used for the definition of the next steps to take.

3. Governance Integration as key to smart cities design

The last two characteristics of smart cities are people centered. To investigate further, we must begin with the question, 'What role do people have in smart city efforts across various urban governance contexts?'.

Traditional solutions for smart cities follow the "god-dominant" paradigm, in which powerful organizations or persons (just like the god) have full control in designing how urban context sensing and actuation should be executed. For urban context sensing, traditional systems usually rely on specialized infrastructure (e.g., air quality monitoring stations, surveillance cameras), which requires a high cost for deployment and maintenance. For urban context actuation, powerful organizations or enterprises determine when, where, and how to deploy or re-distribute different types of resources (e.g., constructing new pavement, rebalancing shared bicycles). As the decision-making process highly depends on the domain knowledge of experts, such god-dominant urban context actuation may not be efficient and scientific in some complicated scenarios. This mode of urban governance, would also exclude most citizen participation [29] , the citizen's role is reduced to being a client or consumer of public services [28], [41]

Table 1 : Traditional Modes of governance of smart cities

Mode	Description of mode	Citizen-state relations: role of citizens	Citizenship tools: types of interaction	Origin of the model
Managerial	Emphasises the effectiveness or efficiency of government policy and programmes.	Exclusive: Citizens are clients or consumers of public services. Public and private actors dominate the policy agenda.	Contracts User satisfaction Consultation	1860' Anglo-American Managerial Model
Consensual		Emphasises programmatic public- private governing relations based on negotiation and compromise	Inclusive: Key societal actors/ citizens and local leaders	Primitive societies and medieval Italian cities
Voting	Deliberation Stakeholder dialogue Participatory models	stakeholders/	Voting	Classical Greek poleis
Pro-growth	Emphasises the re-structuring of public-private relations to boost the local economy	Exclusive: Corporate actors and elected officials determine public policies. Citizens are beneficiaries.	Partnerships Corporate engagement	Economy-first utilitarian models

Adapted and expanded from Pzeybilovicz et alii (2020), Bryson, Crosby, and Bloomberg (2014), DiGaetano and Strom (2003, 366) and Caragliu, Del Bo, and Nijkamp (2011, 338).

In recent years, the dramatic technology progress in mobile/wearable computing, IoT, and cloud computing has enabled seamless connection of the cyber and physical space in a city, which makes the hybrid computing of human, machine, and smart things a new trend. Given this background, there is now a great opportunity to integrate the power of crowds (e.g., citizens, mobile devices, and smart things) into various urban context sensing and actuation tasks, which is complementary to the traditional god-dominant solutions. Yet two relatively new element have changed the context in which smart cities operate:

- The development of mobile data enables urban context sensing tasks by leveraging the mobility of mobile users, the sensors built in mobile phones, and existing communication infrastructure. In comparison to traditional infrastructure-based systems, crowd-powered urban context sensing can efficiently perceive huge urban zones at a lower cost.
- Thanks to the development of sharing economy, ordinary folks can collaborate to fulfil a variety of activities (e.g., rebalancing shared bikes, package delivery, and travel route recommendations), or they can be directed to act more cooperatively (e.g., vehicle-to-vehicle collaboration in driving, sharing reserved tables, etc.). In comparison to the god-dominant paradigm, the participative paradigm optimizes the efficiency of smart city systems by leveraging the knowledge of the multitude. People can collaborate to fulfil a variety of activities (e.g., rebalancing shared bikes, package delivery, and travel route recommendations), or they can be directed to act more cooperatively (e.g., vehicle-to-vehicle collaboration in driving, sharing reserved tables, etc.). In comparison to the god-dominant paradigm, participative paradigm optimizes the efficiency of smart city systems by leveraging the knowledge of the multitude.

While the literature has extensively examined the technology components of smart cities, the critical role of inhabitants in these communities has frequently been overlooked [34]. Too frequently, smart cities fall short of their aims because inhabitants were not adequately engaged in their definition or the impact on their daily lives was not considered. Smart cities are viewed as sociotechnical systems whose ultimate users are citizens.

We argue, on the contrary, that the key for success of Smart Cities is the movement of its governance toward a more participative structure. This is where Participative Smart Cities (PSC) come into play and can be distinguished it from traditional god-dominated smart city computing. Given the changing nature of cities, there is no uniform mode of urban governance that is suitable for all localities, or even the same city, over time. Governance is established by the growth and modification of government and social networks, the reorganization of governmental organizations, and a rise in community participation. Citizen engagement in smart city programs is dynamic; it evolves with time, and residents can accept, react to, or restructure their roles and activities. The configuration of the

elements that comprise a smart city initiative, such as access to digital tools and information, offline participation mechanisms, governance approaches, and modes of government–citizen interaction, varies according to the initiative and the societal and institutional context.

4. Structuring participation in Participation Smart Cities

Harrison and Donnely [1] define participation as the degree to which third parties are directly involved in governmental decision-making. It is critical to note how forums are arranged in this definition, with the goal of facilitating communication between government, citizens, businesses, stakeholders, and concerned organizations confronted with a particular choice or issue [66]. There are numerous models available, including public consultations, public gatherings, focus groups, surveys, citizen councils or committees, referenda, initiatives, and enterprises.

There is significant interest, both in academic study and in government practice, in new forms of state-citizen relations facilitated by ICT, particularly in public involvement or decision-making with citizen participation [67]. Applications based on ICT can be used to increase public participation in public debates concerning societal needs [47] .Citizen-centric e-governance is viewed as a novel way for governments to leverage information and communication technologies to increase citizen engagement in political dialogue and decision-making, thereby affecting significant change in public policy and governance . In general, information and communication technologies (ICTs) can mediate, extend, and modify involvement in democratic and consultative societal processes. These processes entail the use of information and communication technologies to the political, civic, and administrative domains of government.

Certain governments have demonstrated the ability of ICT to create value through cocreation and citizen participation [30]. The citizen is the focal point of applying ICT-based tools for participation, and thus the primary goal is to increase citizens' abilities to participate in governance, including the processes of providing public services at various stages of the production chain, namely planning, decision-making, implementation, and evaluation. Apart from providing public services, smart city efforts typically involve multiple sectors and encourage citizen participation [68]. Additionally, the objective is to empower them to have a meaningful impact on public policies [67], [69]. Social media may play a critical role in fostering responsive government when utilized by the public sector. According to [70] and [71] ,social media monitoring can help increase responsiveness in policymaking and citizen collaboration, but it can also help enable governance processes in which citizens participate and public organizations consider their thoughts and proposals.

According to Cunha and Viale Perreira [24], six defining elements of smart governance and participation have been identified in the literature: (1) ICT use [72]; (2) external collaboration and participation [73]; (3) internal coordination to achieve collective goals through collaboration; (4) decision-making processes [74]; (5) administration and the ability of government agencies to interact with the public online in the delivery of services

and in carrying out their predefined mandates [75] ; and (6) outcomes, where the overall aim of smart governance could be to achieve the social inclusion of urban residents in public services [9]. Such elements all highlight the proximity between the governance and the participators, regardless of their identity, and this is, by definition, a construction flaw.

5. Challenges in participative smart cities for citizen involvement

We strongly suggest that these characteristics result in a variety of dynamic citizen involvement arrangements and that a more comprehensive understanding of governance modes in the digital age – one that embraces and embeds the dynamic nature of citizenship and participation– is required. Far from catching the good part of digitalisation, this is a top-down model that emphasises central governance, which is far from being a given in the next one hundred years. As such, highlighting the links between the parties regardless of relative places, power and influence is not a satisfactory.

ICTs are enabling the construction of new 'collaborative' governance models, resulting in a more dynamic process of governance network configuration that goes beyond the traditional governance models present in each societal and institutional setting. In this regard, new governance techniques based on ICTs are having an impact on how governments design public services, develop smart city solutions, and increase the dynamism of citizen involvement.

This dynamic can be explained by distinctions in the local context and urban styles of government, as well as variances in the tools and opportunities available to different residents. It has yet to be understood at first at a technical level. Human, machine, and hybrid computational resources In terms of computational resources, the power of PSC can be classified into three categories.

1) Machine computation: the collection of machine resources utilized to execute PSC tasks may include the CPU, storage, GPS access, Internet connectivity, and sensor capabilities. For from needing to be centralized, the new options open for a participative machine computation solution. For instance, a huge number of mobile phones may gather and calculate the AQI (air quality index) of the surrounding environment automatically and without human intervention, with minimal added sensors, or even not at all . The structure sensors-computer-network, while interesting, is often already there on the field, and do not need a specific development.

2) Human computation and participation : human participants manually accomplish PSC tasks. For instance, in crowdsourcing-based logistics , human participants transport packages and distribute them to specified places or individuals. Human involvement can be opportunistic or participative. Human participants can engage in PSC tasks in one of two modes: opportunistic or participative.

a) In the opportunistic mode, participants complete PSC tasks as part of their everyday routines without deviating from their established paths (e.g., the air quality monitoring task). Due to the fact that the opportunistic mode does not require information of the

participants' intended travel routes, it is less intrusive for participants and less expensive for task organizers. However, task completion is highly dependent on the individuals' daily routines. Tasks located in locations visited by a small number of participants, or perhaps none, are less likely to be completed.

b) However, in the participative mode, players are obliged to deviate from their original itineraries and travel to certain sites (e.g., the rebalancing shared bikes) because participants must depart from their normal routines and travel to task locations, this incurs additional travel costs and might be inconvenient.

3) A mix of the two : an automobile may allow another vehicle to transmit communication message, or car sharing initiatives.

It is critical for the PSC 's success that it draw a significant number of participants, regardless of the origin of its power. Several factors, however, have a considerable impact on people's willingness to participate. Concerns and motives are two kinds of these elements.

- Concerns include factors that may influence a person's willingness to participate, such as intrusiveness, smartphone energy use, mobile data costs, and the danger of privacy leakage.
- Motivations are how participants are encouraged to participate. For instance, wealth or monetary gain has historically been a significant motivator. Additionally, individuals may be inspired to engage in an activity for social or ethical reasons. With the two categories of issues in mind, we can either address these concerns directly (e.g., by building less intrusive computer-human interfaces, energy-saving approaches, and privacy-preserving procedures) or by constructing appropriate incentive mechanisms along the way.

In our research of the issue of smart cities, we noticed that the analysis around participation in smart cities was very little focused on certain focal points. These points, far from being secondary, are not treated very much, or are dealt with only marginally. These points constitute a kind of roadblock which prevents the majority of smart cities from doing an efficient job in providing public or private services to people. These issues, which are not very present in the literature, do exist in the public documentation. To summaries, these issues are:

- **Selection of participants and assignment of tasks.** Participant selection or task assignment is critical to the quality and efficiency of PSC task completion. The term assignment was itself hard to choose it must not, for the reader, imply any authoritarian choice. The primary factors for optimizing urban context sensing activities include sensing quality and reliability, spatial-temporal coverage, energy usage, and incentive budget. For urban context actuation tasks, the primary optimization variables are service quality, incentive budget, and human intrusiveness. It's intuitive to think of a brute-force strategy that can assess the utility of each conceivable combination in order to find the ideal one. However, because the defined combinatorial optimization problems are typically NP hard

or fall within the Poincaré-Perelmann threes bodies problematic, the brute-force approach is ineffective when a large number of employees or tasks is involved. As a result, prior research has frequently chosen to develop approximate allocation algorithms (e.g., heuristic greedy, genetic algorithm, maximum flow algorithm, etc.) in order to obtain near-optimal solutions. In reality, implementing participative engagement encounters several obstacles inside the problematic itself. To begin, the citizen group participating in the process must be adequately representative of the population. For example, the selected group may be skewed toward those whose lives are significantly impacted by decisions about the smart city plan. This representation could be generated using basic demographic data to guarantee that each subgroup is representative. Second, participation can be costly in terms of time, money, and resources [76]. These obstacles may result in an overrepresentation of a certain social group with the time and resources to engage [77]. To mitigate the decision-making process's time and financial costs, this support might reward citizens with financial but also non-monetary incentives (awards, free training courses, etc.). The decision-making process's time-consuming nature, and hence the difficulty of underrepresentation of persons with limited time, can also be addressed with the adoption of electronic voting systems.

- **System interoperability.** Extremely critical and very rarely addressed, system interoperability is critical and is the primary impediment to better collaboration. These features of interoperability include data exchange as a critical asset that serves as the foundation for information and, as a result, knowledge sharing between departments and organizations (, In this regard, the importance of ICT in facilitating collaborative governance should not obscure the difficulties associated with data privacy and consistency, budget limits, and the ongoing need for technical upgrading. Future study should therefore take a more holistic/general approach to the interoperational elements of front- and back-offices [78].

- **Mechanism of incentive**. All of the concerns outlined above mean that participants must either trust the system, pay a fee or accept some risks in order to participate in a PSC work. Thus, how to establish a compensation mechanism for participants is a critical issue for the PSC . For jobs involving urban context sensing, the cloud server can exert control over participants by incentivizing them to submit the most accurate and informative data. In urban context actuation tasks, participants' behaviour (e.g., driving, strolling, reserving tables, etc.) is directed by incentives in order to maximize resource usage.

- **Scheduling tasks and path design.** Often, a single participant is required to fulfil numerous PSC duties deployed in various locations. As a result, the participant must travel between task locations, posing the optimal task scheduling or path design problem. For instance, given a set of location-dependent PSC tasks and a participant, the objective is to create a schedule that maximizes the number of tasks the person can accomplish while simultaneously taking into account travel costs and task expiration dates. To address the scheduling problem for PSC tasks, many approximation techniques (e.g., dynamic programming, maximum flow, branch-and-bound, etc.) have been developed that take trip distance and task completion time into account. Additionally, while optimizing the task

scheduling problem for real-world PSC activities, we should include other aspects (e.g., the road network, traffic conditions, etc.).

- **Preserves the privacy of participants** Concerns about privacy are a significant human issue that may influence people' willingness to participate in PSC tasks. Location privacy, in particular, is likely the most significant worry of all privacy concerns, as PSC tasks typically include spatial tasks (sensing or actuation) within a metropolis. Numerous strategies for preserving location privacy have been proposed for location-based services. For instance, when a participant uses the cloaking protection method, he or she selects a parameter of l and then uploads a coarse-region covering l fine-grained location cells; - differential-privacy constrains the adversary's posterior knowledge improvement over their prior knowledge of a user's location, while can be set by the user's privacy preferences. Generally, location privacy protection measures include the addition of noise to participants' locations, which may complicate the assignment of PSC assignments.

- **Combining opportunistic and participative forms of operation.** Existing PSC solutions are either opportunistic or participative in nature. Due to the complementing nature of these two modes, a hybrid solution may exist that successfully integrates the opportunistic and participative forms. For instance, we can recruit a group of participants (dubbed opportunistic participants) to complete activities as they go about their daily routines. Then, additional players (dubbed participatory participants) might be sent to situations where tasks cannot be done by opportunistic participants alone. The advantage of a hybrid solution is that it provides a more favorable trade-off between task completion rate and cost. However, when these two categories of participants' task assignments are connected (e.g., they share a total incentive budget), it is difficult to optimize them together, which remains a research problem for the future.

- **Deployment and evaluation in the real world.** Historically, PSC has evaluated applications or frameworks mostly through simulations, which is a common and significant restriction. While some open real-world datasets on participant mobility traces are used for urban sensing tasks, other critical parameters such as task number, task distribution, and sensor settings are frequently approximated by computer programs. Evaluation is more difficult for urban actuation tasks, as it is difficult to assess the influence of specific tactics on urban environments when participants' behaviors are unpredictable. Thus, in order to facilitate a more robust PSC system, we must invest additional effort in the following two areas: (1) large-scale and real-world deployments and evaluations, and/or (2) parameterized simulations employing data-driven techniques and behavioral models (such as utilizing more comprehensive user profiling information).

- **Social networks and technology for the masses:** Several studies in the PSC examine how individuals participate as nodes in a social network. However, social networks may exist for other forms of crowds (such as automobiles, bicycles, and mobile phones), and we could merge them. Research questions in this area include the following: 1) how to establish such social networks for various sorts of crowds; and 2) how to utilize social networks between various types of crowds to enable novel PSC applications. In a similar fashion, PSC technology becomes a critical game changer that has the potential to

transform smart cities into true citizen-centric environments. This technology is a component of an information system that enables residents to report neighbourhood problems.

- **Increasing open government**: Citizens are more engaged when they perceive governments to be receptive to interacting with them and incorporating their perspectives into decision-making processes, as well as when they have access to useful, relevant, and complete information from the government. Transparency, as Nam and Pardo [16] indicate, can be used to make government wiser.

6. A Long Way To Participatory Cities In The EU

The issue of including people in smart cities, and making them participatory has been dealt in a different ways all across the world, with obviously various effects.

In the European Union, due to the centralised structure of states and administrative institutions, the whole development of smart cities is mainly organised around public funding to projects presented as tests or projects to develop frameworks, mainly around Horizon 2020 funding at EU level. In particular, a whole series of funds have been given from 2012 onwards to develop this system. The final report is at the time of publication not yet published. The European Commission's interest in smart cities is based on the belief that, first, cities are geographical and demographic spaces where social problems are particularly concentrated, and hence highly apt testing grounds for developing solutions to social problems into viable business models.

The main problem of this system is the absence of solutions to optimise what already exists (since, by definition, these are not viable business models), but also does not take into account problems without a public-private solution (funding is very little articulated around private-private or non-profit solutions).

As a result, the European Commission's ideal type of urban development articulates around integration of new elements, while also 'actively producing, enacting, embodies, and shaping the new political and economic regimes that are operative at local, regional, national, and global scales' [22]. The challenges posed by their smaller budgets, increased responsibilities, and desire for more autonomy and a stronger city identity are not in line with the programs set by the European Commission's political goals; and inviting economic, social, and environmental solutions through corporate investment, is complicated to set in place. Smart cities, for example, will always be required to write their theme, objective, and technique 'towards' the official calls in the Horizon2020 Working Programmes, or those of other financing schemes, when they are part of a consortium that applies for European funding.

This is partly also the position of a very critical article published in 2018, [81] quote: 'many contemporary imaginations of the smart city, as well intended as they might be, are still cultivating a top-down version of citizen participation and are excluding the interests and perspectives of citizens. This article has sought to provide a fruitful scientific and societal

contribution to finding a way out of this impasse, both through explaining why (i.e. the political economy of granting and pursuing smartness) and how (i.e. the three pervasive discourse practises) the gap between smart intentions and "not-so-smart" citizen participation in the European smart city is currently reproduced, but can be challenged.'
We agree with the issue highlighted by the article, i.e. the problem of the top-down vision of European programmes, which do not offer a solution including the real desires of European citizens - without agreeing with the rest of it, which is much more debatable.

A much more interesting and significative example of a paper highlighting such 'non inclusion' of citizens in the smart cities is to be found in a 2017 paper by Paolo Cardullo and Rob Kitchin, from the NIRSA University Institute in Maynooth, Kildare, Ireland. After analysing one by one the programs the Dublin City and the Irish state organised in the general framework of smart cities, the authors come to the conclusion that among the program proposed at the time, the best inclusion efforts ended only in a paternalistic (in the bad sense of the term) and bourgeois-conformism placation illusion as referred to the Arnstein scale.

We have analysed all the cities inside the EU that appeared in the top 100 IMD/SCO 2021 rankings, collected their voting participation in the latest elections, and analysed individually their web initiatives to find whether they actively encouraged citizen participation into their own smart cities program. While we found no significant correlation between active citizen participation and the election participation, we have found a strong link between the quality of the smart city (according to the IMD/SCO rating) and the people participation support (all cities qualifying as Yes).

City	Smart City IMD / SCO SMART CITIES		Municipal latest election turnout *(when available, numbers without blank votes. If two turn election, second turn retained)*	Active marketing of a citizen participation program on the city website
	Rating 2021	Rank 2021		
Helsinki	A	6	61,9	Yes
Copenhagen	A	7	60,1	Yes
Bilbao	BBB	10	61,81	No
Vienna	BBB	11	65,27	No
Munich	BBB	14	53,7	No
Zaragoza	BBB	15	65,8	Yes
Amsterdam	BBB	17	51,17	Yes
Dusseldorf	BBB	20	45,26	No
The Hague	BBB	23	47,99	No

Rotterdam	BBB	27	46,69	No
Bordeaux	BB	32	36,36	No
Madrid	BB	34	68,23	No
Lyon	BB	39	37,99	No
Hamburg	BB	40	69,17	No
Lille	BB	44	31,9	No
Gothenburg	BB	46	81,35	Yes
Hanover	BB	47	51,3	No
Dublin*	BB	48	32,7	No
Berlin	BB	50	75,4	No
Brussels**	BB	52	82,85	No
Kiel***	BB	53	Unavailable	No
Tallinn	B	56	54,5	No
Barcelona	B	58	66,16	Yes
Paris	B	61	41,51	No
Warsaw	CCC	75	66,67	No
Bologna	CCC	77	51,18	No
Prague	CCC	78	46,44	No
Krakow	CCC	80	56,59	No
Milan	CCC	81	47,72	No
Marseille	CCC	83	31,95	No
Lisbon	CC	95	51,16	No
Bratislava	CC	96	40,68	No
Budapest	CC	97	51,47	No
Bucharest	C	106	36,76	No
Sofia	C	107	40,12	No
Athens	C	111	44,83	No
Rome	C	112	40,68	No

* information was calculated summing up districts, as no public information is available for Dublin as a whole

** Elections done in conjunction with the national and regional election

***Data unavailable because the website was broken

Finland	https://tulospalvelu.vaalit.fi/KV-2021/en/kutulos_091.html
Spain	https://data.europa.eu/fr
Bulgaria	https://results.cik.bg/mi2019/tur2/aktivnost/2246.html
France	https://www.interieur.gouv.fr/Elections/Les-resultats/Municipales/elecresult__municipales-2020/(path)/municipales-2020/

Portugal	https://pt.wikipedia.org/wiki/Elei%C3%A7%C3%B5es_aut%C3%A1rquicas_portuguesas_de_2017_no_distrito_de_Lisboa#Lisboa
Italy	https://elezioni.interno.gov.it/comunali/votanti/20211003/votantiGB AND https://elezioni.repubblica.it/2021/elezioni-comunali/
Greece	https://ekloges.ypes.gr/current/d/home/
Poland	https://wybory2018.pkw.gov.pl/pl/geografia/126100
Austria	https://www.wien.gv.at/wahlergebnis/en/GR201/index.html
Germany	https://www.wahlrecht.de/gesetze.htm
(Munich)	https://www.statistik.bayern.de/mam/produkte/veroffentlichungen/statistische_berichte/b7361c_202051.pdf / page 37
(Rheinland Westfalen)	https://wep.itk-rheinland.de/vm/prod/kw_2020/05111000/html5/Ratswahl_NRW_61_Gemeinde_Landeshauptstadt_Duesseldorf.html
(Hannover Stadt)	https://wahlergebnis.hannover-stadt.de/Wahl-2021-09-12/03241001/praesentation/guv.html?wahl_id=17&stimmentyp=0&id=ebene_3_id_1
Estonia	https://www.valimised.ee/en/local-elections-2021 and https://kov2021.valimised.ee/en/participation/index.html
Czechia	https://www.volby.cz/pls/kv2018/kv1111?xjazyk=CZ&xid=1&xdz=4&xnumnuts=1100&xobec=554782&xstat=0&xvyber=0
Slovakia	https://bratislava.sk/sk/uradna-tabula/Filter/Detail?NoticeboardId=MAG00B08IQYL%232&RecordId=2516
Hungary	https://www.valasztas.hu/helyi-onkormanyzati-valasztasok-2019
Romania	https://prezenta.roaep.ro/locale27092020/romania-pv-final
Ireland	http://www.housing.gov.ie/sites/default/files/publications/files/updated_24mar20_local_election_2019_results_book_final.pdf
Netherlands	https://www.kiesraad.nl/verkiezingen/gemeenteraden and https://www.verkiezingsuitslagen.nl/verkiezingen/detail/GR20180321/671663
Belgium	http://bru2018.brussels/fr/results/municipalities/6074/index.html
Sweden	https://data.val.se/val/val2018/slutresultat/K/rike/index.html

7.Conclusion

From citizen participation in urban planning procedures to municipal energy plans, neighbourhood budgets, and citizen juries, varied types of citizen participation must become more integrated into a broad range of government activities.

As we have noted from our analysis of EU cities, investment decisions in smart cities are undertaken without implicating the most crucial stakeholders: the citizen itself. Citizens' participation in these decision-making processes is critical since allowing people to submit

ideas, voice their concerns, and influence decisions about what to invest in and why can significantly boost the impact of investments.

Citizen engagement techniques can help build a robust and transparent democratic process while also benefiting towns by identifying innovative solutions, enhancing local action, and obtaining support for new ideas. When it comes to investments, participatory budgeting can help facilitate inclusive and creative decision-making throughout the process, from deciding what to invest in and why to providing feedback on the investment's success.

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