Gamification in the context of smart cities

M R Zica¹, A C Ionica¹ and M Leba²
¹University of Petrosani, Engineering and Management Department, Str. Universitatii, 20, 332006 Petrosani, Romania
²University of Petrosani, Computer and Electrical Engineering Department, Str. Universitatii, 20, 332006 Petrosani, Romania

E-mail: monicaleba@yahoo.com

Abstract. The recent emergence of smart cities is highly supported by the development of IT and IoT technologies. Nevertheless, a smart city needs to be built to meet the needs and requirements of its citizens. In order to build a smart city it is necessary to understand the benefits of such a city. A smart city is, beyond technology, populated by people. A smart city can be raised by its citizens' contribution, and gamification is the means to motivate them. In this paper we included gamification techniques in the stage of capturing the citizens' requirements for building a smart city. The system proposed in the paper is to create an application that allows the building of a virtual smart city customized by each user. From this virtual city, the most relevant features are extracted.

1. Introduction. Literature review. Related work

A smart city is an urban development vision to integrate information and communication technology (ICT) and Internet of things (IoT) technology in a secure fashion to manage a city's assets [1].

Its necessity is considered to be driven by the massive urban growth [2].

![Smart City Framework](image.png)

Figure 1. Smart City framework

In the context of a city and most importantly of Smart Cities, citizens became a very important piece in the city’s development. In order to keep them engaged, real quality services have to be offered through the help of the application which is to be implemented [3].
Gamification is a term introduced in 2002 by Nick Pelling [4], but became popular only in 2010 [5]. Gamification represents the application of game principles and design elements in non-game contexts [6]. Gamification is about motivation, fun, rewards, competition and challenges. This concept has been applied in various fields even though it was not identified as gamification.

Connecting with the Smart City framework designed by Arup J. Paul [2], hereby are examples of the concept applied in different fields.

1.1. Economic Sustainability
Regarding the Economic Sustainability, gamification was already applied in the following fields: banking, eGovernment, Infrastructure and Job creation.

1.1.1. Banking. Gamification can motivate people to use digital channels in order to do banking operations, which leads to less operational costs for the bank. ICICI is a bank that applied gamification in the saving area of its products: deposits, savings, money management. They have designed a platform which contains a leaderboard that shows which customer/player has achieved the best score by gaining points [7].

![Figure 2. ICICI Bank application screen shot](image)

1.1.2. e-Gov. Hawaii government wanted to implement a platform that can change its citizens’ perception towards the online government services. The platform was launched in April 2014, with the goal of allowing citizens to access information about their state and county government interactions, services they like, paper and gasoline saving they have made and so on. The result was the online services usage increase instead of paper [8].

![Figure 3. Hawaii.gov platform screen shot](image)
1.1.3. Infrastructure. In UK and Australia gamified programs were implemented in order to encourage citizens to walk and cycle. In Australia the result was that 35% of the car trips to school were replaced with healthy transportation means. A program for public transportation was introduced in Singapore. The goal was to motivate citizens to use the public transportation in other intervals than the rush hours. They were included into a raffle and received rewards. After 6 months of testing in 2012, the result of the program was an estimate of 8% shift from the rush hour to the normal hours [9].

![Insinc platform screen shot](image1.png)

**Figure 4.** Insinc platform screen shot

1.1.4. Job creation. Gamification has also been applied in the field of human resources and personnel recruitment. Marriott Hotels developed an application for people who wanted to work for their company. The application, Marriott My Hotel, allows people to virtually walk inside a hotel in order to become familiar with what their potential job would imply [10].

![Marriott My Hotel application screen shot](image2.png)

**Figure 5.** Marriott My Hotel application screen shot

1.2. Environmental Sustainability

Regarding the Environmental Sustainability, gamification was already applied in the following fields: CO2 emissions, Water, Energy and Waste management.

1.2.1. CO2 Emissions. VTT Technical Research Centre of Finland designed an application tested in Helsinki, Nice and Vienna. The application provides alternative plans in order to minimize the energy costs and CO2 emissions. The result of this project was the energy costs reduction by 15% and CO2 emissions by 30% [11].
1.2.2. Water. Waterwise and WRc is searching for other companies to collaborate in creating a platform which has the goal to change the relationship between water companies and customers by using gamification and also reduce water consumption [12].

![Figure 6. VTT Technical Research Centre of Finland application screen shots](image)

![Figure 7. Waterwise and WRc platform screen shot](image)

![Figure 8. Opower application screen shot](image)

1.2.3. Energy. Opower is one of the companies that implemented gamification into an application meant to encourage energy saving. 75 utility companies became partners with Opower in this project of saving the planet and making green living fun [13].
1.2.4. Waste Management. A team from University of Adelaide designed a web based game, Super Sort, which has the goal to increase awareness about the sustainable waste management system. The game was tested by 300 students and due to its success, the team is trying to also create a mobile application [14].

![Super Sort application screenshot](image)

**Figure 9.** Super Sort application screenshot

1.3. Social Sustainability

Regarding the Social Sustainability, gamification was already applied in the following fields: Health, Education, Food safety and Leisure.

1.3.1. Health. In this field there are multiple examples.

![Mango Health application screenshots](image)

**Figure 10.** Mango Health application screen shots

One of them is Mango Health application which was designed to encourage people to take their medications on time. The application contains reminder alerts for the medication time. People receive gift cards for shopping at Target or GAP or they can donate money to charity [15].
1.3.2. **Education.** Photomath is an application which incorporates a scanner. After scanning the math problem you want to solve, the application helps you understand math, giving you the sense of companionship for learning [16].

![Photomath application screen shot](image)

**Figure 11.** Photomath application screen shot

1.3.3. **Food safety.** A manufacturing company needed a food safety hazards training for their employees. In order to motivate them, a virtual kitchen with potential hazards was designed. The employees had to identify the hazards and answer correctly the question about it. They received badges, trophies and certificates [17].

![Food Safety Hazards platform screen shot](image)

**Figure 12.** Food Safety Hazards platform screen shot

1.3.4. **Leisure.** CWT Solutions Group wanted to improve the loyalty and compliance of travelers, therefore they have designed an application called Game On. The goal is to convince travelers to be loyal not to their favorite supplier but to the offered program [18].
2. The invisible wires that link a community – internet and gamification

Smart City represents the future, and it can be built with and for the people. This is emphasized by the benefits of a smart city, taking into account each sector’s contribution to the real success of the smart city.

The main sectors of a city can be connected throughout the internet and citizens’ contribution. The citizens can be very well motivated by using gamification techniques. The Internet of things represents the motor of a smart city, but the citizens are the fuel that makes everything act together.

We live in an era that enables the potential connection of people and increases social cohesion by IT solutions.

Not all the members of a community can be connected by smart solutions, because some of them do not have access to digital equipment or do not have the knowledge to use it. Another cause can be the pressure put on solidarity by different risks. Finally, some citizens can organize digitally connected groups which may lead to a threat to cohesion and inclusiveness.

In order to solve these problems, the authorities and citizens should find solutions together by collecting citizens’ opinion about the existing problems.

Connecting things has lately proved to be easy to achieve through the help of the Internet of things. Connecting people and citizens’ involvement in a community has always been a continuous challenge. The citizens and the authorities are very important pieces in a community. By creating a real constructive relationship between these two pieces, the city will improve in all fields – infrastructure, jobs, energy saving, waste management, education, health.

Gamification can be a real solution for involving citizens in building a smart city and also in its customization so that it responds to everyone’s needs.

Every citizen has his own point of view regarding the city he lives in therefore the smart city has to be designed so that each citizen can feel at home.

Gamification offers the tools to encourage the citizens to be involved, even if they do not have access or IT knowledge. Gamification represents motivation techniques specific to games. Neither all games are electronic, nor does gamification mean only IT.

Smart city represents the acceptance or not of the future. Therefore, using gamification can also mean the development of IT abilities for all citizens.

Smart city should be perceived as adding services that increase the quality of life but do not influence or eliminate traditions and originality of the place.
This also represents the subject of the research consisting in suggesting a platform which, at the beginning, allows all users to build their own virtual city. This stage represents the requirements capturing stage.

Creating an application which gives the citizen the opportunity to create their own customized city, would represent a real feedback for the authorities for what they can do for the city and its community.

3. Methodology
The suggested methodology is based on the software products life cycle stages. We chose Waterfall life cycle, because it is easier to highlight and because it is included in all the other life cycles, even in the most recent, Agile. The methodology includes also the research methods grouped in 3 stages: pre-use, during-use and post-use. Each stage is represented by specific elements of motivation based on gamification.

| Waterfall phases         | Methods                        | Gamification                                                                 |
|--------------------------|--------------------------------|-----------------------------------------------------------------------------|
| Requirements analysis    | Pre-use:                       | At the beginning, surveys have to be organized in order to establish the points of interest for the community. In order to have as many surveys completed as possible, from various categories of population, people have to be motivated. At this stage, the motivation has to be a reward. The reward can be a future application badge representing that this person is a founder of the virtual community or points which can be exchanged to virtual money after the virtual city creation that can be used for real tax payments. |
| System design            |                                |                                                                            |
|                          |                                |                                                                            |
| Implementation           | During-use:                    | The user will be rewarded for each improvement made to his city. There will also exist competition with points, badges and leader boards between the users of the application. The application has to be fun, so mini-games of solving potential problems which appeared in the city will be implemented. The user that found the best solution will receive a badge and bonus. Sustainable solution can also be implemented in the real city. |
| Verification (testing &  |                                |                                                                            |
| deployment)              |                                |                                                                            |
| Maintenance              | Post-use:                      | The user who found sustainable solution for the city’s problems that can be implemented into the real city will become an |
The architecture of the system built on the proposed methodology takes into account the steps that the application user must follow, for the first stage in which the customer requirements are identified.

Like so, the first stage consist of registering the users, stage in which data about each user involved in the study is gathered, whether we are talking about data that the user can define or pre-existing data about the user (e.g. data gathered from social media websites).

Based on big data algorithms, relevant information is extracted and used to complete the users profiles. These profiles represent the starting point for each Virtual World from the application. This is because the Initial Virtual World will contain only the elements and tools that are fit for the user based on his profile. As the application gathers more users, ad hoc groups will be formed based on the users’ common interests identified by looking at their various interest fields memberships (as seen in figure 13), the completed challenges and the complementarity of the wined/used tools.

![Figure 14. System architecture](image)

This ad hoc formation is achieved by finishing the first three levels. After this, each user will be rewarded with points for the personal achievements and team work and he will be able to check his position in a leader board.

The achieved points also bring badges which will help establish the role of each user in the virtual city (mayor, hospital manager, etc.)

In the last stage, each user’s achievements will be integrated, the roles will become dynamic and the participants will be able to earn cofounder badges as well as change points for virtual currency.

4. Gamification in the requirements capture stage – building the "virtual city"

The application which we want to develop is about Jiu Valley, a mono industrial area of Romania. Considering the fact that this industry, mining, has already started to disappear, the cities of this area...
need a real change. This change is mostly given by the citizens who, for the moment, are trying to find jobs in other towns or countries. Implementing here a smart city application can re-launch the area and keep its citizens engaged.

![Figure 15. From MINE to MY City application screen shot](image)

The application will have a log in section.

![Figure 16. Log in application screen shot](image)

After creating an account, the user has to define his profile consisting in filling some data: Age; Sex; Level of study; Income of the family; Legal status; Children; Work; Hobby.
Figure 17. Profile screen shot

After completing the profile, the user starts building its own city. The first step is to choose a name for the city. In the next screen, the user will have the possibility to indicate the interest field:

- **Infrastructure** – improve the quality of the existing roads, create new roads, and implement local transportation;
- **Health** – improve the access to medical services, create events for encouraging a healthier lifestyle (healthy food, fitness and other competitions for the community);
- **Leisure** – create more recreational places for every age category, create workshops with different activities (pottery, painting, dancing, handmade products, etc.), create the possibility of practicing sports for fun (riding, archery, swimming, paint ball, etc.);
- **Eco friendly** – implementation of rewards for energy saving, water saving, selective collection of waste, participation in organized events for keeping the city and the surroundings clean;
- **Culture** – better inform the community about the cultural events from the city, organizing more cultural events;
- **Personal and professional development** – organize free courses for job orientation and personal development.

The elements which form a smart city will be identified (the sensors, etc.) and will become available for building the „virtual city“ [19].

Figure 18. Smart city benefits

In the initial phase a survey will be conducted in order to determine useful user centred insights. This will be based on both direct and indirect experience. It will be important to monitor the citizens’ desire for participating in this research and to use a mobile software application.
Data will be gathered in order to segment the market based on a general survey regarding the demographic issues, habits, most useful services, perceptions, beliefs, expectations, familiarity with technology. In this phase, the subjects for all the research phases are selected. Two target groups are also selected for the Think Aloud exercise. The first group is formed by citizens who are comfortable with the technology and who will project their own virtual city by using the app. The second group is formed by citizens who do not want to use the app, but their purpose is to refine the most common smart elements form the smart cities generated by the first group.

5. Conclusions
Most of the people of the IT generation can create a smart city, but not all of them will be interested in continuing its development. It is very important to keep the users engaged. This is the reason why gamification is a very important tool that can and should be used when designing a smart city application. People need motivation, fun, competition and recognition in their lives. Considering the fact that the community is the key factor in a city, the community has to be interested and motivated to really participate in the city’s life.

The paper proposes a new methodology that integrates gamification into the life cycle of a software product called “From Mine to My City”. It also proposes a system architecture that targets the first stage of the lifecycle that means capturing user / citizen requirements. This architecture starts from the individual user profiles and, after applying algorithms for analysing and extracting user characteristics and using gamification techniques, virtual cities are built / designed.

References
[1] ***2017 https://en.wikipedia.org/wiki/Smart_city
[2] Arup J P 2016 Smart City Sustainability Framework & Gamification, @medium.com
[3] Pinto J and Rossetti R 2016 Fostering citizen engagement in smart cities through gamification
[4] Marczewski A 2012 Gamification: A simple introduction, Amazon Digital Services Inc
[5] ***2017 https://en.wikipedia.org/wiki/Gamification
[6] Huotari K and Hamari J 2012 Defining Gamification – A Service Marketing Perspective, Proceeding of the 16th International Academic Mind Trek Conference, pp 18
[7] ***LTP 2016 Gamification in Banking: From Transaction to Experiences, https://letstalkpayments.com/gamification-in-banking-from-transactions-to-experiences/
[8] ***2015 https://www.egov.com/news/press-releases/2015/02/23/my-hawaii-gov-recognized-as-2015-harvard-ash-center-bright-idea-in-government
[9] Yen B 2016 How ‘gamification’ can make transport systems and choices better for us, Griffith University, Australia
[10] Xu F, Weber J and Buhalis D 2014 Gamification in Tourism, Springer International Publishing Switzerland
[11] ***2017 https://phys.org/news/2017-02-gamification-consumers-power-consumption-peaks.html, VTT Technical Research centre of Finland
[12] Snowdon C 2014 Gamifying Water, Waterwise Conference
[13] Shane K 2013 3 Mobile Apps for the Gamification of Energy Conservation, @gamification.co
[14] Babar A 2016 Smart Campus: Gamification of Disposing Waste Sustainably, @malibabar.wordpress.com
[15] Yee C 2017 Top Ten Gamified Healthcare Games That Will Extend Your Life, Gamification Examples
[16] Mechelen E 2017 Top 10 Education Gamification Examples for Lifelong Learners, Education Gamification
[17] Reddy S 2016 Gamification and Game based Learning for Training, CommLab, India
[18] Carlson W 2013 Cutting through the buzz on traveler gamification in managed travel, CWT Vision, Sweden
[19] Deloitte 2015 Smart Cities, GovLab, The Netherlands