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ABSTRACT

More and more cities aim to solve their urban challenges by implementing various smart city initiatives. Involving citizens in the design of these projects has proven to be an essential precondition for a successful outcome. Therefore, citizen participation in the context of smart cities has gained a considerable attention by researchers and practitioners. However, participation can be instrumental to solely gain a smart label and must thus be carefully evaluated. Several evaluation frameworks, largely based on the seminal work of Arnstein's Ladder in 1969, have been developed over the years but can be oversimplified, too strict or not fit for a smart city context.

Following design science research, this paper develops a holistic framework to evaluate participation in smart cities by bundling several established evaluation scales from the scientific literature. By means of this framework, it is possible to evaluate to what extent smart city initiatives are citizen-oriented. Then, the framework is applied to the cities of Dublin and London. In order to collect more detailed information, we applied it to the case of Knokke-Heist (Belgium). Based on the evaluation of this city, some recommendations for improvement of its smart city strategy are proposed.

CCS CONCEPTS

• **Computing in Government**; • **Evaluation**;

KEYWORDS

Citizen Participation, Smart Cities, Evaluation Framework, Arnstein's Ladder

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1 INTRODUCTION

More and more cities declare to work on a broad range of smart city initiatives. A lot of different definitions exist for smart cities. In essence, these projects generally aim to facilitate citizens' lives by solving a number of urban challenges through the use of technology. This takes place in various domains: mobility, environment, economy, governance, quality of life, and human capital [1]. Each city will have a distinct main focus, depending on what it acknowledges to be most important.

In literature, the technical side of smart city activities, such as the use of the Internet of Things, sensors, big data and artificial intelligence, is often highlighted [2]. However, the term "smart" is a very broad and multidimensional concept, not only entailing technical concepts, but also human, institutional and other non-technical approaches. A famous critique by [3] tackles the smart city buzzword, underlines the need to start from the human side of the equation and argues that cities can only be smart if citizens are involved in their design. Furthermore, this participation of citizens is also underlined by the "Smart Governance" dimension of the smart city [1] and can be supported by technology in a smart city context [4]. This participation of citizens in the design of smart cities can be mapped to the relevance of user participation in information systems development [5]. However, participation can be instrumental to solely gain a "smart" label and must thus be carefully evaluated. Several evaluation frameworks, largely based on the seminal work of Arnstein's Ladder in 1969 [6], have been developed over the years but can be oversimplified, too strict or not fit for a smart city context. Therefore, by bundling several evaluation scales established in the literature, we develop a holistic evaluation framework for citizen participation in smart cities.

The paper is structured as follows. Section 2 presents previous work aiming at evaluating citizen participation, more specifically in the context of smart cities. At the end of this section the research gaps are identified. Section 3 presents the research questions and the methodology this paper follows. Section 4 describes the different parts of the evaluation framework we developed as well as its application to the smart cities of Dublin (Ireland), London (United Kingdom) and Knokke-Heist (Belgium). Section 5 discusses the limitations of the framework and possibilities for further research. Section 6 summarizes the contributions and provides some closing comments.

2 EVALUATION OF CITIZEN PARTICIPATION IN SMART CITIES

One of the most referenced frameworks for citizen participation is Arnstein's Ladder of citizen participation [6]. In this seminal paper, she argues that participation is not a binary concept but is characterized on a spectrum ranging from non-participation, going through tokenism and finally citizen power. This theoretical framework is still heavily relied on to analyze citizen participation in

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smart cities. For instance, [7] focused on Smart Dublin's initiatives and reworked the original ladder into a broader scaffold. Another recent study applied an adapted version of Arnstein's Ladder to evaluate participation in the case of Smart London [8].

Regarding the evaluation of citizen participation, Arnstein's Ladder can be considered as a seminal framework and has served as an inspiration to a variety of other frameworks. However, the ladder has received a lot of different criticisms on its oversimplification and its strict hierarchy. Regarding the oversimplification scholars argue that there is not enough complexity captured within the model, which does not allow it to reflect correctly the situation, especially in the large domain of smart cities [9–12]. The second focal point of criticism is the strict hierarchy where higher rungs are always seen as superior. However, different situations ask for different levels and types of participation [11, 13, 14]. This is also particularly important in a smart city context where different projects call for different participation methods [15].

Taking these two main critiques into account, we decided to build a holistic framework to evaluate participation in smart cities. As basis for our framework, we will rely on another evaluation framework built upon Arnstein's Ladder that compares and evaluate smart cities as enablers of citizen participation: the CitiVoice Framework [16]. Building on the formalization of [17, 18], this framework categorizes the citizens into three different roles and will be used as a basis for our holistic framework. For each role, different areas are examined, for which different criteria are defined. The first role considered is 'citizens as democratic participants'. This asks for citizen involvement in the decision process. The next role examines 'citizens as co-creators', which represents a bottom-up approach where advantage is taken of citizens' input and ideas through several methods. The last role considered is 'citizens as ICT users' where citizens can use the ICT infrastructure of the city to participate.

This framework allows having more complexity in its evaluation as it focuses on three roles of citizens in smart cities. Furthermore, it does not introduce a strict hierarchy as one role can be more appropriate to a certain context. However, this framework evaluates cities with a 0/0,5/1 scoring for all criteria which is also an oversimplification of reality. Therefore, we will draw from the literature to expand this framework to add scales to it to allow for a more refined and holistic evaluation.

3 METHODOLOGY

In order to design our holistic framework and its criteria, we followed the guidance of the design science research paradigm, consisting of three research cycles: relevance cycle, design cycle and rigor cycle [19]. This methodology was relevant as it allows to develop a concrete artefact and was used in similar context in previous research [15, 16]. Indeed, we iteratively designed it by adapting and adding scales to CitiVoice [16]. For each level of the framework, an appropriate scale was researched and refined to score smart city initiatives through several *Design Cycles*. This search has been carried out on Scopus and Google Scholar. For each level (e.g. "Living Lab"), the search keywords were the level itself, together with other (variable) keywords related with a scale, such as "ladder", "maturity", "topology", "types", "design", "scale" and "range". Additionally, keywords such as "citizen" and "participation" were used to search specifically for frameworks that focus on citizens. All the papers we found in this way were examined as to their use of a classification and whether they focused on citizen participation. If multiple candidate papers were found, the choice was made based on two main criteria: the ease of creating a scale from it and the potential applicability to a real-life case study of a smart city, where it can be used to efficiently evaluate its current approach to citizen participation. These scales were tested through theoretical cases documented in the literature such as Dublin [7] and London [8]. More information on the search and the decision to use a particular approach can be found for each scale in Section 4.

In order to test and refine the framework on a practical case, we studied the smart city initiatives of Knokke-Heist into more detail. This Belgian coastal city is rather small compared to other international case studies we have encountered. This was a deliberate choice since a smaller scale could facilitate for more direct communication with the citizens, hence enhancing citizen participation. Moreover, the city has announced that it will focus more on its citizens and that the smart city can bring value to them. Therefore, it would be interesting to evaluate how much of this focus it has implemented and where it can still improve. To execute this case study, we gathered data via four different interviews summarized in Table 1. The first interview was exploratory [20] and was conducted with the head of ICT and the political representative for digital transformation. With this interview, we aimed to get a global view of the smart city initiatives and to ensure that the city had carried out enough initiatives that we could study. In particular, we introduced the first version of the framework and our own research on this. Next, we conducted three individual in-depth interviews [21] to focus on the framework and evaluate the strategy of the city with it.

These interviews allowed us, in the *Relevance Cycle*, to ensure that the design of the framework will add value to the environment and application domain. Through the *Rigor Cycle*, we ensure that the framework contributed to the knowledge base. These theoretical contributions and limitations will be discussed in Section 5.

4 RESULTS

4.1 Holistic Framework

In Figure 1, we propose holistic framework to evaluate citizen participation in smart cities. The following sub-sections will give more details about each row of the framework. This framework is modular in nature. In future research, modifications and discussions about the rows are possible as the ranking of the elements within the rows only reflect the research from the selected papers.

4.1.1 Citizen Selection. The "Democracy Cube" of Fung [22] is very useful for distinguishing between different types of citizen selection. These types are classified from exclusive in terms of numbers of stakeholders involved at one end to inclusive at the other end. In this way, eight different types of citizen selection can be categorized: *expert administrators, elected representatives, professional stakeholders, lay stakeholders, random selection, targeted recruiting, self-selection,* and *public sphere.* The "Lay Stakeholders"

Table 1: Interviews

N	Role of interviewees	Type	Purpose
1	Head of ICT/Political Representative for Digital Transformation	Exploratory interview	Global view on smart city initiatives and presentation of framework (V1)
2	Political Representative for Digital Transformation	In-depth interview	Presentation and refinement of the framework (V2)
3	Head of ICT	In-depth interview	Presentation and refinement of the framework (V2)
4	Head of Marketing and Tourism	In-depth interview	Presentation and refinement of the framework (V2)

Figure 1: Holistic Evaluation Framework

rung refers to unpaid citizens who have a deep interest in some public concern and thus are willing to invest substantial time to participate. The other categorizations are self-explanatory. This specific framework was chosen because of its clear simplicity and the fact that it is already presented as a scale. Altogether, we believe that these eight categories are able to capture the broad possibilities within citizen selection. However, we chose to add an additional possibility at the beginning of our scale for "No Selection". It is indeed possible that no initiatives are taken for selecting citizens in a specific city.

4.1.2 Participative Goal-Making. Straus [23] developed a framework in order to show the different levels of participation in the decision-making process. This model can also easily be used in order to determine the level of involvement in goal making. No positive or negative connotation is assigned with each level of the framework as delegation might be more appropriate in some cases and consultation in others. This framework was chosen over others because we could easily map it to Arnstein's principles. Some elements from Arnstein were added such as "Manipulation", "Therapy", and "Citizen Control". "Manipulation" and "Therapy" are two items that have a rather negative connotation. They feign some form of citizen participation, with the sole purpose of showing that some initiatives are being undertaken, but genuine citizen participation is never the real goal. These are particularly relevant in a smart city context where cities could implement participation to solely seek the "smart" label. "Citizen Control" requires citizens to be in full charge of all managerial aspects, is a rather idealistic point to achieve in reality. However, we chose to add it to the scale nonetheless, because this was a very important goal according to Arnstein. Our scale is thus constituted from: *manipulation, therapy, decide and announce, consultation, input from individuals, input from teams, consensus, delegate, citizen control.*

4.1.3 Goal Attainment. Originally, Kiresuk and Sherman [24] developed their Goal Attainment Scaling as a general method for evaluating comprehensive community mental health programs. However, the simplicity and clearness of their method makes it possible to use the scaling for many other applications, as in the case in our framework. The goal is predefined and, depending on the actual outcome, there are five possibilities. The predefined goals are one of the possible steps in the previous "Goal Making" scale.

When the predefined goal is *achieved*, a score of 0 is given. A score of -1 means that the outcome is *slightly worse* than the goal, but better than the starting situation. A score of -2 means that the desired outcome is *not achieved*. Of course, the outcome might also be better than expected: a score of +1 means that *more* than the desired outcome, i.e. more than the goal, was achieved. A score of +2 means that *a lot better* than the predefined goal was achieved.

4.1.4 Direct Interaction. We chose to rely on the approaches mentioned in [25, 26], in order to restrain the large number of direct interaction best practices: *interviews with experts, interviews with users, town hall meetings, testing usability, testing functionality, testing accessibility, encourage comments, adhere to standards of service quality*. The more of the techniques listed above that are used in order to gather citizen input, the better. In this way, it is possible to organize the list of general techniques into a checklist. There is no real hierarchy possible within these general techniques, that should be implemented as much as possible to gain the citizens' input in a representative and complete way. The different shapes and colors in Figure 1 depict a checklist rather than a scale.

4.1.5 Living Lab. In order to assess a city's use of living labs, user-driven innovation ecosystem [27], we use a scale based on a framework by Pallot et al. [27]. This framework was chosen because of its simplicity and link to citizen participation. This framework created a classification for living lab initiatives including the way citizens are involved. In addition, the framework does not place a value judgement on the characteristics of a living lab initiative and acknowledges that different projects have different needs. This is in line with the second identified criticisms of Arnstein's Ladder discussed in Section 2. This framework classifies living lab initiatives according to four dimensions. Out of these four dimensions, we are particularly interested in the "evaluation focus" of a living lab. The focus determines the extent to which input from citizens is used in the living lab development and is therefore fit to assess citizen participation. The evaluation focus starts with a *functional test*, which tests the workings of a living lab. Next, a *usability analysis* has a slightly higher participation rate, since it tests user friendliness and ergonomic design. This is followed by *adaptability*, which represents the degree of user friendliness where the living lab can recompose its infrastructure according to the users' needs. Finally, the highest level of participation is achieved when the focus is placed on *adoptability*, meaning that users can create new features themselves within the lab. To these four levels we add the possibility of *no living lab* implemented.

4.1.6 Online Platform. To create a scale for the implementation of online platforms, we identified two papers that cover citizen participation in online platforms. The first paper [28] proposes a framework that classifies public policies into four quadrants. The classification was determined based on "information needed for effective participation' and 'nature of the participants (inexperienced or sophisticated)". Depending on this classification, this framework gives some guidelines on information restructuring, participation mechanisms, registration, and intensity of moderation necessary to facilitate the participation of each group on an online platform. Even though this is an interesting approach to citizen participation, the complexity created by the different situations asking for different principles was impossible to capture by a simple, linear scale. The second paper by Sandoval-Almazan et al. [29] lists 17 principles to foster citizen engagement on social media. Indeed, an online platform can be considered as a centralized platform but can also be enriched with social media [17]. Furthermore, several of these principles on social media can be transferred to the context of a centralized platform. These principles are rather simple but cover a broad scale in the use of an online platform: *clear definition of the online strategy, structure of roles and tasks on the platform, formal documentation, easy and accessible messages, use and verification of results, targeting to specific audiences*. Just as we did for direct interaction, we organize these principles as a checklist.

4.1.7 Infrastructure. The infrastructure can be defined as the technological devices used in the city to foster participation. One framework by Haklay [30] addressing these criteria introduced a classification of the degree to which citizens are involved in citizen science projects. Since this classification was very interesting and easy to apply, it could easily be generalized to citizen participation thanks to the ICT infrastructure of the city in general. The framework defines different levels similar to Arnstein's Ladder. Contrary to Arnstein, Haklay clearly states that a certain level in this framework contains no value judgement. However, he does acknowledge the benefits of trying to move to the highest level.

This framework can be slightly adapted to assess a city's initiatives in infrastructure. The possibility of *not using any smart infrastructure* is added at the bottom of the scale. The other four levels correspond to the levels in the original framework. In the first level, *crowdsourcing*, the participants are included in a passive way. At this level, a complete understanding of the project is unnecessary. Haklay argues that many citizens would like to be included in the project without having to fully understand the science behind it, making this level not necessarily inferior to higher levels. The next level, *distributed intelligence* makes use of the cognitive ability of the participants. Participants will receive some basic training after which they will collect data or provide some interpretation. The training can then be used as an indication of the quality of the participants' work. Further up the scale in *participatory design*, participants can set the problem definition and determine the data collection method themselves (with possible help from experts). However, the assistance of experts is still required for analyzing and interpreting the results. Finally, we find *collaborative science"* at the top of the framework. At this level, a full integration of professional and non-professional scientists is achieved in order to decide on the problems, the data collection and interpretation. Citizens can choose their own level of participation, from start to finish. Moreover, this level opens up the possibility for citizens to carry out the entire project by themselves, without the involvement of any professional scientists.

4.1.8 Open Data. To score open data initiatives, we searched for a framework that also highlights the importance of citizen participation. Only one such framework could be identified, taking the form of a cycle process. This framework looks into six principles on how to create an open data platform and stimulate its use [31]. The cycle starts out by *clarifying the concepts* of open government, transparency and open data. Given their subjective meaning, their definitions have to be clarified before embarking on a new project.

The second principle stresses the importance of *identifying the potential users and needs* before opening up data. This identification can be used to support the prioritization of data to be released. Without careful planning, the process will be very time-consuming and costly without being effective, leading to open data that lacks value and relevance. Thirdly, a well-built *data catalogue* is the stepping stone for open government. Therefore, a format should be used that maximizes reusability and colloquial language. An open format allows for easier access and more dynamic interaction. In addition, government data is typically full of technical terms that are not clear to the citizens. To provide greater understanding, accessible translation and description of these terms should be provided. The fourth principle points out that open government is only a reality when *data sharing* is promoted to create public value through an easy access to the data. This only happens when the public uses the data for non-governmental purposes. The fourth principle is added to foster this public use. However, if the end-users are not aware of the data system or how to use it, the system will have only a limited impact. This is why the fifth principle points to creating a *culture of open data*, open government and transparency to improve the public's usage of the data. Finally, the sixth principle states that *teamwork and multidisciplinary teams* should be fostered to implement the technologies as well as the policies, programs, etc. In scoring a city's open data initiatives, we will examine how many of these principles have been implemented and how far along in the cycle. In addition, we have added to the bottom of the scale the possibility that a city has *no open data initiative*.

4.2 Evaluation Modalities

Because the eight dimensions hold an equal weight, each scale will be scored on the same range. Due to the evolutionary nature of the selected scales, the first item within the scale will have a score of 0 and the last item a score of 10. Everything in between will be equally divided. For example, nine items are present in the "Citizen Selection" scale. Because all scales are scored on 10, and only reaching the first step will result in a score of 0, each further step on the scale will account for 1.25 points (10/(9-1)). Thus, if a city selects 'Professional Stakeholders' in order to participate, a score of 3.75 out of 10 will be given. This is calculated by the cumulative sum of: 0 (No Selection) + 1.25 (Expert Administrators) + 1.25 (Elected Representatives) + 1.25 (Professional Stakeholders) = 3.75.

A similar principle is used when there is not a scale, but a checklist in place. Within a checklist no clear hierarchy is possible, so the goal is simply to check as much of the boxes as possible. For example, in the "Direct Interaction" checklist, there are eight different items to check. Implementing none of these techniques will result in a score of 0, while using all of them will give a maximum score of 10. Each item implemented accumulates thus for 1.25 points (10/8). If a city implements 6 techniques, it will obtain a score of 7.5 (= 6*1.25) out of 10 for the "Direct Interaction" scale.

4.3 Application to Smart Cities

4.3.1 Theoretical cases: Evaluation of Dublin and London. As a first validation in the relevance cycle, we applied the framework to international well-established smart cities: Dublin and London. Information about the activities of these cities were retrieved through scientific literature [7, 8] and from the official websites of the cities. The scores were computed by the researchers. Table 2 summarizes the evaluation of the cities.

This evaluation allows taking a strategic look at the participation strategies of both cities. Dublin has developed several smart city projects and is still trying to grow as a smart city. However, when it comes to citizen participation some improvements are still desirable. First of all, a wider range of citizens should be included. Despite its efforts, it seems that Dublin still only consults a limited amount of citizens (most of which are field experts). In order to improve its citizen participation, the city should try to move into a more public, diffuse sphere, while at the same time also give some power to the citizens, rather than just an advisory role. In contrast, Dublin performs quite well on co-creation with citizens. The living labs are quite advanced and citizen-centric, the online platforms are well-built and several direct interaction techniques are being used. A point of attention resides in the formalization of online platform strategy. However, as previously mentioned, the city may have carried out this formalization without any public information on this. Finally, Dublin has a very strong open data platform. On the other hand, the infrastructure contains barely any citizen participation. The inclusion of citizens as more than simple data points in the system could bring large benefits to the city's infrastructure projects.

Overall, London performs quite well on the dimensions. A point of critique could be made on the selection of citizens and the power they hold. London should try to involve a more diffuse public of citizens. However, the city acknowledged this need and is already making efforts to improve this inclusion. What could still be worked uponed is the citizen power. Citizens still remain largely in an advisory position, while the city should perhaps grant them more decision power. This is also found in the citizen involvement in infrastructure. Citizens are more than simple data points, but their cognitive ability is only used within the execution. By including citizens from start to end, they can provide more input into the decisions and exert more power.

However, in both cities, information could only be retrieved from secondary sources and led to a lack of information for some scales (e.g.: goal attainment). Therefore, we decided to focus on a smart city where direct access to the stakeholders was possible.

4.3.2 Practical case: Evaluation of Knokke-Heist, Belgium. In this study, we strived to apply our own framework to the case of the city of Knokke-Heist (Belgium). It is important to note that Knokke-Heist is a relatively small coastal city of 33,068 inhabitants. This rather low number of inhabitants results in lower budgets and capacity compared to other larger smart cities in Belgium. In this analysis, it is important to keep in mind that, even though Knooke-Heist is striving to improve its smart citiy initiatives and citizen participation, certain projects of the city are simply impossible to carry out due to these resource constraints. In the following, we will discuss initiatives from the board of Knokke-Heist in each dimension and score these initiatives on the scales we introduced into the framework. As mentioned in Section 3, this information was retrieved by conducting four interviews with three city employees

Table 2: Evaluation of Dublin and London

Category	Scale	Dublin	London
Citizens as Democratic Participants	Citizens' Selection	3.75 – 5	8.75
	Goal Making	6.25	6.25
	Goal Attainment	(No information found)	(No information found)
Citizens as Co-Creators	Direct Interaction	7.5	8.75
	Living Lab	10	10
	Online Platforms	5	5
Citizens as ICT users	Infrastructure	2,5	5
	Open Data	8,33	8.33

(head of ICT, political representative for digital transformation and head of marketing and tourism). While doing so, the framework and in particular the added scales are being tested for applicability. At the same time, by presenting the framework to both field experts and novices who are not familiar with smart cities, the framework has been tested for its clarity and comprehensiveness. The information gathered for each criteria is hereunder explained:

Citizens Selection: Knokke-Heist's citizen selection process is dependent on the type of project the city is working on. Quite often, it relies on volunteers (after publicly announcing the initiative). However, if the city is working on a co-creation project, they will recruit experts in a certain field to work on the project. Thus, we can position Knokke-Heist at either '**professional stakeholders'** or **'lay stakeholders'**.

Goal Making: The goal making process is mainly executed by the board itself. Afterwards, this goal is announced to the public. However, after this announcement, citizens are free to give their opinion and suggestions on the topic. This input is then used to change the scope of the project to make it more fitting to the citizens' needs and expectations. As the input given by the citizens is actually taken into consideration by the board, we cannot label this process as consultation, but rather as **'input from individuals'** or **'input from teams'.** Whether this input is given by teams or individual citizens is once again determined by the type of project.

Goal Attainment: The city and the board give feedback on the involvement of citizens in their smart city projects at set time intervals. Each time, they conduct an elaborate study on their goals and progress. We computed the aggregation of the goal-attainment for each project and assigned one general score to the dimension with the **goals of participation generally attained**.

Direct Interaction: From the identified interaction techniques, Knokke-Heist's smart city initiatives have implemented the following **five** techniques: Interviews with experts, Town hall meetings, Testing usability Testing functionality, and Encourage real-time comments and suggestions.

Living Lab: Knokke-Heist dreams of implementing a living lab. The infrastructure for such a lab is already in place in a certain housing area. However, the city has not yet been able to execute it, this is mostly due to budget restrictions and the fact that not all board members are motivated by this living lab. Because of this, we can place Knokke-Heist at the lowest level of our scale**, 'no living lab'**. It is important to note that smaller cities are simply confronted with smaller budgets.

Online Platform: Knokke-Heist is active on social media where it has implemented all **six** of the identified principles. However, it also has an online platform[1] on which citizens can voice their opinions, hold brainstorm sessions and open discussions where it implemented **none** of the principles. Thus, the score is computed as average of the online platform and social media.

Infrastructure: The city has many sensors working to control water levels, public garbage bins, noise, traffic counts and humidity within public buildings and equipment. At the moment, citizens are not involved in these projects at all. This places them at the lowest level of our scale ('**no use of smart infrastructure'**). However, Knokke-Heist is planning to execute a project that would map cycle and jog routes. In order to achieve this, the city will use citizens as sensors to examine these routes. A project like this would grant them at the level of crowdsourcing.

Open Data : Currently **no open data platform** is available for the city of Knokke-Heist. A data catalogue is one of its goals, but this is infeasible on the current budget and capacity. In addition, the city also believes that a certain initiative should come a from regional (Flanders) or federal (Belgium) level.

Table 3 summarizes the computation of the evaluation into scores for the city of Knokke-Heist.

Through the evaluation and thorough analysis of the city with the framework, we were able to deliver managerial recommendations to the city officials. Our framework allows us to formulate suggestions that are non-expensive to implement. We took into account the budget restrictions of the city. Therefore, we did not recommend actions about open data platforms or living labs as they could reveal to be more expensive. These recommendations can be summarized into a few key points of action linked to the framework above:

#1: A great deal of citizen participation in Knokke-Heist depends on volunteers, the city should aim for more inclusion. By extending its communication to several different channels, the city could reach to a wider audience, which leads to the inclusion of a more diffuse public.

#2: Even though the city has performed several actions on its social media, the implemented principles have not been transferred to the online platform. Moreover, their workings and responsibilities are completely separated from each other. To tackle this, the

[1] https://knokke-heist.citizenlab.co/

Table 3: Evaluation of Knokke-Heist (Belgium)

Category	Scale	Evaluation (Knokke-Heist)	Recommendation
Citizens as Democratic Participants	Citizens' Selection	3,75 – 5	#1: Target inclusive participation
	Goal Making	5 – 6,25	#2: Increase decision power of citizens
	Goal Attainment	5	-
Citizens as Co-Creators	Direct Interaction	6,25	-
	Living Lab	0	-
	Online Platforms	5	#3: Foster collaboration between social media and online platform
Citizens as ICT users	Infrastructure	0 - 2,5	#4: Focus on accessibility of smart city initiatives
	Open Data	0	-

city should foster the collaboration between the respective responsible departments to unify strategies, roles and responsibilities, and communication style in all online communication.

#3: Citizens should have more influence in the decision-making process. For instance, the city could further exploit the possibilities of its online platform. Currently citizens can already launch new ideas and brainstorm on current topics in the city. However, it is very unclear what is being done with these ideas. The city should not just collect these ideas but engage more into a conversation with citizens. This could be done by simply commenting whether or not the city will further explore a certain idea or, even better, by engaging into a constructive discussion with the users.

#4: The city should test for accessibility in a new smart city project. This can be illustrated in their future project of mapping out walking and cycling routes. When launching this project, it should not solely test whether a sensor or an app is working and correctly registering the routes. In addition to this, they could test the compatibility of the app with different phones or with the sensors on different types of bikes. This test would ensure accessibility to a broad audience. It should also aim to include a diffuse public. Given the importance and large presence of tourists in the city, the city should aim to include these tourists as well.

5 DISCUSSION, LIMITATIONS AND FURTHER RESEARCH

In this section, we explain the inherent limitations of this research and how further research leads could address them. The main limitation emerges from the selected literature sources for the scales. Despite the thorough literature review, different scales could be added to the framework in the future due to the growing body of knowledge about participation in smart cities. Thanks to the modular nature of the framework, the adding and removal of scales is made easy and constitutes a promising lead for further research.

A second limitation can be found in the difficulty to retrieve information about some elements of the framework (e.g. goal attainment). Some information is often not made public, and even when progress reports are being published, a goal attainment score largely depends on a single project and can therefore not be used to assess the overall strategy of a smart city. Further research should investigate leads to retrieve this information through appropriate interview guides and questions.

The framework has been refined and tested on two rather extreme types of smart cities. On the one hand, Dublin and London are large cities with a massive amount of smart city initiatives. On the other hand, Knokke-Heist is a small city with a rather low amount of smart city projects due to the budget constraints. By leaving out a test on more intermediate smart cities, the framework might contain some other, unidentified shortcomings. The possible adaptation of the framework depending on the type of smart city evaluated also constitutes a valuable research lead.

The Knokke-Heist case has been conducted on limited information. Even though we conducted several interviews, the collected information is likely to be precarious. We conducted four interviews with three different stakeholders. There might be some information left that these stakeholders have no knowledge of, or that was not discussed during the interviews. In addition, the interviewed stakeholders are servants of the city and hence may portray some (subconscious) biases.

6 CONCLUSION

This paper introduces a holistic evaluation framework for citizen participation in smart cities, drawing from seminal Arnstein's Ladder and from more recent frameworks such as CitiVoice. Our framework evaluates to what extent a smart city's initiatives are citizen-oriented in a holistic manner though three roles: 'Citizens as Democratic Participants', 'Citizens as Co-Creators', and 'Citizens as ICT Users'. Within each of these dimensions, criteria from selected literature sources are added to evaluate participation through a scale. This holistic evaluation enables having a strategic overview on the participation activities performed in a city. The framework was then applied to the cities of Dublin and London through information retrieved from websites and scientific papers. For the case of Knokke-Heist (Belgium), information was collected by conducting interviews with different relevant city representatives and recommendations to strengthen citizen participation in Knokke-Heist were issued by applying the framework to the city.

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