Gamification in a Smart City Context. An Analysis and a Proposal for Its Application in Co-design Processes

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Abstract. In the academic debate on smart city definition, the "human" part of the city is gaining a prominent position as a decisive factor in good city policies. So, Public Administrations (PAs) are looking for the citizen involvement in the decision-making processes, in order to create products and services really meeting the city needs. In this context, gamification principles are more and more employed as facilitator of the citizen engagement process. In this paper, we intend to show the main findings of our analysis on the literary review about application of gamification principles in the smart city context, providing some considerations about their possible application in public policies co-design.

1 Introduction

In the last years, the academic literature gave several definitions and visions of the concept of "smart city", setting some common multidimensional components related to three main categories: technology, people, and institutions [1]. According to Hollands [7], who provided a preliminary critical polemic against some of the more rhetorical aspects of smart city, each of these definitions is strictly related to the field of study of the single researcher who delivers it.

Generally, in the vision of smart city the use of ICT is emphasized, but recently into the academic debate on smart cities people became the center of the urban smartness. The Human Smart Cities Manifesto [3] is emblematic of this vision. In detail, "Human Smart Cities are those where governments engage citizens by being open to be engaged by citizens, supporting the co-design of technical and social innovation processes through a peer-to-peer relationship based on reciprocal trust and collaboration. […] A Human Smart City adopts services that are born from people's real needs and have

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been co-designed through interactive, dialogic, and collaborative processes. In a Human Smart City, people […] are encouraged to compose their own services using available technologies in simple, often frugal solutions". We agreed with this "human" vision of the smart city. Moreover, we suppose that the use of gamification principles can support citizen engagement in the smart city co-design process. In detail, we deem the game mechanisms and dynamics can produce socially virtuous behaviour, by improving the world understanding and by making some actions more enjoyable [5].

In this paper, we intend to show the main findings of our analysis on the literary review about application of gamification principles in the smart city context, providing some considerations about their possible application in public policies co-design. In detail: in the next section we will define the gamification and co-design methodologies, focusing on their integration in order to involve citizens in city issues; in the third one we will analyse the academic literature about application of gamification principles in the smart city context; in the fourth section we will discuss the findings of our analysis; in the fifth one the conclusions and future work.

2 Citizen Engagement in Gamification and Co-design Processes

Nowadays, Public Administrations (hereafter PAs) are opening to a larger citizen engagement in decision-making processes concerning local public policies activities [24], aware of the importance to really meet the citizen needs in the design of new services or products [2, 3]. This attitude is consistent with the increasing joint involvement by citizens aiming to actively influence the decisions of the PAs (*bottom-up* approach), or even aiming to work together by organizing themselves without PA presence (*crowdsourcing* approach). Anyway, it is the duty of the PA trying to involve as much as possible all citizens interested by a given action.

Co-design is a practice very useful for citizen involvement in PA-driven decision-making processes [40]. It is particularly suited to bring citizens to the city issues and to make them more satisfied, since it helps to provide a vision shared between the different stakeholders living in the smart city environment [25] and to meet people effective needs. In co-design process designers encourage and guide users to develop solutions (i.e. new products and services) for themselves, attempting to actively involve all the stakeholders, and not limiting participation to a selected group of people (*lead user* approach). As for other similar approaches, like co-creation (i.e. creativity that is shared by two or more people) and participatory design (i.e. user participation in system design), the user is considered as a partner [25], not as a subject to be studied, but in co-design all the players (i.e. designers, researchers, and users) have the same importance in the system design.

In the report of the Smart Cities project [40], the co-design process is implemented following the five stages design thinking process (i.e. the design-specific cognitive activities that designers apply during the process of designing [4]), that includes: problem statement (with the identification of user needs), immersion and empathy (in the specific problem), synthesis (of the emerged ideas), ideation (of new products or services), prototyping (of a model quickly showing citizens and users what their inputs have produced). By actively collaborate into the design process, the

user results to be involved in that particular matter, but the *intensity of the engagement* [40] (i.e. if the engagement is simply a case of fact-finding, or people are able to shape the outcome together) changed depending on those in charge for delivery of the service or product.

From the point of view of a PA opening to a larger citizen engagement in decision-making processes, the intensity of engagement have to reach the higher level and the larger number of people involved. In this regard, the *gamification approach*, whose main purpose is to engage people through innovative modes, could help in actively involving citizens during the design activities. In detail, according to Deterding et al. [36], "gamification" is "*the use of game design elements in non-game contexts*". It differs both from "playful interactions" (in which there are no rules, competition, and goals), and "serious games" (in which complete game for non-entertainment purposes are used). Gamification can be used to make more attractive task and activities in different areas of application, therefore improving the participation and the motivation of people who have to perform them [6]. So, we deem that gamification and co-design can be joint together to enhance citizens engagement in the smart city context.

3 A Literature Review of Gamification in a Smart City Context

Only recently, in the academic debate, the city has been investigated as an area of application of gamification principles. In this paragraph, we will introduce a brief literature review regarding the application of gamification in a smart city context. The use of these principles can be analysed from different points of view. So, we will focus on the gamification modes for engaging citizens in the city issues. On this basis, we will consider people as "citizens" and "players" at the same time.

The most part of the scientific contributions on gamification applied in a smart city context concerns the design and the development of web and mobile applications (or proofs of concept) addressed to the citizens. In this work, we analyse 24 game applications (or proofs of concept) applied in a smart city context. Since our focus is the citizen engagement through gamification, we consider three main elements: the *playing area*, the *user interaction modes*, and the *roles performed by the citizens* while using a certain application.

In particular, the "playing areas" aspect allows us to investigate the main environments and matters affected by game applications, as well as the places and the topics *where* citizens are involved. The "interaction modes" are important for the identification of the actions performed by users in the smart city context, showing *how* citizens are involved. Finally, the "roles" aspect permits us to identify the kind of activity that citizens perform in the smart city context, to figure out *what* effect the engagement produces. Below, the main findings of our literature review.

3.1 The Playing Areas of Game Applications in the Smart City Context

As "playing area", we mean both the places where citizens are engaged through gamification, and the topics on which they are involved. In the considered applications, the main playing area is the physical environment of the city. As a consequence, most part

of these applications are *mobile* and they mainly affect the *mobility* and *environment* issues. In particular, their main aim is to prompt citizens to do more eco-friendly activities. For example: to reduce the CO_2 emissions [9, 18, 29]; to choose sustainable means of transportation [10, 18, 30]; to promote collaborative riding [35]; to recycle [10, 14]; to check noise pollution [12]; to foster sustainable communities [16, 39]; to foster healthy climate [16]; and to educate in energy conservation [31].

In addition to the mobility and environment fields, we found that the gamification principles are used also into the *touristic field*. For example, Gordillo et al. [8] propose a new way of visiting a city by employing a "treasure hunt", in order to provide people some information about the cultural heritage. Moreover, in [20] Lorenzi et al. describe a mobile application based on QR Code technology with the aim to incentivize the use of a National Park.

Another important field of application of gamification in a smart city context concerns the *relationship among people*. In [13], for example, Laureyssens et al. describe a public game designed with the only aim of augmenting the community cohesiveness, as well as in [19]. Moreover, in [32] Bista et al. propose an online community in which some users can give support to others relying on their previous experiences in specific matters.

In other cases, the applications affect *a large number* of playing areas. In this regard, in [11] Crowley et al. present a mobile application designed with the aim to prompt citizens to report on issues about the whole city context, i.e. mobility, environment, living, government, etc. Also Lehner et al., in [23], propose a mobile application in which citizens can share personal ideas or opinions about all the issues concerning the city.

3.2 The User Interaction Modes of Game Applications in the Smart City Context

The applications we analysed have different user interaction modes. As "user interaction mode", we refer to the main actions that user needs to perform in order to progress in the game. So, it is related to the modes of citizen engagement in the game applications. By analysing them, we have identified the following user interaction modes:

1. *The user acts and the system records the user actions and/or data about user actions*. According to this interaction mode, user is free to perform actions in the real environment; the system automatically records these actions or the data about them. This is the case of the application described in [12]: citizens go through the city and the system records data on the city noise. Moreover, the application of Kuramoto et al. [15] records data about the citizen behaviour in public means of transportation, while in [17] Gnauk et al. design an application that registers the citizen data consumption.
2. *The user self-reports the performed actions and/or data about them*. In this case, user performs actions in the real environment and he/she autonomously reports his/her actions and/or data about them on the application. In [9], Liu et al. design an application in which user needs to indicate the performed actions in the sustainability field. Only after doing this, the system is able to indicate if these actions lead the users to progress in the game or not. The application of Vara et al. [10] provides the

user the typologies of actions among which he/she can indicate the performed action (e.g. "walking", "biking", etc.), while in [11] Crowley et al. design an application in which users can share the problems encountered in the city context.

3. *The user completes missions*. In this case, the system gives some goals to the user and the latter performs actions in order to achieve them. In [16], for example, Lee et al. describe an application that gives communities some missions concerning the respect for the environment, while the application of Jylhä et al. [18] gives people missions about the sustainable mobility.
4. *The user shares user-generated contents*. According to this interaction mode, user can share personal contents in order to progress in the game. For example, in [23], Lehner et al. propose a mobile application in which citizens can share contributions about the city environment (e.g. ideas, opinions, etc.) in order to strengthen his/her participation in the city issues. Similarly, in [32] Bista et al. propose a mobile application in which citizens can share their experiences in order to support other people in similar situations.
5. *The user explores locations*. This interaction mode foresees to explore the city and to find specific places in order to progress in the game. For example, in [8], Gordillo et al. consider the city as a "learning gamified platform", with specific "Learning Points of Interest" to be discovered. Moreover, in [22], Chan proposes a game application with the aim to prompt people to explore alternative routes for their commute, in order to reduce the traffic congestion.
6. *The user simulates a situation*. In this case the game strengthens the user's skills in a simulated environment. For example, in [33] Schoech et al. develop a violence prevention game for youths, by putting them within some possible real-life situations. The youth civic education purpose is present in [34] too, where Barthel designs a video game in order to provide young people with knowledge about the governmental processes.

3.3 The Roles of Citizens Using Game Applications in the Smart City Context

Finally, as "role" we intend the kind of activity that citizens perform in the smart city context. The main roles of the citizen using the game applications are:

1. *Learner*: the citizen learns something in order to improve the quality of his/her life or to change his/her lifestyle. He/She can assimilate contents (e.g. in [8], Gordillo et al. consider the city as the place in which citizen can play and learn something about its history) or behaviours (e.g. in [21] the application aims to encourage students to increase the physical activities; the application described in [30] aims to encourage cycling). In some cases the target of the applications is young people (e.g. [33, 34]).
2. *Examinee*: in this case, it is examined whether or not the citizen performs the correct behaviour. Therefore, the citizen is not a "learner", but the application only evaluates his/her behaviour. For example, in [9], Liu et al. design an application aiming to evaluate if user do eco-friendly activities. He/She knows the correct behaviour, and he/she needs only to put it into practice.

3. *Teacher*: the citizen "evaluates" and monitors the city and its elements. For example, Crowley et al. [11] design an application in which the user has to report the problems about the city. In this case, the citizen is not a "learner", nor an "examinee", but he/she acts on the basis of a prior knowledge. The same thing occurs in [23], where the described game application is based on the contributions of the citizen: he/she can share his/her ideas or opinions about the city context. The "teacher" role is particularly emphasized in [32], where Bista et al. propose an online community in which people can give support to others, through advices and opinions.
4. *Sensor*: the citizen collects data and information on the environment that PAs can use for specific analysis on the urban context. This is the case of the applications described by Garcia Marti et al. in [12], in which the "crowdsourcing approach" allows the collection of data about the noise pollution, and by Gnauk et al. in [17], where the aim of the application is to collect data about energy consumption.

4 Discussion

The game applications we analysed engage citizens according to different degrees. The analysis of the user interaction modes (Sect. 3.2) points out that the game mechanisms can be more captivating (e.g. the user interaction mode "Share user-generated contents"), or less (e.g. the user interaction mode "The user acts and the system records the user actions and/or data about user actions"). The analysis of citizen roles (Sect. 3.3) shows that these applications generally aim to prompt people to assume a good behaviour in living the city. The most affected fields are mobility and environment (Sect. 3.1).

However, in these game applications, the citizen engagement settles on medium degrees of intensity. Indeed, only in very few cases the contributions of the citizens are the core of the applications. We refer in particular to the work of Crowley et al. [11], where citizens can report on issues about the city context, and to the work of Lehner et al. [23], where citizens can share ideas and opinions on how to solve city problems.

On the contrary, we assert that the degree of intensity of citizen engagement through gamification can further increase. Consequently, *citizens would be required to collaborate and participate, in a gamification context, during the decision-making processes concerning the smart city issues* and *to take part during the co-design of new services and products in the urban context*. According to this consideration, we assert that the areas of *gamification* and *co-design* can be profitably integrated. Below, a no complete list of the meeting points of these two areas:

1. *Improvement*. On the one hand, co-design results lead to the improvement of quality of life (through the realization of new services and products). On the other hand, the commitment in the game applications leads to the progress of the player (through new levels, new powers, etc.).
2. *Several roles and Empathy*. On the one hand, in co-design processes different stakeholders with specific needs work together and collaborate to design products and services for themselves. The people involved are asked to fully "play" the role they

have (for example, one of the main tools used during a co-design process is the customer journey mapping, in which stakeholders indicate their own habits and daily activities). On the other hand, during a gamification process player plays a role, with specific characteristics, and different players can play different roles.

3. *Story*. On the one hand, co-design process is a developmental process: it "tells a story", that the involved stakeholders will lead to a "happy ending" (to design a product or service). On the other hand, one of the "affordances" that can be used during a gamification process is the "story", in which the narrative elements play a central role. The "story" elements are closely related to the "roles".
4. *Human aspects*. On the one hand, co-design processes count on people (with their specific wants and needs) as designers. On the other hand, according to [36] in gamification processes, HCI (Human Computer Interaction) field is not related to the technological aspects, but to the user interaction ones.
5. *Creativity*. On the one hand, in co-design process a point of strength is to find innovative solutions to new or traditional problems. On the other hand, imagination and creativity are fundamental elements of the games. In general, creativity supports problem solving.
6. *Results orientation*. On the one hand, all the steps of a co-design process are oriented to the design and prototyping of a product or service that citizens can use. On the other hand, during a gamification process players intend to achieve specific aims (points, badges, to win a competition). The achievement of the results gives satisfaction.
7. *Rules*. On the one hand, a co-design session has rules that participants must follow. On the other hand, during a game, players can achieve specific aims only if they follow the given rules.

Considering these common points, we argue that gamification techniques and principles can be applied during the co-design processes, in order to improve citizen engagement and participation in the realization of new products and services in the smart city context. In the academic debate, some authors have begun to explore the contact area between co-design and gamification. Their works concern two main fields of application: the collaborative working environments (e.g. in [37] Fernández-Luna et al. focus on CIS - Collaborative Information Seeking systems; in [38] Moradian et al. focus on brainstorming systems) and the learning context (e.g. in [26] Dodero et al. present a study in which co-design is blended with gamification and collaborative learning). Nowadays, the contact area of gamification and co-design in the smart city context is still an unexplored area.

5 Conclusions and Future Work

Following a "human approach" to the smart city services and products design, we investigated how gamification principles were applied in a city context in order to engage citizens. We found that despite the aim of gamification is the involvement of people, nowadays its application is underestimated by the PAs looking for a deeper involvement of citizens in the city issues. On the contrary, we argue that gamification is really suitable

to be used in decision-making processes and during the co-design of new services and products in order to motivate citizen to actively participate.

On the basis of this preliminary analysis, our future work will be addressed to the implementation of the gamification principles in co-design processes, by focusing on the identification of the more suitable game patterns [27], affordances, models and methods in accordance with the specific city context. In so doing, we will evaluate in which degree gamification increases the intrinsic and extrinsic motivations [28] of citizens at participating in city development.

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