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Serious Gaming as an Enabler of Truly Smart Cities

Abstract

Despite claims for the development of 'smart cities' for more than two decades, the term is still unclear. This is in part because the academic approach to 'smart' is ever-changing, while current methodologies used to conceive, design and operate smart cities sometimes overlap with, and sometimes contradict, each other. Due to a combination of technological advancements and market forces, smartness often comes within reach of a service provision approach. For this reason, academic methodologies that aspire to deliver 'liveability', which addresses the need for a balance in the aims of city development by putting people – that is, individual and societal health and wellbeing, and as a consequence planetary wellbeing – at the heart of the decision-making process, play a vital role in delivering smart cities. As the authors have argued repeatedly: 'smart' is only 'truly smart' if it leads to more sustainable, resilient and liveable cities.

Interestingly, the very uncertainty surrounding the definition of smartness can be harnessed in the interplay of different concepts that encourage the 'gamification of smart' – the use of serious gaming to deliver truly smart outcomes. Although city simulation games already exist (Sim City, Our City, etc.), where players are dealing with scenarios for developing urban contexts, so far there is no concept of how these virtual environments can develop real-life scenarios and skills that can be harnessed to make practical improvements to city living. This would have the potential to lead to further innovations in implementing true smartness alongside technologies that aim to engage users in 'liveable practices' (those that advance us towards more liveable cities). For this reason, the essence of 'smart city games' should be deeply rooted in liveability approaches so that this idea can develop into serious impacts through societal, environmental, economic and governance actions. Furthermore, the gamification of smartness is a form of engagement that results in education of what it means to be, and how it is to live in, a smart city. In this situation, liveability goals would direct education and engagement in 'smart play' and change the attitudes and behaviours of the gamers themselves. Games, as a self-explanatory method for learning, can introduce in an immediate and scalable way liveability actions using new technologies. The idea can also be introduced in a form that will enable the engagement of users who would otherwise abstain from technologies or social media. This means that actions towards liveability should be included in real-life scenarios alongside the demand for high-tech solutions to problems in smart cites. Therefore, the architectures of gaming technologies should be designed to facilitate low-level interactions that enhance the participation of low-tech users in the high-level technologies used to make cities truly smart.

The above discussion would mean that smart city simulation games need to introduce a concept of liveability that embraces societal, environmental, economic, and governance interdependencies as educational components in the recreation activity for players that are dealing with scenarios for developing urban contexts. Rather than a recreational activity that implements technology, therefore, the inclusion of 'truly smart thinking' into city gaming practices is an action that engenders both ethical and educational benefits to the user (the gamer), offering skill development and adding value in societal and individual terms.

1. Introduction: The Smart Cities Context

Future cities research aimed at supporting transparent decision making at all levels of governance, from local to global, has the concomitant benefit of directing engineers (and collaborators from all the urban professions) to provide solutions to urban problems that are truly smart – i.e. they embrace resiliency, sustainability, and liveability, features which should be deeply rooted and transparent in the methods adopted for city engineering (Rogers, 2018). However, smartness as is a term that often fails to fully capture its potential, given the very many, usually narrow, interpretations of its meaning (Cavada *et al.*, 2014). When it comes to specificity of the smart city concept, it would be best seen through the lens of liveability, since without such a lens 'smart' falls into the realm of digitally-enabled service provision and would not provide the wider shared benefits that this paper advocates: the smart city concept being 'truly smart' (Cavada *et al.*, 2014; 2019).

The concept of liveability was captured in a 5-year, multi-disciplinary research programme entitled '*Transforming the Engineering of Cities to Deliver Societal and Planetary Wellbeing*' (Liveable Cities, 2013). Liveable Cities explored the fundamental city engineering – adopting the concept of engineering being the application of ingenuity (the root of the word engineering) to problem solving – needed for the betterment of living in urban areas. The disciplines of the team members included engineering, economics, architecture, geography, ecology, psychology, and other social and environmental sciences from four UK universities, yet the team worked towards transdisciplinarity by developing methodologies that treated cities as holistic systems. For convenience it viewed cities through Social, Environmental, Economic and Governance Lenses, but acknowledged that all urban systems are interdependent to some degree: intervene in one system and the other systems are likely to be impacted to a greater or lesser extent (Leach *et al.*, 2017; Liveable Cities, 2013).

However, truly smart cities are not just visionary; practical implementation of engineering interventions can, and should be designed to, lead to truly smart cities. For example sharing schemes (which might or might not benefit from digitalisation) that are proposed to deliver resource and community cohesion benefits, though in fact support several aspects of the four lenses of liveability associated with city living at a local scale, are no different in concept to shared utility or transport systems (Boyko *et al.*, 2016). Given the common internalisation of the smart ideal, urban areas (or 'cities' for short as used herein) often enact digital solutions in collaboration with multinational corporations. However the infrastructure required to implement the wider-scale solutions that these digital schemes aim to provide should be reconsidered (i.e. reconfigured or redesigned) to generate the multiple additional forms of value that they could offer, ensuring that solutions are truly smart (Bouch *et al.*, 2018). Engineered solutions (or in the smart city realm, city initiatives) should be conceived as holistic, cutting across different sectors, and resilient, i.e. ensuring that they are equally effective in the future under different circumstances or contexts (Cavada *et al.*, 2017, Lombardi *et al.*, 2012; Rogers *et al*., 2012). This paper explores the literature on gamification methodologies and explores how this approach can be used to bring about truly smart cities.

2. A Methodology for the Gamification of Smart Cities to make them Truly Smart

The aim of this paper is to explore the implementation potential of gaming technologies – using recreation – to find ways towards more liveable worlds, revealing new techniques and embedding the experience of the journey in the gamers. Therefore, this paper seeks to review the literature on recreational technology to leverage the connection between truly smart cities and gamification methods to address the following objectives:

- To understand the effects of recreational location-based services (LBS).
- To support the gamification of truly smart cities.

3. Location-Based Games

3.1 *Fundamental types of Location-Based Games*

A wider acceptance of the term 'game' explains the experience as an individual or team member taking part in an activity described as a "positive participation strategy" (Fasce, 2014). With the support of contemporary technology, the gaming industry has been able to expand in terms of multimedia, types of games, ways of participation, and interaction. Innovative technologies have been integrated in digital networks to create a Location-Based Services Network (LBSN), a foundation for social media and online location games connecting the geo-location of the user / gamer to the virtual (online) location; this becomes a part of their 'online existence' that enables the gamer's spatial exploration (Saker and Evans, 2016a,b). An initial characterisation of such games yields three main classifications: (i) unfolding stories, (ii) social media, and (iii) replication of the real world (Imbellone *et al*., 2015).

PokemonGO, as an example of unfolding stories, is an online gaming application that develops a storyline depending on the geolocation of the gamer. It requires players to chase and catch computer-generated mythical creatures that appear on their smartphone screens, blending the virtual with the physical environment. It therefore theoretically enhances both social interaction and way-finding in the urban context – it strengthens social ties between players and the game context (Garrido *et al*., 2017; Saker, 2018). Papangelis *et al.* (2017a,b) developed a mobile game named 'Conquering the City' in which gamers test their location for its qualities: gamers can post online their own interpretation of the given city context ('*claim it*' from other gamers) and this in turn offers the ability to analyse the communication – mostly via path exploration and communication between players.

In the second, social media, category Foursquare (similar to Twitter and Facebook) allows participants to digitally inscribe their geo-location with other users using information, commentary, or images of the place. This information is transcribed in a digital map and could be used to analyse contextual information on a micro-scale. It is this complex matter of distinguishing the kind of information posted that is valuable (Likhyani *et al.*, 2015; Vesconelos *et al*., 2015; Zhou *et al.*, 2016).

In the third category sits city simulation games (with SimCity being far the most played), which Adams (1997, p. 385; 391) consider to be "*abstract notions of urban development built into the simulation and its response patterns … a visual vocabulary*". Requiring the same skills as other games, it is a digital topographical space where the player combines systems (notably systems of infrastructure services and the built environment) to construct and develop an imaginary urban context. Often, the urban context mimics the reality of the current situation (e.g. car-dependency, which is a mainstream urban perception) – the ability to move far from contemporary city paradigms (e.g. in terms of modes of transport) would be a valuable advancement for city simulation games (Bereitschaft, 2016; Rizzi, 2001; Sukhov, 2016; Kim and Shin, 2016). According to Woessner (2015), city simulation gaming is not a collaborative process, but places the individual gamer as the mayoral figure following his or her own decision-making strategy without political influences and based on personal opinions (which might or might not be informed by any relevant education or skills in city development) or an obscure image which they wish to portray whilst playing (Wohn and Wash, 2013; Atkinson and Willis, 2009). City gaming in general offers the experience of the positive effects of a game and realisation of city complexity with an associated sense accomplishment, and develops an enhanced understanding of city governance and the human implications of city living (Lin and Lin, 2017, Johann, *et al.*, 2001, Wright, 1989). City simulation uses Location-Based Game (LBG) technologies; the same technologies that are

used in commercial sectors to deliver cost and time efficiencies and sometimes to predict potential risk in projects (Bangert, 2013).

3.2 *Way finding technology for Location-Based Games*

LBGs mostly use Geographic Information Systems (GIS), a computer system which collects and displays geographical data and has been used extensively as a tool to ground decisions and display real time datasets from the built environment, for example to assess energy use (Li *et al.*, 2016; Monica *et al.*, 2015; Togawa *et al.*, 2016). The range of possible applications of GIS is enormous, considering the big data available (as well as the ability to combine datasets to reach conclusions), but also in terms of the shared infrastructures offering a novel understanding of how cities operate (Zhao *et al.*, 2016; Yue *et al.*, 2015; Tao *et al.*, 2013; Virrantaus *et al.*, 2002). GIS has offered urban reasoning in strategic decision-making, for example for air pollution strategies, and also for theoretical implementations such as the Flomena *et al.* (2019) Lynch study that describes urban nodes, which all contribute of course to way-finding gaming technology (Kose *et al.*, 2017; Khan *et al.*, 2018; Ahlqvist *et al.*, 2016; 2012).

Batty (1997), almost two decades ago, perceived the future urban context as a single entity that could be turned into a digital form, which opened up a new dimension for seeing a variety of opportunities long before the smart city movement was widely popular. Today, however, this happens sporadically, with private organisations (Arcadis's Digital Twins; Gupte, 2019), public organisations such as city municipalities or some individuals (gamers, perhaps, being some of them) being able to access parts of the digital city (Shennan, 2018). This leaves a huge unexplored opportunity for citizens' participation in the public realm, not only as clients of real-time data geo-location, but as individuals with the opportunity (or rather, their civic right) to experience, understand, and explore the city as a whole, and become part of the city decision-making process (Medaglia, 2007). More specifically, GIS technology has advanced the introduction of sensors into urban systems and made them easier to manage (Hacke *et al.*, 2013), which both makes the systems less susceptible to risk and reduces management costs. In the next section we explore the effects of city gamification, which include envisaging the challenges and also opportunities for creating a truly smart city.

4. Societal, Individual and Technological Effects of Location-Based Games

We see PokemonGO as the most representative example of city simulation mixed with realistic contexts: providing physical activity and at the same time presenting an opportunity to socialise with other players, thus helping collaborative engagement and learning of the urban environment (Nigaglioni, 2017). This is in contrast to the other primary generator of physical activity named the 'Pikachu effect' (Kaczmarek *et al.*, 2017). Within the PokemonGO system, new interaction methods among individuals (or teams) can potentially further explore and develop learning environments, especially directed towards the younger generation that have an interest in innovative technologies (Nigaglioni, 2017). Along with the opportunities, way-finding presents challenges, as happens with many innovative technologies. These challenges include numerous game (or device) updates and economic prerequisites for continuing the excitement of the game when the initial enthusiasm fades and where the continuation of the success cannot be sustained (Althoff, 2016). Despite parents' distress at the risk that augmented reality games can have on traditional life patterns, where children would tend to focus on their screen rather on the physical environment, family interactions seem to benefit from the joint PokemonGO hunting activity. Furthermore, it

provides contextual exploration, a practice that could offer multiple benefits in future cities by enriching citizens' perspectives of the city and its values that need protecting (Lindqvist *et al.,* 2018). On a personal level, challenges often relate to age and other demographic limitations, while a narrowly-targeted, siloed approach is often adopted by private organisations and those who manage the system (Yue, 2015).

4.1 Societal effects

We first explore the societal effects of gamification, where recent research suggests positive health implications in general (due to the outdoor activity required while playing) in contrast to the indoor playing of video-games (Kaczmarek *et al.,* 2017). However, while gamification of cities motivates contextual interaction and connections with fellow gamers, it cannot be expected to be the sole contributor to behavioural change due to the temporal character of almost every augmented reality (AR) game (Nigg *et al.*, 2017). However, the effects of gamification at a city-scale are not yet fully explored: can an AR game affect the city entity? Currently, some elements can be considered to play a societal role. A 'good city' according to Amin (2006) considers social value to play a central role in local governance. Yet, citizens are usually connected emotionally to cities, not least by what they experience through their senses and this can lead to more sustainable and smart attitudes (Belance, 2016). This is something that smart city products have not addressed, thus many of them (*smart cards,* for example) are not used by everyone; their management in this case should be context dependent and devised to provide benefits to all individuals (Belance *et al.,* 2014). As an example, Ahas and Mark (2005) refer to the 'Social Positioning Method' (SPM), a place and real-time specific method to be used for social observations that can affect decision making and have an input on urban planning policy. Poplin (2012) describes the '*NextCampus*', a game approach to evaluate stakeholders' views on campus relocation (in Hamburg, Germany) according to potential scenarios and cost, building use and general influences. These views will not define directly final decisions, but the game is part of a process of encouraging participation and repeated evaluation to assist in reaching the final decisions on the campus move. A further example of gamifying diagnostics, especially useful in education systems, is a game ('*QuesTInSitu: The Game*') which presents data to support self-assessment using visualisations to engender student interactions with the trends (Melero *et al.,* 2015).

These digital tools could provide the contemporary way for individual expression of the complex city environment; contradicting the argument of Proshansky (1978:165) that digitalisation has a negative connotation of one's existence in the city. The urban context, he believes, is a complex urban system in which citizens are characterised by a *nexus* of city senses. As we see today, digital technologies have shifted the route of cities onto a temporal axis and the current automation of city systems is a reality. However, digital systems have a huge energy footprint which adds its own problems to the mix of city systems, at least to the climate change challenge (Batty and Xie, 1990). Furthermore, paediatricians have called for guiding principles on safety, particularly in cases where engagement might lead to physical or criminal actions (Serino *et al.*, 2016). Jung *et al.* (2015) suggest that safety procedures should be implemented in the existing infrastructure of location-based services and games.

The gamification of cities might bring current urban challenges to a digital level, such as places as locations of conflict where groups or individuals associate with urban cultural territories, and indeed innovative technologies might impose challenges that are not yet evaluated. However, innovative technologies also offer opportunities for understanding, and forecasting, and provide benefits for the city as a whole and the individual gamer.

4.2 Individual (self-identity in gamification)

Location-based technologies offer users an opportunity to represent themselves and their choices online, as individuals – game identity is here related with both the self and the locational context of the game (Papangelis *et al.*, 2017c; Saker, 2016). Here participants communicate and make personal decisions based on the visual representation of space. They can claim special knowledge of space ('mayorship'), and can see where their peers are at a certain moment in time, which brings an element of accomplishment in the game (Saker and Frith, 2018). Schwartz and Halegoua (2015) suggest that such a digital self-paradigm is the reflection of one's aspirational online self, yet one that relates its existence according to an accurate locational representation in terms of context (map, images, or opinions) and provides traceable historical evidence.

However, as Halegoua (2015) notes, the user's intentions might differ from the reality. Often participants (similar to internet and social media experiences) represent themselves in the virtual world of gaming in a different way to their real-life behaviour – their online persona fits their aspirations or the rules of the game they are playing, an attitude that has been expressed also in online purchases and payment (Kim and Kankanhalli, 2012). In the same way that an individual uses virtual purchases which fit their online persona (noting that this remains a private action), individual transactions might be part of the wider digitalisation while still remaining on a personal level – there are parallels here to the change of governance control of the banking system (Yoris and Kauffman, 2007). Similar to the individual use of the internet, online action is personalised rather than a collective shift to digitalisation (Brunsting, 2002). When digital solutions are addressing life choices and actions at a personal level and applied to life scenarios (for example applications in health), they show an increased a level of worth, while building stronger ties between participants and offering the opportunity to measure participant attitudes in emergency situations (Schmitz *et al.*, 2015). An alternative use of virtual applications ('Route Mate') has been developed to support, in real-time, those with disabilities that can obscure travelling choices (Brown *et al.*, 2011). Furthermore, technologies can be used to improve memory using senses, such as sound, which can have further implications for enhancing scenescapes in the city (Vemuri *et al.*, 2004).

However, the way that a gamer senses the context or their online selves does not equate to situations in the real world: often it brings personal online risk and gamers want to protect their identity. In individuals' attempts to achieve privacy, unrealistic characters can be integrated into the system and change parameters or players can appear at non-existing locations, both devices that protect personal data (Liu *et al.*, 2013). This means that altered (unrealistic) elements become part of the game dataset. Moreover a pretend virtual location can easily change, and become more detailed, due to the constant improvement and the feeds from wearable technology (Benford *et al.*, 2004). Additionally, a pretend character or location can develop a storyline which gives the characters the potential to act differently in the given scenario, which means this could be an educational tool as long as the game is morally constructive (Mariani and Spallazzo, 2016).

Research on personal context showed that the public is likely to use way-finding technologies, say in transport scenarios. However it seems that it is mostly the younger generations that are at ease with digital skills (Ho, 2012). These required skills, however, are not yet part of the school or other educational curricula, but it is evident that they can provide encouragement, especially to younger generations (Giedd, 2012). The effects of gamification, Giedd continues, are not properly established yet and so we are not entirely sure how it will unfold in the future. Under other conditions, individual gaming responses can lead to

estimations of behaviours, for example group dynamics and behavioural patterns using rewards and predictive actions (Morschheuser *et al*., 2017; Avrahami *et al.*, 2005).

4.3 Gamification technology for current smart cities

Game exploration for smart cities currently poses a challenge, because we are neither aware of the smart city 'limitations' nor understand properly the complete range of possibilities that technology offers. Boulos *et al.* (2017) suggest that technology can provide a basis for the smart city as a sharing platform that supports local governance (or, indeed, large organisations) as well as citizens (community actions, health, safety, and even data interrogation are some of the possibilities) provided that participants are skill-literate and willing to share personal information (L'Heureux, 2015; 2017). Further to the analytical possibilities for smartness, therefore, technology needs to respond to what Zica *et al.* (2018) term conceptualisation challenges; for example, requirements of the skills set to 'play the game' or their continuous advancement therein.

A more probing question is: how will technology lead future developments? It is here that a truly 'joined up' approach to cities is needed, something that is almost universally lacking in practice and yet something that gamification of cities could pioneer. Cities, if they are to be (truly) smart, need systems of interoperable technologies that are holistically integrated, covering both their infrastructure and governance systems (Delmastro *et al*., 2016), and yet the ambition must be wider than this since the scope should include the complete range of the system of systems that make up cities. For this, the systems need mapping to understand how they interrelate, i.e. to establish system dependencies and interdependencies (Bouch and Rogers, 2017). It is likely that once such an integrated system of technologies is in place to support the smart city, it can support a citizen-city decision making process, i.e. achieving the goal of enabling citizen participation, and potentially one that is visualised in real-time (Raper *et al.*, 2017).

At a smaller scale, smart city initiatives have developed solutions that (intentionally, or not) have adopted gamification methods; for example, car-sharing schemes which claim reductions in CO_2 levels (Olszewski, *et al.*, 2018). Virtual Reality (VR) is a strong tool since visually influencing people is a powerful way of bringing about changes in the way people think and act. It therefore should be used for issues that have a positive effect in society (Sakamoto, *et al.*, 2014). The myriad abilities of VR, such as spatial representation, align with technical requirements of the stakeholders such as planners, engineers, and local authorities, but they are not harnessed in a manner that is integrated into one system that supports social ties and real-time communication, and is available for use by individuals (Saker and Frith, 2019). Therefore, even though VR has been available since the 1980s, it has been used by professionals to recreate contexts mostly for clients or specific service providers. However the time is right for what is termed 'serious gaming' to help communication with clients and complex decision making (Jamei, 2017; Ramos, 2018).

The need of those creating smart city technologies to understand what is truly smart is of paramount importance, since digital technology supports the idea of becoming 'smart' mostly only in relation to things that can now be quantified and built into a current system, making the processes faster and more efficient than traditional processes (Anthopoulos, 2017). While this presents unforeseen challenges for the system itself, and especially for those that are affected by it (Miorandi, *et al.*, 2012), it is the broader lost opportunity to change the systems and their outcomes, to make them truly smart, that is more important here. GIS offers possibilities to geo-locate and quantify smart city parameters: for example, urban areas that seek to identify illegal activity or opportunities for low carbon transportation (Togawa *et al.*, 2016). If a city were to adopt elements of gamification, citizens as gamers could make

decisions based on their positive experiences, influenced by their personal sensation of the city (Opromolla *et al.*, 2015); thereby improving their wellbeing and bringing with it many associated societal and economic benefits.

However, the question remains of how we should conceive the smart city via a holistic approach to the improvement of its systems and not just as a set of systems adapted to work as now and solely changing to suit the available technology. A more ambitious question would be: how could the gamification of smart cities offer the potential of citizens having the civic right to perceive and influence the *genius loci* of their urban space, for example by being able to influence future interventions?

5. Gamification in Smarter Cities

So far, it has been established that the practicalities of geo-location games, as shown from the literature, can have an impact on individual and group attitudes, while with the help of VR and AR technologies, the impact of interventions can address wider challenges in society at a collective and on an individual level. More specifically, entailing game elements would entice participants to the game and support citizens in developing skills to be able to use the smart cities systems (Carrasco-Sáez *et al.*, 2017). Furthermore we have established that implementing smartness via gamification means that city interventions could be devised to be truly smart: satisfying liveability and overlapping (resilient, sustainable) city agendas and not solely bringing about system efficiencies due to the use of technology – the latter would be just 'intelligent' (Cavada, 2019; Rogers, 2018). Alongside a theoretical approach of smartness, a practical approach is required and this provides the justification for the gamification of truly smart cities in the research agenda.

For example, a UK research programme conducted at the University of Birmingham (Mapping and Assessing The Underworld) has developed technologies relating to civil interventions in cities based on ground-penetrating radar (GPR), other geophysical techniques and embedded sensors to reveal the location and condition of the buried utility infrastructure. This is a case of using sensor technologies to enhance the resiliency of city systems, and is research that ultimately underpins future city decisions that impact the living quality above ground (Rogers, 2015). Decisions on how we add to, maintain, replace and upgrade this infrastructure impacts city living, and therefore is there a role for citizen preferences to be unearthed to guide the engineering choices that should be made? This might embolden city decision-makers to adopt trenchless technologies in preference to trenching, for example, with all the social and environmental benefits that this would bring (avoiding traffic delays, improving air quality, avoiding pedestrian and business disruption, and so on (see Hojjati *et al*., 2017, 2018).

In the engineering context, gamification is seen as a civic model that builds a narrative for city collaboration at a lower level, providing a bottom up perspective rather than top down governance, which has been dictating city systems so far (Rogers *et al.*, 2014). A conceptual framework for a bottom up approach would evaluate the current (and heritage) context, and view city interventions in terms of positive impacts, placing the people – that is the users, or gamers – at the core. This can happen only if they are aware of the situation and its implications, and are able to intervene digitally or in real life, to guide the overall or individual effects of future engineering (Rogers, 2018; Papangelis *et al.*, 2016). We consider this type of action as a 'smart' initiative, a move towards integration of services and future city operations and actions, by enhancing public participation (Cavada *et al*., 2017). Engineers need to think and act 'truly smart', that is in way that connects the societal benefits and individuals to their professional activity – using ingenuity to solve society's problems. We argue that truly smart city initiatives (whether policies, changes to the urban fabric,

changes to city operating systems, making data available or whatever) are initiatives that deliver impacts to the liveability lenses adopted by the Liveable Cities programme (Leach et al., 2017) and assessed using the Smart Model Assessment Resilient Tool (SMART) for true smartness (Cavada, 2019). These lenses, which are described hereafter, are: societal, environmental, governance, and economic.

6. True Smartness

Cities worldwide have been developing smart agendas as part of their local governance systems, two good UK examples being found in the plans of the Greater London Authority (GLA) and Digital Birmingham's Smart City Roadmap (MoL, 2018; DB, 2014). Although smart agendas are dynamic, influenced by funding, political cycles and different timeframes for different impacts, there is only sporadic public participation – at least as a stated objective. In a truly smart city context, a holistic (properly informed top down and bottom up) approach would provide clarification of the liveability agenda and put people at the centre of the liveability initiatives (Cavada *et al.*, 2017). The goals for liveability are based on community and individual wellbeing and planetary wellbeing, where health, citizens' aspirations and cultural benefits are all prioritised (Liveable Cities, 2013).

Foremost, the effects of smart cities' gamification should be societal, and focus on fairness (equality and equity) when they address issues such environmental sustainability. A good example of smart city initiatives that positively impact on liveability actions are those contained in Birmingham's: 'Smart City Roadmap', strategic agenda aimed at life improvement in the city (DB, 2014a); the 'Eastern Green Corridor', combining skills, health and investment to improve city living locally (BCC, 2018); and the 'Birmingham Development Plan' to support urban and population growth with an eye to the requirements for sustainable living (BCC, 2013). Similarly, in London actions such as: 'London's Smart Park Sustainable Districts', which aims to expand the sustainable capabilities of the Queen Elizabeth Olympic Park (MoL, 2015); 'Sensing London', deploying contemporary sensor technologies to assess air quality (MoL, 2015b); the 'Living Lab' that is advancing technologies to allow environmental evaluation in central London (MoL, 2014a); and 'Hyde Park Sensing' – another set of sensing technologies to assess environmental qualities and improve the quality of living that city parks offer by measuring ground, air, and water conditions (MoL, 2014b).

In environmental terms, systems that should be included in the gamification process need to address the two main aspects of truly smart city resources: resource efficiency and resource security (Rogers et al., 2017); or to put it into a human-focused perspective, to allow for bottom up feeds into this process. The effects of environmental practices need to prioritise local impacts, for which geolocation technologies are able to help. Examples in smart city agendas that have demonstrated this environmental prioritisation include 'Smart London' that aim to embed environmental solutions in the city's smart agenda (MoL, 2018) and 'London's Smart Park Sustainable Districts' which, by offering sustainability opportunities, provides an example in which multiple benefits can be derived (MoL, 2015). Perhaps unsurprisingly, environmental considerations are also found in Birmingham's 'Eastern Growth Corridor' initiative (DB, 2019b). Taking this argument to a higher level, any smart city gamification approach could (and should) embrace environmental considerations and be guided by the global Sustainable Development Goals (SGDs; UN, 2015).

Societal and environmental considerations are felt across individuals and society in multiple ways, and in turn affect the economy in terms of enhanced productivity as well as business development that can support the shift into a truly smart context. For this, the financial goals of smart initiatives should include sustainable financing that supports 'green'

solutions separately from economic growth. A good example here is Copenhagen, which is widely claimed to be a smart city in part because it has developed its city systems around the green economy (CoC, 2018). Some examples from UK smart city agendas include provision of financial support to local businesses from: the 'Greater Birmingham Digital Academy', targeting acceleration for local businesses (DB, 2019c); the 'Small Business Digital Capability Challenge Fund' given to local business for upgrading their digital systems (DB, 2019d); the 'Birmingham Smart City Alliance' group of local businesses that are collaborating on the development of data (IA, 2018); and the 'Energy Smart City' initiative that is developing opportunities in support of London's energy strategy developed by Arup (Buscher *et al*., 2016) and which is engendering collaborations between local business and universities. Similarly, the 'Singapore Networked Trade Platform' is an online system to support businesses to develop solutions in the energy market (GovTech, 2019).

Governance is one of the pillars, or lenses, of liveability and provides the basis for developing truly smart agendas. In order to implement solutions that are truly smart, cities need to understand, and where necessary change, governance systems to ensure fair governance and support public participation (Simonofski, *et al*., 2017; Granier and Kudo, 2016). Often, European cities get funding from national or European reserves, which means that smart initiatives are developed according to competition between cities (EC, 2018a,b). This paper proposes that cities develop governance systems that go beyond established political agendas, and their timescales, to enable truly smart practices, and in particular practices that amplify public participation using the gamification approach. One of the latest updates in the smart agenda that supports public participation is the updated version of the 'New London Plan', which addresses urban development challenges and regulating solutions (MoL, 2019). However, governance examples vary: Singapore's Whole of Government 'Ask Jamie' online service sets out to enable citizens' participation in governance (GovTech, 2019b), while 'Singapore Personal Access (SignPass)' gives citizens the ability to access government information online (GovTech, 2019c). Similar practices are needed to support this proactive bottom up approach, as opposed to the far more limited passive engagements offered by collective citizens' data system approaches (Cavada et al., 2019).

7. Concluding Discussion

This paper has explored the literature on digitally-enabled smartness and its relationship to way-finding technologies. These ideas are explored as a narrative that extends into social media and the development of the online world (Imbellone *et al*., 2015; Garrido *et al*., 2017; Saker, 2018; Papangelis *et al.*, 2017a,b). The paper has shown that innovative technologies used in gaming have much to offer in delivering the (truly) smart agendas in cities. For example, it was shown that the positive impacts of using the digital technologies (or simply playing the games) include informing and changing societal and individual attitudes, and therefore behaviours. Often, the way-finding games have positive impacts in terms of local context exploration, thereby strengthening community ties and providing additional educational benefits, as well as making clear what might beneficially be done to improve the local city landscape and systems (Lindqvist *et al.*, 2018). However, the full extent of the role of way-finding games and their benefits is not clear, even though there is currently some evidence of their efficacy. Game-like technologies in health or mobility, for example, have not come near to exploring their full potential (e.g. in terms of scalability) in creating truly smart cities.

We have also explored some of the actions in smart city agendas that promise more liveable, and therefore ethically-constructive, outcomes; initiatives that are able to provide shared benefits. Given the current uncertainties in the conceptualisation of smart, the

gamification approach should help to bring clarity to the definition – by trialling interventions and analysing the responses – and contribute to a more a robust way of delivering societal and individual benefits that align with the truly smart agenda. Gamification in tandem with a progressively refined conception of true smartness should support benefits that span across the liveability lenses. We propose that way-finding games are valuable tools for citizen participation (and enjoyment) in the development of truly smart cities and guide actions that support the delivery of societal, environmental, financial and governance goals. The practical achievement of greater (true) smartness requires the design of a suite of actions (smart initiatives), which position individual and societal wellbeing (people) and planetary wellbeing at the core. A truly smart agenda does not focus only on available digital technologies, many of which have been designed solely with efficiency of existing systems in mind, but rather offers clarification to the educational and participatory role of the way-finding games.

In practical terms, the results of this study can be implemented both to support smarter cities and to advance the scope and function of digital games. For this, existing digital platforms created to support infrastructure and city systems design and operation could be adapted to provide a fundamental basis for public participation, implementing a gaming approach to trial, and thereby assess the efficacy of, city system interventions and disseminate the results to all city stakeholders (citizens, urban practitioners, businesses and those that govern cities). This, we believe, can offer entrepreneurial opportunities as well as opportunities for the direct engagement of the wider public.

Another possibility for the development of true smartness would be the creation of new methods for gamification in local contexts, noting that gamification can be used both to reveal high-tech and low-tech solutions. Here lie many opportunities for neighbourhoods and communities, but also discrete city events, such as currently exist in the Birmingham with the hosting of the XXII Commonwealth Games in 2022. It is expected that the Games would be highly digitised, aiming to reach the widest spread of populations (e.g. in terms of access and mobility) as they take place, but they also represent Birmingham's chance to create a long-term legacy of recreational participation and promotion of green and healthy living.

This paper therefore adds to the existing literature on city gamification by exploring how gaming can be used to help generate truly smart cities. It has explored the ways in which recreational technologies can bring about practical changes to city systems as well as understanding the beneficial effects of existing gamification methods. Mainly using geo-location digital systems, gamers interact with each other and the context where the game takes place. This gives the opportunity for further exploration and trialling the "what if?" questions posed by potential city interventions, an important step in the development of opportunities for existing systems (as explored briefly in terms of buried infrastructure in relation to the Mapping and Assessing the Underworld programmes) and proposed implementation (Birmingham XXII Commonwealth Games). Overall, we argue that if we want to make way-finding technologies truly smart, it is important to identify and deliver liveability benefits – those that enhance individual and social wellbeing and planetary wellbeing across the environmental, societal, economic and governance lenses. The benefits, however, extend to the individuals that take part in the process: the gamers.

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