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The Serious Game: a learning tool to enhance the communities in the context of sustainable cities

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Abstract: In smart communities, people need and user's awareness is key issues. Recent literature contains several social elements in the urban planning field and recognizes the fundamental role fulfilled by human factors. Users are the focus in delivering new urban services and in achieving sustainability in the longer terms, they are observed as key actors to attain real sustainability. Nowadays, this goal seems closer thanks to new interactive technologies that allow applying innovative learning methods as well as social research methods. Among the learning tools, the Serious Games (SGs) represent a very promising medium to be adopted in this context. They have multiple learning objectives and can be applied in many areas for all targets of people. One of the most important features of the SGs is to make interesting and entertaining issues improving the knowledge of users' actions and teaching SGs could represent a strategic hub to promote educational programs and involve the adoption of new lifestyles based on the idea of energy saving. The main challenge is to understand the several possibilities and application fields where this tool can be applied, discovering its countless potentiality.
In this contribution the characteristics of SGs are analyzed, their application fields, their benefits, and rescues descending by their use are synthetically presented and discussed.

Keywords: Serious Game, Smart Cities, Sustainable Communities, Citizen Design Science, User-centered design

Introduction

Nowadays many cities are tackling urban and social challenges in terms of sustainability. Those challenges are related to territorial conflicts, poverty, quality education and gender, climate action and responsible energy consumption and production. In this perspective, an emerging but pivotal concept is one of "smart cities and communities". Although a shared definition is still missing, the smart cities involve several aspects and therefore they can be analyzed through different sustainable perspectives as social, technological, economic and environmental. This intersection among different and sometimes conflicting disciplinary areas makes the proper understanding and design of the smart cities and communities a very difficult task (Albino et al., 2015; Dewalska-Opitek, 2014).
For this reason, the 2030 Agenda for Sustainable Development provides strategic directions to support the future development of cities and communities, identifying 17 Sustainable Development Goals (SDGs), which are defined as an urgent call for actions by developed and underdevelopment countries, in a global partnership (sustainabledevelopment.un.org).
Notably, the SDG 11 -Make cities and human settlements inclusive, safe, resilient and sustainable-its about the issue related to urban growth and its safety development in several cities all around the world. Among the different aspects highlighted by the SDG11, the citizens' involvement has great importance. Every project, decision, and action are done in cities has an impact on the citizen's quality of life. Allowing citizen to participate in urban projects and initiatives, and making them active stakeholders in urban activities or analysis, it could improve the achievement of specific goals for cities development. Accordingly, the Citizen Design Science (CDS) is recognized as being an interesting approach to involve citizens in urban design from a sustainable perspective. It concerns the citizens' involvement towards the planning and the management process in a city, through an easily accessible design, (Mueller et al., 2018) based on three fundamental pillars: the Citizen Science, that refers to the participatory aspects and the kind of data collections, the Citizen Design that implicates the active design by citizens and finally, the Design Science essential for transforming the citizen's design proposal into tangible urban drawings and plans (Mueller, et al., 2018). In the CDS framework, it is possible to identify different methods used to support the citizens' involvement in smart cities. They usually refer to questionnaires, focus groups, and workshops. However, according to the literature (Leydesdorff and Deakin, 2011; Nalbandian et al., 2013; Joshi S. et al., 2016), the need for new participatory methods emerges.
With this respect, the aim of the paper is to analyze the different definitions and dimensions of smart cities and CDS concepts and methods, as the Serious Game tool with its application towards sustainable issues. The Serious Game (SG) methodology is one of the applications used in the Citizen Design Science context, and in this article has been done a first classification of the most innovative SGs realized, during last 10 years, towards sustainability context, starting from previous existing work.
This text is organized in 3 main sections: section 1 concerns a review of relevant literature on the smart cities, the communities and the concept of user-centered design discussed in CDS. In section 2 an overview about SGs is presented, through a literature review between 2007 and 2018, with a description of the main characteristics of this type of games with their relative benefits and rescues coming from their application. Section 3 is dedicated to a serious games catalogue realized in the last ten years, more about quantitative and qualitative application considerations.

Smart cities and communities

A shared definition of smart cities is still missing; therefore, some authors try to underline its core components and characteristics. A city can be defined "smart" when "investments in human and social capital and traditional (transport) and modern (Information and Communications Technology, ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory government" (Caragliu et al., 2011). In other words, cities are defined smart when the city government has the ability to optimize the exploitation of both tangible and intangible assets, enhance the citizens' quality of life, boost resources' productivity, and solve emerging issues (Komninos et al., 2013; Shaffers et al., 2011). Moreover, strategies to execute and manage smart cities projects vary among cities, as well as organizational and managerial researches in this field are scarce (Michelucci et al., 2016). Smart cities are interdisciplinary: they require

investigation and cooperation across several disciplines, spanning from economics to social sciences, from politics to infrastructure management and others (Celino and Kotoulas, 2013).
Trying to determine a definition and its domains of application, two main kinds of research can be subsumed from the literature review. The first stream of research is technology-centered and focused on application domains that are heavily based on modern ICT application in different fields, such as in energy consumption, public transport or waste and water management. The latter stream of research is more people-centered because, even if technology and infrastructures are still important as enabling factors to reach objectives, nowadays the research is more focused especially on soft domains such as welfare, social inclusion, culture and human capital (Caragliu et al., 2011; Toppeta, 2010).
The relevance of citizen's involvement in the urban context has definitely increased in the last years. "The ability for all people to communicate with one another and agencies and groups that represent them provides a new sense of possibility to the idea that smart cities are based on smart communities whose citizens can play an active part in their design" (Joshi S. et al., 2016). There are different ways to involve and take actions where citizens can give opinions and take part in urban initiatives. During last years, smart city plans are characterized by a more bottom-up approach, through new forms of collaboration and participatory governance, where the analysis of people's needs and the definition of social objectives drive the selection of specific enabling technologies (Leydesdorff and Deakin, 2011). It is exactly at this time that the role of technologies becomes interesting and relevant. Today we can immediately find out a lot of information about what is happening anywhere in the world just surfing the internet. Naturally, this is not the only way to get familiar with the smart cities' participatory initiatives. Known methods are questionnaires, focus, and discussion group, workshops, typically used for enhancing the participation and collaboration among people, sharing opinions and ideas. The debates and comparisons between citizens become more interesting if they can discuss with local governance or municipality. From literature (Nalbandian et al., 2013) emerges that better results can be obtained when, during these moments of confrontation, governance and public actors participate and collaborate together with all citizens.
Furthermore, the cities can be defined smart also when they include active political participation, citizen services and good use of e-Government instrument, for improving the decision-making process, the public policymaking and the public governance, everything at the same time. One of the substantial characteristics of smart governance is to enhance citizen participation both in private or public collaboration. The implementation of smart governance infrastructure can facilitate service integration, collaboration, communication and data exchange. The relationship between public managers and citizens become an important component to define the role of the management in leading smart cities initiatives. With this regard, Corrigan and Joyce (1997) discuss the right of the citizens, to be included in the decision-making process of their municipalities: public managers' interaction with the society is essential for the creation of effective services created for the community. The link between public managers and the community facilitates the partnership among sectors, groups, and individuals (Nalbandian et al., 2013). Three challenges for public managers can be identified in order to pinpoint what is administratively sustainable and political acceptable: "to create and enforce a chain of responsibility that needs to avoid political alignment; to synchronize jurisdiction and other forms of external authority with the problem to be solved; to integrate the real citizen's need in the local government and administrative structures" (Nalbandian et al., 2013).
Smart devices, Internet of Things (IoT) and ICT by far outnumber human beings in smart cities. Public administrations can use ICT as a tool to group people together and stimulate innovation, knowledge, problem-solving and, more in general, economic growth (Caragliu et al., 2011; Hollands, 2008). The rise of IoT application and the large-scale adoption of web technologies and tools in urban environments have proven that internet-based solutions can successfully address societal challenges (Celino and Kotoulas, 2013). IoT provides the connection between all these objects to facilitate and make people's lives more comfortable and efficient in all situations (Khajenasiri et al., 2017).

Citizen Design Science

The citizen science has been defined, by the UK Environmental Observation Framework (UK-EOF, 2011), as a "volunteer collection of biodiversity and environmental data which contributes to expanding

our knowledge of the natural environment, including biological monitoring and the collection or interpretation of environmental observations".
Bonney et al. (2009) define three different levels of Citizen Science. There are contributory projects which mean mostly crowdsourced data collection, collaborative projects consisting in data collection and data analyses of citizens and last, co-creative projects where researchers and citizens work together in a project, for the most part of the time. Citizen Design Science is most related to the last line of the research approach. The CDS is based on 3 main pillars. The term Citizen Design is not yet commonly found in scientific literature. Generally, it is used to describe a specific kind of participatory design. The word 'citizen' is referred to people that live in cities and belong to urban communities; 'design' indicates the way of performing the participation in the creation and design phase. Thus, the Citizen Design is a dynamic designing of the urban habitat by citizens (Mueller, et al., 2018). One of the first application of the Citizen Design method was adopted and described by Kevin Lynch's strategy of mental mapping. This study was presented in "The Image of the City" (Lynch, 1960). The task was very easy, ask participants of the studies to draw through simple five elements, places and objects that are most remarkable in a city, from a personal point of view perception by landmarks, nodes, paths, districts, and edges.
Instead, the Design Science defined by R. Buckminster Fuller (Papanek and Fuller, 1972) as a systemic form of designing, is continuously understudying, especially in the fields of innovative technology and creativity. In the last century data science and big data are seen as possibilities to bring unnecessary breakthroughs. "The difficulty addition for Citizen Science in urban design is that it is not clear how the input of activities through citizens' engagement can be translated to the language of designers and how the local knowledge from citizens can be used as contribution to experts' works in urban planning" (Mueller et al., 2018). There are a series of different approaches which follow the philosophy of the citizen design such as: the work published by Edwing and Handly (2009) showing a way to measure a city area through walkability aspect; or the text of Bryson et al., (2013) that combined the idea of design science together with participatory design in urban planning giving guidelines for participatory processes; and Stimmel (2015) suggested a designed thinking method for urban planning in smart cities including a "human-centered process that comprehends the phases of empathy, creativity, and rationality". Inside the Citizen Design Science, every element is essential for others to make this strategic science a successful application. If there isn't Citizen Science, the dynamic part where people can truly design expressing their ideas, they will stay just on a low and theoretical level. Citizen Design Science, especially with the citizen design pillar, aims to underline the importance of people involved in the planning process, saying that would be impossible without the creative design aspect. "The allure of citizen design is also the gaming aspect and the fascination of new technology for younger people. Not only is it a no right or no wrong process, but people can also express their ideas in an unanticipated way which could mean a higher motivation to participate" (Mueller et al., 2018).
The role of technologies is to provide tools in Citizen Science context, using them to employ people for evaluating the participatory design phase.
In this regard, participatory design is considered when people are directly involved in the design process. Citizens or people generally involved in urban projects, may serve as a simple idea input but they can also make decisions in a process. It is possible to recognize two different approaches: the bottom-up and top-down. In the first approach designers and stakeholders are together involved implementing rules in the design tool and they prepare a relevant design task that citizens are requested to solve. Thanks to the citizens' feedback the designers can evaluate them and extract useful design criteria which influence the designers' master planning.
In the latter, one citizen can only try to solve issues shown by governance or other professional profiles, without the collaboration, for example, with designers, architects, and engineers and with other citizens too. Sanders (2002) said that people express their experiences by saying, thinking, doing, using, knowing, feeling and dreaming. Of course, discussion, focus group interviews, questionnaires, and observation events, or the use of "tools" and "do tools" can help to access the experience of sharing ideas. The "make-tools" can be a possible solution to transform ideas and personal abstractions in realistic proposals. Especially, interactive tools allow people to express themselves in different ways, actively creating or managing objects and situations, they can also express themselves in a new and unusual way.

In summary, CDS is a crowd creative strategy for smart cities to integrate the citizens' experience and expectations of the urban environment through their own design proposal for newly planned or redeveloping existing urban and social areas. This science describes a new strategy of urban design with the purpose to overcome the technological perspective of current urban planning methods towards a participatory planning method, more user-centered. Interactive tools can create the opportunity for a large number of people to simultaneously provide direct feedbacks without high expenditure. Active design in workshops with citizens is the most common approach to overcome the limited creativity of participatory planning tools. Methods which combine these two solutions is what is possible to define as the Citizen Design Science.

The Serious Games, definitions and a classification

The first definition of SG was written by Clark C. Abt (1987), the pioneer of this expression, inside his first publication called "Serious Game". He defined a game as a "particular way of looking at something, anything". In addition, he also said that "reduced to its formal essence, a game is an activity among two or more independent decision-makers seeking to achieve their objectives in some limiting context. A more conventional definition world says that a game is a contest with rules among adversaries trying to win objectives".
The author describes the SGs as a "game that can be played seriously or casually by people. We are concerned with serious games in the sense that these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement. This does not mean that serious games are not, or should not be, entertaining".
According to Abt theory, Costikyan (2002) defines a game like "a form of art" in which participants, called directly players, can make decisions to manage resources through game actions and activities searching of the game goal.
Zyda (2005) provides another interesting description for identifying that SG could be defined as a mental contest, played also with electronic devices in accordance with specific rules, which "uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives."
SGs have multiple learning aims, they can be applied in many areas and targets all age groups (Mouaheb, et al., 2012), they can be considered also as teaching tools, a means of entertainment, and an information and communication technology system. The goal for an SG methodology consists of the reduction of problems complexity to such a level of abstraction, that the players can easily interact with it, discussing it and comparing with each other (Johan de Heer et al., 2010).
In other words, the SGs are defined as a methodology which proved to be effective methods applied to many research and practical fields (such as education, management, industries, and health care) but they are not so much used in social learning context of smart cities and generally urban planning. Indeed Abt (1987) reported that games may deal with important behavioral issues, and they can concern considerable problems in almost all academic and intellectual field. "Education, analysis, and evaluation are all rich fields for the use of the serious game. In education, games are used by teachers for classroom instruction in social studies, sciences, and humanities, and for guidance counseling." He also mentioned the possibility to apply this tool for testing alternative military strategy, for evaluating, for instance, regional transportation plans, public responses to the environment and other issues related to sustainable urban contexts. One of the main strengths of the SGs is that they can support effective decision processes being able to acquire data directly from people in general, through a very simple approach based on entertainment. Basically, this tool is not applied in urban planning or smart cities context, because it is generally used in the educational field and other sectors such as health care, engineering, defense or politics (Ouariachi et al., 2018).
According to Ouarachi et al., (2018) the education embraces SGs because teachers recognized their potential: "game is motivating, provide on real-time immediate feedback, they can adapt themselves to the level of the learner, they encourage distributed learning, and they can be used for other excellent teaching techniques" (Gee 2003; Gentile 2011). An interesting consideration can be made also about the use of games, understanding what are the numbers and the prevalence of games' trend. From Statista (2018) the market of serious games is one of the fastest growing areas in educational media and it is expected that can grow from 3.2 billion U.S. dollars in 2017 to 8.1 billion in 2022. "Creating awareness

and promoting attitudinal and behavioural changes on sustainable issues is crucial, and serious games can play an important role by allowing players to experience unfamiliar circumstances that are not possible in real life: for instance, being a mayor with the power to change a whole city towards a more sustainable place, balancing pollution, energetic productivity and citizens´ happiness as players experienced" (Ouariachi et al., 2018). Among these different definitions, an interesting consideration concerns the importance and the role of the adjective "serious". In fact, all the expressions above do not mean that the addition of serious term indicates a limit for the game for being enjoyable. On the contrary, it suggests that its rule can be used to impart knowledge in a playful way. The term serious is used by Abt to indicating the sense of study, relating to matters of great interest and importance, raising questions not easily solved, and having important possible consequences. In fact, the serious game expression can be identified as an oxymoron where the seriousness of thought and problems are linked to the experimental and emotional freedom of active play.

A Serious Games' classification

Research about existing realized games in terms of sustainability themes has been done, focusing on the last decade. The work was made according to guidelines and researches described in two main scientific publications, Stanitsas et al. (2018) and Ouariachi et al. (2018), and according to the consultation of some serious games online sites or database such as Serious Game Classification, Games for Change and Games 4 Sustainability. In a Serious Game Classification online database, the games are classified according to their gameplay, their purposes, their markets and target of users, alongside with user-contributed keywords (serious.gameclassification.com). Games for Change is a community founded in 2004 with the aim to empower game creators and social innovators to drive real-world change using gamification method and technologies. The final target is to help people to learn new thing improving a sense of community and trying to contribute to make the world a better place to live. About their activities, they organize an annual festival for serious games and students' challenges, training students and educators to run game design (gamesforchange.org).
Game for sustainability is an online platform where users can learn and practice sustainability through serious games applications and find links with the themes of sustainable development goals. Starting from the different objectives involved in this online database and platforms, to conduct this research, some specific keywords have been selected and used such as serious games, educational games, applied games, environmental games, gamification, and game-based learning games. Through this keywords selection, the first step has been to trace the documents, searching in online databases such as Scopus, Web Science and Google Scholar, several articles and papers concerning serious games applications. Subsequently, it was made a documents' selection through abstracts and full-text reading, in accordance with relating appropriate information.
For this search were investigated some different subject areas such as computer science, engineering, social science, and environmental science. Among these, there were analyzed several document types including journal articles, whole books, and book chapters, conference papers, and dissertations. The scientific contents identified in these works include documents that represent models, techniques or a literature review made exploring and describing SGs, through their history, their application, their assessment, showcasing study practices for an educational contribution (Stanitsas et al., 2018). In practice the analysis was made considering the most famous serious games realized in the last decade, identifying their genre and type, of the underlying specific target users and their game theme/topic. Finally, it has been trying to find a link between the aim of serious games and simulations arranged by the Sustainable Development Goals. Sometimes the goals are expressively mentioned, especially in Games 4 Sustainability site, while other times the date are not found, definitely for the games created before 2015.
The criteria used for doing this first classification have been reported in table 1 while the results of the research are shown in table 2.

Year	*Serious Game Names*	*Genre and Type game*	*Target*	*Game Theme/ Topic*	*SDGs*
From 2007-2018	Title of every Serious Game realized in the last 10 years	Distinction based on the typologies classified as: ▪ App game ▪ Board game ▪ Card game ▪ Online game ▪ PC game ▪ Video game ▪ Web game and the genres classified such as: ▪ Adventure ▪ Education ▪ Policy exercises ▪ Puzzle ▪ Strategy ▪ Simulation/ and strategy ▪ Role-playing game (RPG)	People directly involved in the games, simply called players, they can be: ▪ Children, Youth ▪ The general public (GP) ▪ Students	Description of the main themes or topics takes on inside the games. For this classification, games were analyzed on the basis of sustainability concepts. For instance: ▪ (Sustainable) Urban planning, development, and management of smart cities ▪ Renewable energy source ▪ Waste management ▪ Water cleaning and management ▪ Sustainable immigration and cultural integration ▪ Sustainable actions for the environment	List of Sustainable Development Goals identified in 2015 by the United Nations. They are 17 priority goals that cover important issues to solve in 2030 by developed and developing countries

Table 1, Criteria used for doing the SGs' classification

Some considerations can be made after this first classification. The first result is that 67 games have been found and analyzed. These are the most famous and important games realized in the last decade towards sustainable themes and issues. The most part of the information games was found starting from 2014 especially about the SDGs connections and the increase of online and video games.

Indeed, most parts of games are online, followed by hybrid simulation game and PC/video game. In this field, technology and the internet play an important role and, as expected, the board and card games are the minority. About the theme and topics tackled by the games, the majority of them have been designed to educate students and professors sometimes, with the general public too. This stakeholder is typically a motivation group of entities that need to be clearly aware of sustainability topics for personal own reasons. Generally, the issues of these analyzed games are to increase awareness of sustainability issues and stimulate interest and engagement. The general public, on the other hand, is a group of players who have no direct interest in engaging with these games, more reason to involve them to enhance their curiosity and improve their awareness about these themes (Stanitsas et al., 2018). The majority of the games wants to educate players towards sustainable themes resumed in macro areas such as water and waste management, renewable energy source, sustainable immigration, and cultural integration, (sustainable) urban planning, development, and management of smart cities. Therefore, the largest quantity of games found belongs to the environmental aspects. The other games belong to the economy, quality education in general terms, politics, and culture. Environmental management games tend to be highly popular nowadays, especially due to ecological destruction and the huge increase in the use of the Earth's natural resources (Damania et al., 2018). The Socio-Economic, Socio-Environmental and Eco-Efficiency dimensions are almost equally developed (Stanitsas et al., 2018). One of the most interesting consideration can be made towards the connection between sustainable education games themes and the 17 sustainable development goals. In a particular way, the SDG11 is really focused on the development and management of smart-sustainable cities and their communities. Nowadays many cities all around the world are tackling social, economic, urban challenges in order to support the growing population and the environmental impact of urban sprawl. Citizens are main characters inside these contests. One of the target indicators proposed by SDG11, the 11.3, is to enhance inclusive and sustainable urbanization, involving citizens in planning and management in all cities. About this is interesting that, especially in the last 5 years, As reported in table 2, most parts of the games are designed for the sensitive general public or specific stakeholders to raise their awareness. The SGs can be innovative, interactive and dynamic tools able to combine, at the same time, sustainable goals with the stakeholders' involvement. For instance, this game classification may be extended and better correlated to other SDGs such as clean water and sanitation, quality education, climate action, affordable and clean energy, and responsible consumption and production. Moreover, these games'

classification is just a small part inside the games' world, the research can be improved adding other information and consulting other scientific research done and online catalogs. The classifications' criteria could be increased for instance with a distinction between type and genre. Other features can concern the gameplay, the creators' name, the eventual price, languages, the duration and especially about the game availability.

Year	*Serious Game Names*	*Genre and Type game*	*Target*	*Game Theme/Topic*	*SDGs*
2007	**Climate Challenge (BBC)**	Strategy Online and PC game	General public	Climate challenge, carbon dioxide emission	13
	Electro city	Strategy Online game	Students	Energy and environmental management	7, 11
	Energyville	Strategy Online game	Students	Energy and environmental management	4, 11
	Encon city (NO INFO)	N/A Online game	General public	Sustainable energy supply	N/A
	Food Import Folly	Educational simulation Online game	General public	Quality food imports	2, 4
	PeaceMaker	Puzzle Video game	General public	Created to simulate the peace-making process in the Middle East.	16, 17
	Stop disasters	Simulation and strategy Online game	Children, Youth	Methods of prevention and mitigation.	12, 13
	World without oil	Simulation, RPG Online game	General public	Oil environment risk	-
2008	**Catchment detox**	Strategy Online game	Children, Youth	Managing a river catchment and creating a sustainable economy.	11, 12
	Global Conflicts: Latin America	Adventure Online game	Students	Environmental problems	1, 3, 10
	Heifer Village: Nepal	Simulation Online game	General public	Environmental management	1, 2, 3
	Wild web woods	Education Online game	Children, Youth	Sustainable development	4, 16
2009	**City Rain: building sustainability**	Adventure Online and PC game	General public	Green city simulation puzzle	11, 12
	MIT CleanStart	Simulation Online and PC game	General public	Green urban management	7, 8, 9, 12
	PowerUp	Education Online game	Students	Fossil fuels and renewable energy	4, 7
	SOS 21	Simulation Online game	General public	Broadcast ecologic messages.	7
2010	**Cityone**	Simulation Online and PC game	Students	Urban and sustainable planning	11, 13
	EnerCities	Education Online and PC game	Students	Energy saving and environmental awareness	4, 7, 11, 13
	The fate of the world	Strategy Online game	Students	Impacts of climate change, population growth, resource over-exploitation	8, 13
	Green my place	Education Online game	General public	Player's behaviour towards energy saving issue	7, 11, 12
	Sustainable Delta	Simulation and strategy Hybrid game	General public	Water system and management	6
	The UVA Bay Game	Educational simulation Video game	Students	Reclaimed water management	6
2011	**Citizen Science**	Adventure Online game	Students	Water and pollution issue	6
	River Basin Game	Simulation, RPG PC game	Students	Water management in agriculture	2, 6, 12
	Spent	Educational simulation Online game	General public	Poverty and homelessness	1, 2, 3, 4
2012	**Aqua Republica**	Simulation and strategy Online game	Students	Managing limited natural resources	6, 12, 13, 14
	Earthopoly	Educational environment board game	Students	To care for the earth and protect our precious resources	4, 12

	EconoU	Simulation and strategy PC game	General public	Sustain a fictional University to economic sustainability.	11, 12
	Irrigania	Simulation and strategy Online game	Students	Water conflicts among farmers in a simplified way	6
2013	**Climate change Survivor**	Simulation board game	General public	Climate change impacts	13
	Climate Defense	Education App game	General public	Preventing global warming	7, 12, 13
	Energy2020	Education Online game	General public	Climate-based disaster risk reduction	4, 13
	Pipe Trouble	Puzzle Online game	General public	Real-world issues surrounding the exploitation of natural gas.	11
	Plan It Green: the big switch	Educational simulation Online game	Children, Youth	Design and create your own energy-efficient city of the future.	7, 11
	World climate	Simulation PC game	General public	Decisions affect the global climate system	13, 17
2014	**About that Forest**	Simulation, RPG Video game	General public	Earth resources management	10, 11, 12, 15
	Ciclania	Educational environment Online game	General public	Environmental issues	6, 7, 13
	Les maîtres de l'eau	Educational environment Video game	General public	Water management and urban planning	6
	Never Alone	Puzzle Video game	General public	Resource management	12
2015	**Cities: Skylines**	Simulation and strategy Video game	General public	Government's role in social sustainability	11, 12, 13, 16
	Earth: A Primer	Simulation App game	General public	Food sustainability & geopolitics	15
	EcoChains: Arctic Crisis	Education Card game	General public	Food chains and protect Arctic animals	13, 14, 15
	Evacuation Challenge Game	Policy exercises RPG	General public	Disaster response and evacuation during the disaster.	5, 11
	Extreme Event: Coastal City	Simulation RPG	General public	Sustainable urbanism	11
	Polar Eclipse	Education board game	General public	Climate change and climate risk	13, 14, 15
	The Arcade Wire: Oil God	Strategy RPG	General public	Fluctuations in gasoline prices.	12
2016	**2030 SDGs Game**	Simulation Card game	General public	Taking the "real world" into the year 2030.	all 17
	Flood Resilience game	Simulation, RPG board game	General public	Flood, Flood Resilience	6, 9, 11, 12, 16
	Laudato Si	Simulation board game	General public	Religious education	1, 10, 12, 13, 15
	Lie, Cheat & Steal	Simulation board game	General public	Green project management	16
	Minecraft: Education edition	Educational simulation PC game	Students	Learning in traditional classroom environments.	4
	UrbanClimateArchitect	Simulation Online game	General public	Water management for SD	11, 12, 1 3
2017	**Energy transition game**	Policy exercises RPG	General public	Energy transition, renewable sources	7, 8, 9, 13, 15, 16
	Flood control game	Simulation Board game	General public	Flood disaster management	6, 16
	Gifts of culture	Simulation, RPG board game	General public	Flood resilience	3, 4, 6, 10, 11, 15
	Gogoals	Educational board game	Children, Youth	Sustainable development goals	all 17
	Lords of the valley	Simulation App game	Students	Practicing strategy, collaboration, and leadership in a complex environment	6, 8, 10, 11, 14, 16
	New shores: a game for democracy	Simulation PC game	General public	Climate change in the context of democracy.	8, 10, 11, 12, 13, 14, 16
	Nexus	Simulation and strategy Board game	General public	Sustainable civilization	2, 6, 7, 12, 17
	The Catan: oil sprigs scenario	Simulation board game	General public	Environment. Pollution.	6, 7, 9, 12, 14, 15
	The world's future	Simulation, RPG board game	General public	Heritage urbanism	all 17

2018	**Co-construisez, qu'il disait**	Educational simulation RPG	General public	City planning	11
	ECO	Strategy Video game	Students	Participation in town planning	6, 12, 15
	Il était ANRU'ne fois	Educational simulation Card game	General public	Relationships in smart communities	11
	Interactive Board Game (SIG)	Board game	General public	Implementation of SDGs	All 17
	La fabrique des territoires durables	Educational simulation Board game	General public	Development and management of sustainable cities	8,11, 12
	Paris 1800	Simulation, RPG board game	General public	Urban transformations with historical references	8, 11, 12
	Unda	Educational simulation Board game	General public	Management of sustainable cities	11

Table 2, Sources: Stanitsas et al., 2018; Ouariachi et al., 2018; Games4sustainability.org; SeriousGameClassification.com; ville-jeux.com

Conclusion and future development

This paper framed the smart cities concepts, reporting an overview of the current literature review, and the central role that they covered in the last years. Smart cities and communities are one of the 17 SDGs identified by the 2030 Agenda. As written in SDG 11, one of the targets decided for smart cities and communities is to "enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries". (sustainabledevelopment.un.org). These themes are key issues, the communities and the involvement of their citizen are in the middle of attention, covering a fundamental role for improving the smart cities future development. Architecture and urban design are excellent and interesting fields where is possible to apply Citizen Science methods because one yet unsolved task is to describe unambiguous criteria for liveability and sustainability in cities. At the same time, this issue is challenging because there is no a clear definition of liveability so it can have different meanings for people, especially if they are coming from different regions, places, and cultures. (Mueller, et al., 2018) Towards sustainability, the 2030 Agenda defined precise 17 goals with relatives' targets in order to save the planet, especially for the future generation. Nowadays, people' involvement becomes the main topics discussed. The citizen participation and involvement in urban activities have become active and relevant part during transformation periods. The growth of involving methods in an urban planning context has given to citizen the opportunity to share their ideas with other citizens and especially with governance too. Activities such as discussion groups and workshops are particular moments and occasions when citizens thought became reality. The methodology known as Serious Games can be used to better improve the interaction among the different stakeholders involved in an urban context. The work made on the use and application of SG methodology in an urban context, about sustainable themes, shown that this interaction is possible. The perspective to design a learning tool for involving citizens in an urban context and also teaching them sustainable behaviours is possible. The first classification of SGs realized towards sustainable goals has been done, and literature reviews towards themes such as urban planning, sustainable living, and energy saving, shown great interest in the scientific community.

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