THE SCIENCE OF PLAY: CONFESSIONS OF AN ENGINEER EXPLORING SCIENCE AND TECHNOLOGY STUDIES. AN STS ANALYSIS OF SERIOUS GAMES AND CO-PRODUCTION

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ABSTRACT

The present study explores the concept of co-production in the context of science and technology studies (STS) and its application to serious games in smart cities. Co-production, which highlights the interdependence of science, technology, and society, challenges traditional notions of expertise and emphasizes the active involvement of diverse actors in the design and implementation of technologies. The article examines the role of serious games in public participation in smart cities, focusing on their outcomes and limitations from an STS perspective. The concept of co-production in STS emphasizes the significance of recognizing the complex interactions between scientific knowledge, societal practices, and technological innovation. STS scholars argue that scientific knowledge is shaped by social and cultural contexts, and they highlight the importance of understanding the social and political dimensions of scientific knowledge production in policy-making processes. The article explores how STS perspectives challenge traditional views of agency and object, considering the active role played by non-human objects, such as technologies, in shaping social reality. Serious games are identified as a means to facilitate co-production in smart cities, allowing users to simulate real-world situations and engage in decision-making processes. The benefits of serious games are documented in the literature for increasing engagement, understanding complex urban issues, and promoting collaborative decision-making. However, it has also been challenged by critical perspectives from STS scholars who question the transformative potential of serious games, citing evidence that some games reinforce existing socio-technical systems rather than fostering radical change. Results of our study show the importance of a critical approach to serious games, recognizing them not only as tools but also as objects of study that reflect broader social and cultural values. STS insights call for a nuanced understanding of serious games' social and political implications and advocate for the active involvement of users and stakeholders in their design and development. Overall, this article contributes to the field of STS and Urban Facilities Management by examining the intersection of co-production, serious games, and smart cities, providing a valuable perspective on the potential and limitations of serious games in fostering public participation and shaping sustainable urban development.

KEYWORDS _ *Co-production, Science and Technology Studies, Smart cities, Serious games*

INTRODUCTION

Science and technology studies (STS) explore how society, culture, and politics interact with scientific and technological development. The concept of co-production is central to STS, which considers science, technology, and society as intimately linked and co-constructed. Smart cities, with their integrated and interconnected technological systems, present an ideal context for exploring co-production through serious games (Cavada and Rogers 2020). This paper will focus on the implementation of serious games in public participation in smart cities, their outcomes, and limitations, viewed through the lens of STS. The starting point for this reflection is my own doctoral work in which I have prototyped a serious game to teach children about sustainable urban transformation and enable their participation in decision-making processes. In this context, I have researched the scientific literature on the use of serious games for public participation and documented their manyfold benefits. However, coming from the field of engineering and adopting a design science research methodology, I have not explored the concept of co-production, nor have I paused to analyze how the prototype has been shaped by diverse knowledge systems. This is an attempt to explore some of these unknown territories. After defining the terms of smart cities and public participation, we will introduce the concept of co-production in STS and discuss it in connection with public participation. Then, we will nuance the almost unanimous discourse of the benefits of serious games, by introducing the work of STS scholars on the shortcomings of serious games in achieving deep socio-technical changes. It is important to underline the fact that this work solely focuses on "serious" games which refers to games developed for another purpose than pure entertainment (Susi, Johanenesson, and Backlund 2007). They emerged from the field of education and training as a way to improve knowledge transfer and engagement of the participants (Laamarti, Eid, and El Saddik 2014). This paper does not cover the other body of literature that focuses on games designed primarily for entertainment such as traditional video and computer games.

SMART CITIES AND PUBLIC PARTICIPATION

There has been a substantial amount of literature produced on the concept of the smart city since the term was first introduced in 1994, with a significant increase in attention following its adoption as a cornerstone of the European Union's development strategy in 2010, (Mangnus et al. 2022; Collins et al. 2021) . The European Union continues to intensify its efforts and funding capacity for smart city projects. In total, the funding program Horizon Europe will invest 360 million euros in research and innovation actions lined to the Climate-neutral and Smart cities mission (European Commission 2021).

The development of smart cities is a complex process that requires the involvement and engagement of citizens to ensure sustainability and success. The United Nations Sustainable Development Goal (SDG) 11 emphasizes the importance of sustainable urbanization, which includes making cities inclusive, safe, resilient, and sustainable. To achieve this goal, cities must adopt participatory approaches that engage citizens in decision-making processes, such as those related to urban planning and transportation infrastructure (Prabowo, Temeljotov Salaj, and Lohne 2021). Similarly, SDG 13 focuses on climate action and the need to reduce greenhouse gas emissions. Citizen engagement and upskilling are essential in achieving this goal as well, as individuals need to be aware of their impact on the environment and understand how they can reduce their carbon footprint (Preston, Mazhar, and Bull 2020; Schleicher and Schmidt 2020). Citizens' lack of motivation to engage in participatory processes makes it challenging to recruit representative samples (Temeljotov Salaj et al. 2020; Jowkar et al. 2022; Lim and Yigitcanlar 2022). In addition, the choice of participation method determines which demographics are capable to engage or not. At the end of the process, the results of public participation can be difficult to implement in the plans, especially if essential knowledge about the issue at stake is not sufficiently transferred to participants. A change towards more sustainable behaviors is also necessary in order to achieve the goals of sustainable urban development (Khansari, Mostashari, and Mansouri 2014). Public participation is a broad and multi-dimensional concept that

has been discussed extensively in various fields of research, including urban planning, public policy, and environmental studies (Innes and Booher 2007; Rowe and Frewer 2000; Reed 2008; Bovaird 2007). According to Arnstein (1969), public participation is a process that allows citizens to actively engage in decision-making processes and to have a genuine impact on the outcomes of those processes. This definition emphasizes the importance of power dynamics between the government and citizens, with public participation serving as a means of empowering citizens and ensuring that their interests are taken into account (Akbarinejad, Temeljotov Salaj, and Johansen 2023). Several scholars have proposed typologies or models to conceptualize the different levels and types of public participation. For instance, Pretty (1995) proposed a ladder of citizen participation, which ranges from "manipulative participation" to "interactive participation and self-mobilization", with each rung representing a different level of citizen involvement and influence in decision-making processes. Rowe and Frewer (2000) identified three levels of public participation: passive, where citizens receive information but do not provide feedback; consultative, where citizens provide feedback but do not have decision-making power; and collaborative, where citizens and decision-makers work together to create a mutually beneficial solution.

THE CONCEPT OF CO-PRODUCTION IN SCIENCE AND TECHNOLOGY STUDIES

Co-production is a concept that has gained significant attention in Science and Technology Studies (STS) over the past few decades. Co-production is based on the premise that knowledge and expertise are distributed among different actors, and that successful innovation requires their active involvement. In the context of STS, co-production is particularly relevant because it challenges the traditional notion of expertise and the role of scientists and engineers in the innovation process. Instead, it emphasizes the importance of public participation and the incorporation of diverse knowledge systems in the design and implementation of technologies. According to STS scholars, there is an interdependence of scientific knowledge production and societal practices. It refers to the idea that scientific knowledge is not simply a product of objective observation and experimentation, but rather it is shaped and constructed through interactions between scientists, the technologies they use, and the broader social and cultural contexts in which they are embedded. Jasanoff and Kim (2009) introduced the concept of "sociotechnical imaginaries" to show how knowledge and social order are coproduced, that is, how social arrangements and institutions influence the production of knowledge. This understanding of co-production has been influential in the study of science and technology, as it emphasizes the importance of recognizing the social and political dimensions of scientific knowledge production in policy-making processes.

STS is a field of study that explores the interrelations between society, technology and science. It provides a useful framework for analyzing the socio-technical dimensions of co-production in smart cities. According to STS scholars, technological innovations are not solely the result of technical expertise, but rather emerge through a complex process of negotiation and co-creation between experts and users (Layton 2007). This process involves the recognition of the social and cultural context in which technologies are conceived and implemented, as well as the co-construction of knowledge and values. Hess and Sovacool, (2020) argue that in the literature on public participation, STS perspectives depart from the broader literature by analyzing how participatory and consultative processes construct publics rather than simply represent them. Similarly, STS perspectives challenge underlying assumptions about definitions of participation, publics, and democracy. By examining how different types of publics are constructed through various participation processes, they have developed alternative designs for participation processes. This approach shows that concepts such as "the public" or "public participation" are actively constructed through social processes. The insights gained from this approach can inform the practice of public engagement by leading to alternative approaches to the design of engagement and participation. Participation has been an important part of design for many years; however, it is a concept that is vaguely defined and polyvocal. Latour's

Actor-Network Theory (ANT) provides a new way to frame participation as a "matter of concern" and to challenge the concept and practice of participation (Andersen et al. 2015). In their study, Andersen et al. (2015) investigate how ANT can be used to better understand participation in Participatory Design by looking at an example project, Teledialogue. Teledialogue is a research and design project which aims to use technology to strengthen the dialogue between placed children living in foster care and their social workers. ANT emphasizes the mediated and processual aspect of reality and how facts are produced and constituted through hybrid actor-networks. It also shows how participation is not limited to design events or premised by physical presence or intentional interaction, and that there is no gold standard for a priori evaluation of the quality of participation. According to Andersen et al. (2015), participation is a relational and heterogeneous network achievement which is achieved beyond specific design processes and projects. Through the Teledialogue project, it is shown that children are always participating with others and that their participation is manifested in action. ANT challenges the notion of participation as a means to an end and enables novel ways to discuss and practice design as a network achievement. The longstanding problems in social theory about agency and object have been extensively discussed in the STS literature (Woolgar 1990). One of the traditional views in social theory has tended to see agency and object as separate entities, with agency being attributed to human actors and objects being seen as passive and devoid of agency. This view has been criticized in STS, which argues for the co-production of agency and object in shaping social reality. As (Jasanoff 2004) notes, the co-production perspective challenges the notion that humans are the only active agents and instead emphasizes the active role played by things in shaping the social and political world. For example, in the context of smart cities and public participation, technologies such as sensors and data analytics are not simply passive objects that enable human action, but rather are active agents that shape and influence human behavior and decision-making (Foth et al. 2015). Foth et al. (2015) investigated the changing role of people from passive members of the plebs to active instigators of change and prompted Human Computer Interaction (HCI) designers to consider social, situational, cultural, and contextual factors when designing for community and civic engagement. The concept of co-production in STS therefore challenges traditional views of agency and object, and calls for a more nuanced understanding of the complex interactions between human actors and non-human objects in shaping social reality. This view is not only more accurate, but it also has important implications for policy and practice, as it highlights the need to take into account the active role played by technologies and infrastructures in shaping social outcomes (Jasanoff 2004). By recognizing the co-production of agency and object, policymakers and practitioners can design more effective interventions that take into account the complex interplay between human and non-human actors in shaping social outcomes.

One way to facilitate co-production in smart cities is through the use of serious games . They can be used to simulate real-world situations and enable users to experiment with different scenarios and solutions. In the context of smart cities, co-production is essential in ensuring that citizens have a voice in the development and implementation of tech-driven solutions that impact their communities (Senior et al. 2023). Serious games are games that have a purpose beyond entertainment, such as education or training (Scurati, Ferrise, and Bertoni 2020). In the context of smart cities, serious games can be used to engage citizens in urban planning and decision-making processes (Angelidou and Psaltoglou 2019; West et al. 2019; Wolff et al. 2017). Citizen's involvement can help to increase transparency and accountability, and improve the quality of life in cities (Andalib, Diaconu, and Temeljotov-Salaj 2023). When it comes to their effectiveness, serious games have been shown to lead to higher levels of engagement and learning compared to traditional methods. They can help citizens to better understand complex urban issues, and provide a means for them to express their preferences and concerns (Horgan and Dimitrijević 2019; Angelidou and Psaltoglou 2019) Additionally, serious games have the potential to reduce the power imbalance between citizens and government, and promote more collaborative decision-making processes (Koplin et al. 2017). Several case studies demonstrate the effectiveness of serious games in fostering public participation in smart cities. Gamification of processes is one way the public authorities have explored to engage younger publics

in the co-creation of urban spaces, the most institutionalized example is the UN habitat program "Block by Block" using Minecraft for participatory design (Delaney 2022). The benefits of games and serious games are that they allow learners to experience situations and engage in learning activities that are otherwise impossible or difficult to implement and experience in the real world (Corti 2006). There is evidence that the use of games supports the development of skills such as strategic thinking, planning, communication, collaboration, group decision-making, and negotiation skills (Camilleri 2022). Games in education can also bring difficult-to-understand abstract concepts closer to students and could facilitate the understanding of several scientific concepts (Gabriel and Schmölzer 2021). In their study, Gugerell, Funovits and Ampatzidou (2018) demonstrate that serious games that incorporate environmental storylines can serve as effective entry points for promoting environmental awareness, interest, and knowledge, even among individuals who may initially have lower levels of intrinsic motivation or environmental attitudes. The review of the scientific literature in the field of serious games and public participation in smart cities reported mostly positive outcomes and benefits. However, when exploring the field of serious games in energy transition, we retrieved a study that largely nuances this almost unanimous consensus. Wagner and Gałuszka (2020), conducted an extensive study on the role of serious games in energy transition, in which they explored the concept of sociotechnical imaginaries and their relationship to "serious gaming". They investigated whether these imaginaries could potentially be used to influence players' attitudes towards green solutions, in which case the serious games could introduce new ideas of energy governance. However, based on their analysis of 51 energy-themed serious games they did not find evidence of such claims. On the contrary, they found that energy imaginaries presented in the games comforted the established "socio-technical regimes and its gradual evolution, rather than supporting a radical change in the energy socio-technical system" Wagner and Gałuszka (2020). Findings from this study are important to consider in the development of a serious game for smart and sustainable urban development. Even more so when developing a game that is targeting children, if we want to avoid fostering the same "old socio-technical systems" but rather encourage them to explore new possibilities and shape alternative futures. Through the lens of STS, serious games are not only tools but also objects of study. They reflect broader social and cultural values and can shape the way people think about and interact with technology. STS scholars draw our attention towards a critical approach to serious games that takes into account their social and political implications.

REFLECTIONS AND CONCLUSION

One of the challenges of serious games is that they tend to be designed by experts and professionals, without much input from the users and stakeholders. This can lead to a narrow and limited understanding of the complex socio-technical issues at stake, and can result in technologies that do not meet the needs and expectations of the users and stakeholders. STS scholars have also pointed out that serious games can create a false sense of participation and democracy, as they tend to be designed in a top-down manner, with little room for negotiation and co-creation among the participants. Serious games can also reinforce existing power structures and inequalities, as they tend to favor certain groups of stakeholders over others, and can perpetuate the marginalization of minority voices and perspectives. To address these limitations and challenges, STS scholars call for a more critical and reflexive approach to the design and implementation of serious games. This approach involves recognizing the diversity and complexity of the stakeholders and their knowledge systems, and incorporating their perspectives and values in the design and implementation of technologies. In practice, for us prototyping serious games for participation, it means creating a more equal and democratic platform for negotiation and co-creation among the participants early on, and ensuring that the outcomes of the process reflect the needs and expectations of all stakeholders.

In conclusion, serious games present an ideal context for exploring co-production in the context of public participation in smart cities. However, their implementation requires a more critical and

nuanced approach, which takes into account the diversity and complexity of the stakeholders and their knowledge systems, and ensures that the outcomes of the process reflect the needs and expectations of all stakeholders (Ertiö 2015). STS provides a useful framework for analyzing the socio-technical dimensions of co-production in smart cities, and for developing alternative approaches to the design and implementation of serious games that are more inclusive, democratic, and reflexive. As suggested in the title, although this paper might not have harnessed the full potential of STS to critically examine the question of serious games for public participation in smart cities, it is an attempt to open the minds of engineers working on such topics and encourage them to look beyond their approach of prototyping and user-testing. Further work is needed to examine the power relations at play in participatory processes using serious games and to discuss the literature on the different levels of participation from a co-production perspective.

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