Learning Urban Sustainability by Playing

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Abstract. Sustainability and the concept of sustainable development are currently adopted as a founding paradigm of global, national and regional development strategies. As such, they necessarily permeate new visions of urban development as well, leading to reflections of economic, environmental and social sustainability in urban planning and design practices. In this context, the paper aims to reflect on the capability and usefulness of Serious Games in conveying knowledge with respect to the development of sustainable cities to students, as future planners and architects in urban areas. Such games are part of the several participatory approaches and models of urban innovation and planning and have an explicitly educational purpose with respect to tackling complex problems. Given their increasing application in the field of sustainability, but their limited use in the context of sustainable cities, this paper explores two serious games (Urbax and urbEN), developed in urban and territorial settings within two different European projects, to reflect on their potential capability to convey specific ways of action and knowledge with respect to the issues considered in Sustainable Development Goal 11 (SDG11) of Agenda 2030. The analysis allows observing that although the two games were not initially designed to align with specific SDG11 targets or convey information on sustainable cities, both demonstrate the potential capability in spreading specific knowledge for urban sustainability.

Keywords: Serious Game · urban sustainability · Sustainable Development Goal 11

1 Introduction

Urban transformation can be considered a wicked problem [1, 2], namely a complex problem for which there is no simple method of solution. Indeed, they do not foresee a single right strategy for resolution, due to the fact that every attempt can affect different stakeholders, and there are no clear stopping rules. All urban transformations see the interfacing of different actors, who have different interests – economic, environmental and social – which often prove to be misaligned and unrelated. In this sense, each of them stands up for their own interests following peculiar strategies thus often leading to conflicting situations with implications on the transformation. Nowadays, this situation is more complexified by the sustainability issues that closely affect our cities. Indeed,

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sustainability and the 2030 Agenda have become the founding paradigm of global, national, and regional development strategies [3–6] and of urban interventions.

Traditionally, real estate development processes see as their main driver the creation of economic value [7] and consequently, as a main yardstick for observing their feasibility, their economic sustainability is verified. However, in the current context, the sustainable development approach applied to urban planning and design brings with it implications of broadening reasoning on how to operate on cities and on which values are to be created in addition to the economic value.

In this context, conveying information, knowledge and possible ways of action turns out to be fundamental in undergraduate courses in architecture and territorial planning, whose students will be the future architects and planners of our cities and therefore may represent the end users of these games. In this regard, Serious Games prove to be a useful tool for conveying the complexity of urban transformations to future planners and architects by involving them in a process of "learning by playing" [8]. Serious Games represent one of the emerging participatory models of urban innovation and planning [9] and their application appears to be growing considering the sustainability context [10]. As reported by [10] Serious Games can support making players aware of the challenges associated with sustainability, provide knowledge and understanding of sustainability, and encourage players to implement environmentally, economically, and socially balanced solutions. Indeed, in simulating urban transformation processes, the play in the role of specific stakeholders, the outline of possible transformation strategies and the interaction with other actors enable students to understand real urban problems. However, their use in the field of urban planning and sustainable city development still appears to be limited. Thus, this paper intends to fit into this gap and aims to address the following research question: *can Serious Games developed in urban settings be a useful tool to convey specific knowledge with respect to the development of sustainable cities?*

To answer this question, a comparison of two Serious Games developed in urban and territorial settings is provided, to observe in which way they can support in spreading knowledge with respect to the Sustainable Development Goal 11 (SDG11). The 2030 Agenda represents an internationally recognized framework of goals that provides strategic guidance on sustainable development [3]; within this framework, SDG11 constitutes the goal of urban relevance "to make cities and human settlements inclusive, safe, resilient and sustainable". The intent, therefore, is to cross-reference the reading of the two games with the different SDG11 Targets, to observe on which specific points they may be useful. It is worth noticing that the two Serious Games are not specifically originated from the SDG11 of the urban Agenda 2030, however the comparison provided allows us to observe how these models can differently convey specific knowledge or ways of action regarding urban sustainability, and more in detail with respect to some SDG11 Targets. The two Serious Games considered in this paper, in whose development the first author has been, respectively, the scientific coordinator of the whole project and the scientific coordinator for Politecnico di Torino, and the second authors of this paper were actively involved in the most recent project, are the following:

i. URBAX2 (Urban Planning System in Europe), developed as part of the European Leonardo da Vinci project, a European Union action program for the improvement and development of vocational training in Europe;

ii. urbEN (Urban Energy Management Game), developed within the framework of the Erasmus + project "Locally Organized Transition of Urban Sustainable Spaces" (LOTUS) that involves a consortium of partners from different European countries, including universities, research centres, and community organizations.

The paper is organized as follows: Sect. 2 briefly defines Serious Games and outlines the two pedagogical tools URBAX2 and urbEN. Section 3 provides the design of the research and Sect. 4 identifies the sustainability lessons that can be learned by playing. Lastly, Sect. 5 summarizes the conclusion.

2 Serious Games as a Learning Tool in Urban Complex Decision-Making

Serious Games are part of the participatory approaches and models of urban innovation and planning and are games with explicitly educational purpose. These are carefully designed to be played "seriously" to highlight complex problems [11]. Serious Games were developed in the military field in 1948 [9] and then implemented in various disciplines to support learning, knowledge transfer, and management of research and practice problems [12, 13]. Indeed, the scientific community recognizes such games as motivating and supportive of distributed learning [8, 10, 12, 13].

Serious Games prove to be useful from a learning perspective since [14]: i) tell stories of real-world contexts; ii) offer new ways of communication; iii) stimulate interaction between players/actors; iv) set specific goals and help the achievement of these through the definition of reasoned strategies; v) stimulate problem-solving and allow for effective support of decision-making processes.

Starting from the recent literature review conducted by [15], which proposes a classification of existing Serious Games with respect to their links with the SDGs, some elements can be highlighted concerning their potential with respect to the context of urban sustainability and the parallel limitedness of application in this context. The analysis [15] reviews 67 currently functioning Serious Games related to the SDGs context and notes that some of them are developed as board games, thus according to traditional methods, and some are developed online according to more innovative methods. These are used by allowing interaction between the different players involved, encouraging playful public participation aimed at teaching on the one hand and entertaining those involved in the game on the other. In this sense, the use of such games in the urban context to improve virtuous behaviour turns out to be feasible. In parallel, the literature review in [15] notes that most of the games were designed primarily with respect to the themes of sustainable environmental actions, climate change, water management, and sustainable urban development. Concerning the latter, it can be observed that 27 of the analyzed games refer to SDG11, thus 40 percent of the sample, however, only 13, thus 19 percent, deal with the topic of sustainable urban development; in the other cases SDG11 is crossed but the topic dealt with is more specific than other SDGs. In this sense, it can be seen that the field of application of Serious Games to the context of SDG11 still appears to be currently limited.

2.1 URBAX2 (Urban Planning System in Europe 2)

URBAX2 is a pedagogical tool that aims to represent the relationships between urban markets and public policies in the field of urban planning, with a focus on the definition of land uses and supported by a software [16]. This was created as an evolution of the previous URBAX pedagogical tool, developed and used within the French system, in order to adapt its use to other European systems (Italy, UK, Germany, Sweden and Spain). The broader context in which the development of URBAX is set considers the incessant restructuring and planning transformations dictated by contingent situations, which cities have undergone in recent decades [16]: actors define and manage urban space, so to diminish developments that are not fully foreseen, there is a need for tools that support the understanding of how planning activities work within the urban market framework.

Accordingly, professional training in the field of urban planning and development should clarify not only the technical-administrative mechanisms characteristic of planning interventions, but also the dynamics that develop between the different actors involved [16].

From this perspective, URBAX2 is designed to enhance students' understanding of the effects of private actors' actions and public policies on the market and private land ownership. What characterizes URBAX2 is its ability to provide support by representing in a sufficiently realistic way the dynamics of the urban context and the derived effects at the socio-economic level of the actions implemented by local actors.

The educational objective of this serious game is threefold [17]: i) to foster an understanding of the strategies of urban actors; ii) to convey knowledge of the urban planning system in order to propose comprehensive urban planning strategies; and iii) to disseminate the ability to use planning tools and methods related to a historic district, new neighbourhoods and areas of economic activity.

Accordingly, URBAX2 considers the following four roles corresponding to the four main functions typical of local urban planning scenarios: the city government, the organization building low-income housing projects, economic operators (industrial investors) and real estate operators (construction companies). The simulation considers a theoretical city of 8,000 inhabitants in a declining situation: the city's buildings are in poor condition, there are brown areas in the surroundings, economic activities are declining, and the population is decreasing. In this context, game players are required to develop the city with few resources through acquisitions, transactions, building permits and construction, while the socioeconomic effects of their actions are automatically simulated by the software [18].

Through the game, players learn about social interactions, which is one of the key elements of local planning [19]: negotiations and agreements are one of the ways in which relationships develop between subjects and between subjects and plan. Also, during the game, actions of buying and selling land and buildings, applying for building permits, construction work by developers, investment by industrial operators, and management of the master plan by municipal administrators come into play.

The URBAX and URBAX2 serious games have been used in European educational settings proving to be a valuable tool for training students in the urban planning system.

2.2 UrbEN (Urban Energy Management Game)

UrbEN is an educational simulation tool in the form of a role-playing game on urban energy management aiming to educate and engage users on the complex issues surrounding sustainable urban energy management [20]. The broader context in which urbEN development is set considers the increasing need to support municipal citizens, and companies in their transition toward a zero-carbon future, due to the challenges posed by climate change [21]. Achieving sustainable urban energy systems requires the involvement of diverse actors from both public and private sectors [22, 23], who operate within a complex web of interactions at regional, national, and European levels. Therefore, educators in the field of urban planning and development must incorporate the dynamic integration of new energy concepts into their curriculum to equip future urban planners with the necessary skills and knowledge to navigate the challenges and opportunities presented by the transition toward sustainable urban energy systems [24].

In this perspective, urbEN is designed to enhance the innovative and creative capacities of students in the field of urban energy management, enabling them to effectively address the challenges associated with urban energy transition. This gamified approach enables students to evaluate different interests and integrate them into a holistic and comprehensive perspective.

Hence, in order to put forward a local energy autonomy planning strategy the serious game's educational objective is twofold, aiming at understanding: i) the local actors' energy strategies; ii) the interactions between elements of the local system. Accordingly, the following seven roles corresponding to actors investing in the production and storage of renewable energy and in energy sobriety are included within urbEN: the Local Authority (LA), a Non-Governmental Organization (NGO) representing civil society, two energy operators (local and national), an entrepreneur, a property developer, and a farmer. The simulation involves a virtual city in which the player assumes the role of one of the seven urban energy actors responsible for making decisions about energy use, production, and distribution.

Through a series of challenges and scenarios during the serious game, the players learn about energy efficiency, renewable energy, smart grids, and other key concepts in sustainable urban energy management. Moreover, the serious game also features educational resources and tools that provide additional information and support for players.

It is worth noting that although a serious game may be based on a scientific model, it is not in itself one. Indeed, urbEN aim is to have players understand basic notions within a short time frame and in a playful way [25]. Therefore, the serious game is focused solely on the energy issue, despite the awareness that climate change is not solely an energy-related issue [26, 27].

The urbEN serious game has so far been used in educational settings succeeding in providing an engaging and interactive way to learn about urban energy management and raise awareness of the critical issue of sustainable energy in cities.

3 Research Design

Based on the simulation of urban dynamics through the two serious games described, this paper aims to observe whether and how they convey learning of knowledge and ways of action for sustainable development and more specifically for which SDG11 Targets. With this in mind, the research was organized according to two phases (Fig. 1).

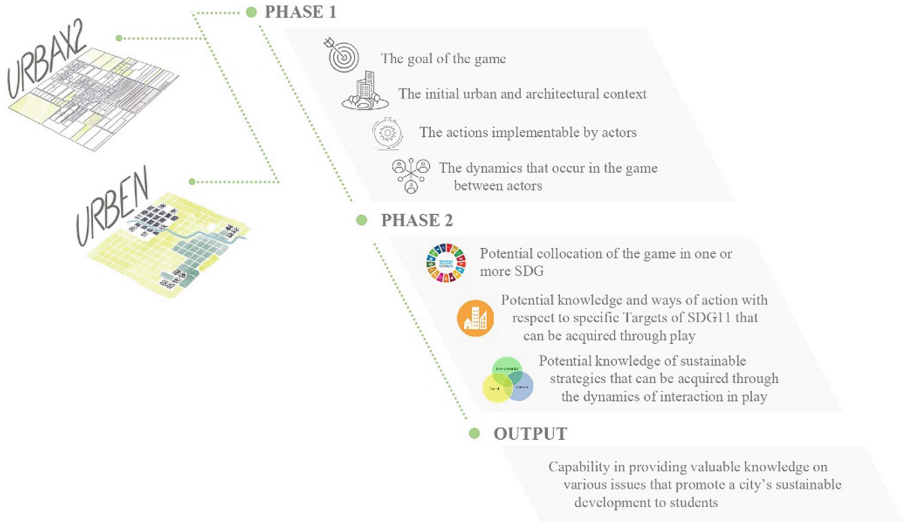

Fig. 1. Overall design of the research

A first phase explores three aspects of the selected games: i) the initial urban and architectural goal and context; ii) the real estate, energy, social, and environmental investment actions that can be implemented in the game by the different actors, with a view to achieving individual private and collective public goals; iii) the dynamics established in the game among the different actors, derived from the needs of each actor to achieve his or her personal goals. The first two aspects were detected and analysed in the materials relating to the rules and instructions of games and those relating to the pedagogical elements of the game. The last aspect was instead detected and observed following the applications of the two Serious Games in first person by all the authors of this paper in the case of the game urbEN and by the first author in the case of URBAX, in different occasions of tests and training activities, and with students of the courses of planning and architecture at the Politecnico di Torino and with students of Economics courses at the University of North Eastern Piedmont.

A second phase consists in the observation of three implications directly derived from the three aspects of the game just listed above: i) considering the goal and the context, it is observed in which potential SDGs of the 2030 Agenda the game can be placed; ii) on the basis of the actions that can be implemented in the game, those that can be directly attributed to the specific Targets of the urban goal, thus SDG11, are

highlighted; iii) considering the dynamics among the actors, it is outlined what indirect understandings of sustainable strategies can be derived from the active game.

3.1 The Goals of the 2030 Agenda and the SDG11 Targets

The 2030 Agenda and SDGs were approved in 2015 and entered into force in January 2016 in order to guide international action with respect to sustainable development and thus with the aim of guiding development efforts between 2015–2030. This agenda defines a set of international goals and Targets, which constitute not only the objectives to be achieved for sustainable development, but also the benchmarks for sustainability assessments [7, 28–30]. Indeed, since now sustainable development constitutes the founding paradigm of development new visions at all levels - global, European, and national - [3–6, 31], it is interesting to observe how learning through games can convey knowledge about the various overall goals of the 2030 Agenda.

Table 1. Target of SDG11

Target	Description
11.1	By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums
11.2	By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons
11.3	By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries
11.4	Strengthen efforts to protect and safeguard the world's cultural and natural heritage
11.5	By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
11.6	By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
11.7	By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities
11.a	Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning
11.b	By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels

In the specific urban context covered within this paper, the goal of urban relevance is SDG 11, which considers 9 Targets that are monitored globally with 15 indicators [30]. Table 1 provides an overview of the 9 urban Targets.

4 Sustainability Lessons Learned by Playing

This section aims to show the cross-analysis of the two Serious Games – URBAX2 and urbEN – considering the elements outlined in the two phases of the research design. In this sense, Table 2 outlines the context and overall goal of each game, followed by the potential SDGs of placement. Accordingly, the recalled SDGs would constitute the sustainable context of the games, thus the scientific reference against which the game can contribute to providing sustainable development knowledge.

Table 2. Placement of the two serious games under analysis in relation to the SDGs of Agenda 2030

Serious Game	Urban and architectural context of the game	Main goal of the game	Potential SDGs
URBAX2	Theoretical city of about 8,000 citizens in a declining situation: the city's buildings are in poor condition, there are brown areas in the surrounding area, economic activities are declining, and the population is decreasing.	The players in the game are called upon to develop a declining city, reactivating its markets by acting at the urban and architectural levels with attention to land uses.	
urbEN	Theoretical city comprising built-up areas (center, medium- and low-density neighborhoods), uncultivated urban areas, and a public housing district. At some distance from the center there are two villages, which can potentially be expanded. The remaining space is rural.	Game players are called upon to develop the city and neighboring villages in terms of energy management. So they are responsible for making decisions about the use, production and distribution of energy.	

As Table 1 highlights, URBAX2 seems to align with SDG11 as it focuses on interventions in buildings and urban context to improve the economic, environmental, and social conditions of a declining city. UrbEN is based on an economically and socially functioning urban and architectural context, and the development of the city through the game focuses on energy issues, thus on the use and production of energy within the city. Although energy monitoring is not a primary focus of SDG11, the implications of energy

actions and other SDG-related issues like climate change, education quality, industries, and infrastructure are interconnected with the city. Moreover, the game refers also to issues related to housing affordability, or land use control, that are essentials for SDG11. Therefore, SDG11 constitutes the main reference goal as the main context, together with SDG7 related to energy.

Continuing with the exploration of the two games and thus of the actions that can be implemented by the different actors, it is possible to observe how both ensure the acquisition of knowledge on different SDG11 targets. Table 3 reports for each game the actions that can be traced back to the urban goal Targets considering the actors to whom implementation is granted (for more information on the set of actions and actors in the game see [18, 32]).

As can be observed from Table 3 the URBAX game can convey knowledge to students relative to five targets. Indeed:

- *Target 11.1, affordable housing*. In the role of constructors, students are asked to think about the development of housing that must meet the market demand and social status of the district. Thus, housing with affordable or higher prices depends on the target population. In addition, in the role of local government, they may decide to act with subsidies, and tax benefits for the renovation of properties if the socioeconomic characteristics of the district's population do not allow for spontaneous renovation. In this sense, the opportunity to act on the properties is given to everyone in order to favour their improvement from the point of view of adequacy and safety.
- *Target 11.2, transport system.* In the role of local government, students are called upon to improve the blocks of the district in which they operate in order to increase its attractiveness. Besides creating public facilities, it's important to consider and act upon public transportation connections and services. If the current cultural background is rooted in sustainable paradigms, students can learn about them in various academic courses and apply them while reflecting and directing their actions within the game. In this regard, they will consider sustainable, safe, and accessible transportation services while taking into account the occupants' social status and socio-economic categories in the district.
- *Target 11.3, land use.* The game in general, as noted in Table 1, fits into this target as it considers urban and architectural development with a focus on land use. Specifically, in the role of local government, students are asked to manage land use, thus observing building permits and projects submitted and received from other actors and reflecting on their implementation in relation to the amount of land consumed in the district. They are also the ones who regulate land use in the district and in this sense delineate buildable land, thus reflecting on edge density [33] and the amount of buildable land. In addition, they may decide to act with subsidies, tax benefits for property rehabilitation, which may limit new construction interventions with direct implications on land use.
- *Target 11.6, air pollution and waste management*. The action of building renovation by direct builders and indirect local government touches on the possibility of reflection with respect to the decrease in air pollution due to improved energy performance of buildings.

Table 3. Implementable actions in the two serious games under analysis that can be traced back to the SDG11 Targets

Actor		Action	Target SDG11
URBAX2			
Local Government		Improving the attractiveness of the district: creation of public services, public open spaces	11.2;11.7
		Regulating land use: providing building permits	11.3
		District intervention with subsidies, tax benefits for property renovation	11.1; 11.3; 11.6
Constructor		Construction of housing in line with the social status of the district: affordable housing	11.1
urbEN			
Local Authority		Electric public transportation: link between town centre and peripheral villages	11.2; 11.6
		Cycling path: cycling path linking villages to the town centre	11.2
		Thermal renovation of public buildings: Increasing energy efficiency of public facilities such as schools, theatres, municipal rooms, administrative premises, sport and leisure centres, community centres	11.6
National energy network company and Local energy network company	 	Solar panels on farm buildings and on farming land and on hypermarket roof space	11.6
		Geothermal energy	11.6
Property Developer		Green affordable housing: High energy efficiency mix of affordable and social housing for lower middle class	11.1
		Ordinary affordable housing: Medium energy efficiency mix of affordable and social housing for lower middle class	11.1
		Green single family homes operation: green low-density housing	11.1
		Ordinary single family homes operation: ordinary low-density housing	11.1
		Renovation scheme for social housing: thermal renovation of DEV's social housing properties	11.6
Private Company		Electric public transportation: link between town centre and peripheral villages	11.2; 11.6
Farmer		Solar panels on farm buildings: photovoltaic panels on farm buildings roofs	11.6

- *Target 11.7, safe, inclusive and accessible green and public spaces.* In the role of local government, students reflect on and consider the creation of public open spaces, which should be safe and accessible spaces.

As for urbEN, it can convey knowledge on three specific SDG11 targets with different specific actions. In detail:

- *Target 11.1, affordable housing.* Reflections and knowledge with respect to this issue are mainly acquired through the direct role of the property developer, who builds, and in the indirect role of the local authority, which requires, encourages and accepts the development of certain actions. Students, indeed, take note of and reflect on: the development of green and/or ordinary affordable housing for the middle class, with medium to high energy efficiency; the construction of low-density family housing; the renewal of the thermal performance of the social housing they own.
- *Target 11.2, transport system.* In the role of the local authority, students reflect and disseminate to other stakeholders, possibly seeking funders such as the private developer, on actions to improve transportation services, particularly acting on the implementation of electric public transportation and new bicycle routes.
- *Target 11.6, air pollution and waste management.* In the role of the local authority, local and national energy companies, property developer, farmer, and private companies, students learn theoretical aspects and ways of action to reduce air emissions, implementing actions in the game such as: placing solar panels on buildings, developing geothermal energy systems, renewing energy efficiency of public and private buildings, and developing electric public transport services.

As far as the dynamics of the game are concerned, one main stimulus for reasoning – applicable to both games under analysis – considering sustainable strategies at the urban level can be observed, namely that of enacting trade-offs. Indeed, each actor is free to favour or hinder public policy according to its own interests, and in this sense the local authority can, especially in the case of hostile actors, enact compromise strategies. This means interacting and negotiating with actors to find meeting points, suggesting the implementation of more sustainable actions on certain dimensions of sustainability such as environmental and social to compensate actions that are profitable economically but not very sustainable with respect to the other dimensions. These mechanisms may entail an indirect understanding of sustainability, of its different dimensions, and of sustainable practices to be implemented strategically for the common good. Moreover, these dynamics can lead to a greater awareness and understanding of urban dynamics, its actors, with related interests and needs in relation to sustainable issues, potentially leading to a positive change in attitude and in the structuring of intervention strategies for sustainable development.

Above all, the game allows for an understanding that for sustainable urban development all actors are crucial and to be considered within the strategies, whether they are public or private actors and hostile or sympathetic to cooperation: sustainable urban transition cannot take place without the interaction and intervention of all actors.

5 Discussion and Conclusion

This paper explores two serious games to answer the question: can Serious Games developed in an urban context be a useful tool to convey specific knowledge with respect to the development of sustainable cities?

The analysis allows observing that although the two games were not initially designed to align with specific SDG11 targets or convey information on sustainable cities, both demonstrate the potential to provide knowledge and ways of action related to different SDG11 goals. On the one hand, URBAX2 was developed prior to the approval of the 2030 Agenda and aimed at fostering an understanding of urban actors' strategies and conveying knowledge of the urban system to propose comprehensive urban planning strategies. On the other hand, the urbEN game was developed considering the concept of sustainability but mainly focused on the energy transition of cities, thus just one of the many issues that involve the urban context and that need to be considered for the development of sustainable, safe, resilient and inclusive cities. Accordingly, it seems to us that Serious Games have considerable potential with respect to the transmission of knowledge regarding specific targets of the SDG11. Indeed, both the serious games in analysis allow for reasoning about how to operate in cities following economic, environmental, and social sustainability logics.

In this perspective, the results of the analysis make it possible to observe that the conceptualization of sustainability in the urban and architectural context can be seen as a lens that enables attention to certain aspects of urban transformations, which if conducted according to good practices would positively promote the development in terms of the three pillars of sustainability. Thus, even serious games that do not explicitly prioritize sustainability, such as URBAX, can provide valuable knowledge on various issues that promote a city's sustainable development. Reflections on urban district development will thus likely take into account sustainable, safe, and inclusive actions. For example, the URBAX game, which considers as a goal the reactivation of a declining city through action at the urban and architectural levels with attention to land uses, would imply that: a) regulating and managing land use leads to reflections with respect to strategies aimed at minimizing the consumption of virgin land; b) reactivating the markets of a city in decline determines the creation of services and consequent housing for the population, the realization of which must take into account different socioeconomic situations and thus consider affordable housing; c) the presence of housing in poor condition may lead to reflections in terms of benefits derived from its renovation both in social terms, with respect to the health of users, and in environmental terms, with respect to the reduction of air pollution and land consumption. In a different way, the urbEN game considers within the design of the game inputs traceable to SDG11 targets as actions necessary to achieve an energy transition goal, such as the construction of affordable housing for the middle class with a high level of energy performance.

The use of such games in conveying knowledge about urban sustainability to future architects and planners could potentially have implications related to policymaking. Indeed, the games allow students to experiment and implement strategies as private and public actors by learning shared skills in urban planning, market and strategic logic needed by PA workers. The municipality is the "place" where urban planning is carried out and the PA is the entity that can intervene directly on the planning of urban

space through provisions of use, funding, incentives and direct interventions, therefore knowing certain dynamics can be an element in favor of a careful policymaking. In line with this, it could be considered that the application of the game with real PA subjects and other stakeholders could highlight the importance of implementing certain actions or limiting others with a view to shared and conscious sustainable development. For example, it is very difficult that in reality a private actor put aside his/her own economic interests in favour of benefits for society or for the environment, so observing how his/her personal action can actually have positive spillover effects on the welfare of the city could potentially lead him to think according to different strategic patterns.

Among the recognizable limitations in the application of these games is undoubtedly the need to decomplexify reality. This element leads to making some mechanisms oversimplified or establishing game elements governed by dominant dynamics imposed *a priori*. Another limitation observed in applications may be that whereby all or most students assume the goal proposed by the local authority (in the game) as their own, sometimes sacrificing even the primary goals of the actors they are impersonating. This certainly leads to a successful sustainable outcome of the game, however, it may be an overly positive view of reality, which, instead, clashes with multiple issues, interests and priorities.

Although this paper only examines two serious games, it recognizes that there is a vast array of other serious games that exist and can potentially convey specific knowledge on sustainable cities [15]. This paper emphasizes the potential of serious games as tools to transfer this knowledge and highlights the need for future analysis of other serious games developed in urban settings. Furthermore, it suggests that designing a new game that focuses specifically on transferring knowledge about all the issues considered in SDG11 could be a promising avenue for future research and development. The potential for using these tools to promote sustainable urban development can be maximized by exploring more serious games and creating new ones.

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