

Enhancing Citizen Participation through Serious Games in Virtual Reality

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1 ABSTRACT

Recently, an increasing number of cities are in the process of developing new strategies and concepts to become Smart Cities. Participatory approaches that include all stakeholders are essential for urban developments to be smart and widely accepted. Nevertheless, only a few cities have linked their citizen participation with city planning. This is where this innovative Virtual Reality (VR) project comes in. Technological progress in VR now enables people to be virtually integrated into an emerging future. In combination with gamification methods, educational tools with long term impacts can be created. As of yet, gamification in a non-VR environment has been successfully applied in different projects. This project aims to unlock the untapped potential and examines how a serious game in a high-end VR environment can increase citizen participation in a Smart City.

To create the VR application, a user-centered design method was applied. In a first step, a prototype, the serious game “Virtual Energy Hero”, was developed, which addresses energy and sustainability topics. The game was very well received by more than 90% of approximately 250 players (by the end of 2018). The storyline of the game, as well as its game mechanics to enhance interactivity and immersion, are the main areas for improvement, as identified through interviews, a literature review, tests and surveys. These learnings were considered when designing the second game “Virtual Smart City Hero”. By creating virtual scenarios of the Smart City Winterthur, based on the city’s 3D model, people are offered the opportunity to dive into the topic and interact with current and future Smart City elements. Through interactive mini-games, the players are given an immersive experience.

The “Virtual Smart City Hero” is currently under development and still in the design phase. It is planned that after playing the game, the players are encouraged to join a web based innovation platform. There, they can conceptualize and discuss new ideas and participate in bottom-up initiatives. The platform will promote collaborations between different actors - citizens, administrations, research institutes and the private sector. Impact assessments will be made and it will be analyzed how the platform has to be designed for citizens to become active Smart Citizens.

Keywords: co-creation, serious game, virtual reality, storytelling, participation

2 INTRODUCTION

When looking at a Smart City as a holistic system, citizens need to become involved from the beginning of the city’s transformation process. Citizen participation bears great potential for Smart Cities to not only be developed top-down, but through bottom-up approaches, addressing the people who live in that city. The main value of citizen engagement is seen as being the promotion of citizenship values, the improvement of accountability, the improvement of confidence in government, the maintenance of legitimacy, the achievement of better decisions and the building of consensus (Barber, 1984; King et al., 1998; Thomas, 1995). However, many administrators and citizens are often frustrated about this, not knowing the way to effective citizen participation.

This ongoing project applies a practical approach to investigate whether citizen participation can be enhanced through an innovative gamification approach based on Virtual Reality (VR). VR systems have recently emerged as a powerful three-dimensional, interactive visualization tool. Through an immersive and high-end VR environment, citizens are transported to an emerging future, learning how they can use new technology innovatively and build on its possibilities. The first prototype of the VR game, called “Virtual Energy Hero” (VEH), addresses energy and sustainability topics. Its sequel, the “Virtual Smart City Hero”, aims to improve citizen participation and is currently under development. It is expected that through VR games, users recognise, experience and – in the broader perspective – further develop the potential of a

Smart City through the use of a web-based innovation platform. In a first step, the VR game aims for a sustainable learning effect. Second, the players are motivated to participate in Smart City processes and actively shape their city of the future.

The next chapter briefly summarizes the findings from literature. They cover smart cities and citizen participation, VR and gamification topics with an enhanced focus on serious gaming. In the fourth chapter, the user-centred design method, that was utilized in designing the “Virtual Energy Hero” as well as the “Virtual Smart City Hero”, is described. After that, our preliminary results follow, including a description of the developed games. Lastly, conclusions are drawn, including an outlook on how this project is planned to evolve, especially with regard to the innovation platform.

3 THEORETICAL BACKGROUND

3.1 Citizen Participation in Smart Cities

The term “Smart City” is understood as a future concept for progressive cities. An increasing number of Swiss and international cities are following this trend, driving the process forward by strategically anchoring the term Smart City through pilot projects and funding programmes. According to Smart City Switzerland,¹ cities are described as smart “if they solve their tasks by means of a participatory approach involving a wide range of stakeholders and using new technologies”. The aim is to connect infrastructural fields of action (energy, buildings, mobility, ICT) in such a way as to achieve lower overall energy and resource consumption and a higher quality of life (Moser et al., 2014). New business models and participatory approaches are needed not only to meet the needs of the residents, but also to integrate them into the development process of solutions through co-creation. A former study from ZHAW highlights the importance of co-creation in a Smart City process and identifies the need for information, sensitization and activation of the public (Zwahlen et al., 2016). Participatory mechanisms allow citizens to take part in the design, implementation, monitoring and evaluation of public policy. According to Gassmann et al. (2018), there is a need for designing new concepts concerning decision-making processes including citizen participation. Smart cities should not become overly technocratic and instrumental, but rather apply a more citizen-centric approach. Citizen participation, in Figure 1 implied by the element “Smart Society”, should be an essential part of a Smart City strategy (Zwahlen et al., 2016).

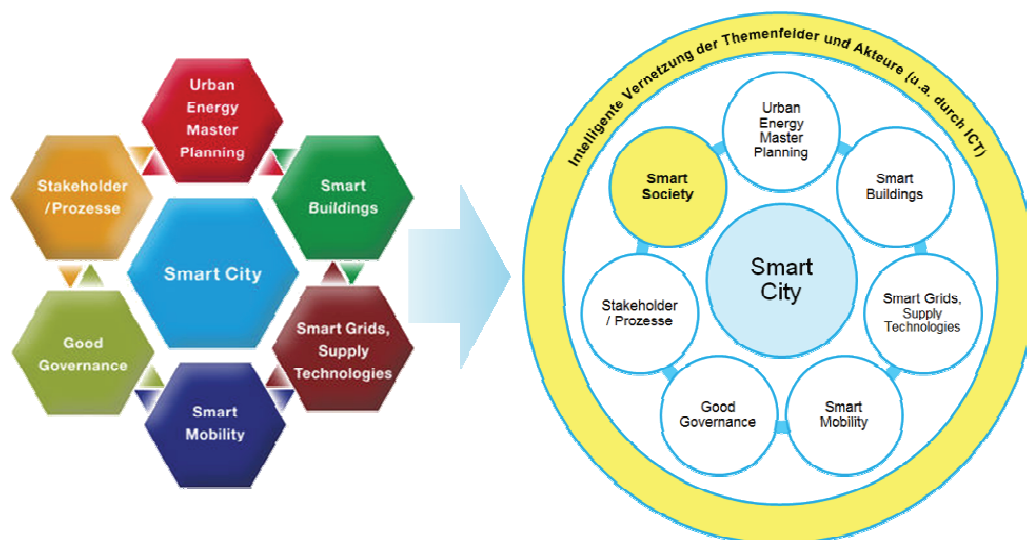


Figure 1: Making the Smart City concept more citizen-centric by supplementing it with the "Smart Society" element (Zwahlen et al., 2016)

For example, a more citizen-centric approach has currently been applied by Barcelona, as they “re-politicize smart city and shift its creation and control away from private interests and the state toward grassroots, civic movements and social innovation” (Cardullo et al., 2019).

¹ <https://www.local-energy.swiss/programme/smart-city>

One way to increase citizen participation as well as the interaction between the different stakeholders is an open innovation platform. An innovation platform should enable public and private sector actors to coordinate their activities and resources (Lee et al., 2014). The Smart City Amsterdam² programme, for example, supports citizen participation through an innovation platform. This platform enables the population to promote Smart City project ideas and find partners for their implementation. In Amsterdam, the platform has already supported various bottom-up projects such as "Games for Cities", a program that explores how games improve city-making, or "GridFriends", a project for sharing renewable energy between households.

3.2 Virtual Reality, Gamification and Serious Gaming

Technological progress and innovation in VR technology mean that VR is growing with unprecedented speed and now, the technology is on the verge of mass adaptation. Today, it is possible to experience high quality and immersive experiences on affordable consumer devices, taking traditional computing interfaces to the next level (Anthes et al., 2016, Berg et al., 2017). The possibilities with VR to visualize and quickly adjust to environments through user feedback enable a better understanding of the design aspects for a particular context and/or spatial perception of users (Liddicoat et al., 2019). Especially in the context of urban development, VR has been employed to present proposals in intuitive and interactive ways. It enables all stakeholders, such as policy makers, local communities, as well as urban planners, to experience and better understand the planned changes in an environment before the development takes place, and thus enhances information sharing and consensus building throughout the planning process (Axford et al., 2007; Engel et al., 2012). Studies show that the possibility of VR to experience scenarios from different perspectives has profound effects on the problem perception of users. For example, a study on 3D replicas of news events showed that VR scenarios promote empathy and can strongly influence and even change public opinion on current issues (de la Peña, 2010). Through VR an emotional bond between audiences and subjects can be established and this connection encourages users to search for additional information in order to contextualize what they have experienced in the VR scenario (Google News Lab, 2017).

According to Karl Kapp, the author of *The Gamification of Learning and Instruction*, "Gamification is using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems" (Kapp, 2012). Game thinking and game mechanics are two key concepts of gamification. Game-based mechanics represent aspects of a game that make it tempting to play. This can include points, badges, levels, or any quantitative scoring system. Game thinking can be characterized as the interface and competition within a game. The blend of these helps to immerse and motivate individuals to perform tasks in a desired manner in many separate applications.

Within a gamified concept, different elements have various effects upon the user. In a systematic review of 25 studies, researchers counted the number of times specific game concepts were employed in each study. It was found that the concepts of feedback (mentioned 17 times), challenges/goal-setting (15 times), social sharing (11 times), and rewards (10 times) were the most popular game elements utilized in studies (Johnson, 2017). These four game elements share a common goal: increased interactivity and immersion. Comparative feedback, which involves knowledge of the performance of others, has been shown to be a helpful tool in managing energy consumption (Siero, 1996). For example, it is possible through gamification to engage people and to produce effective energy savings in the short term (Wemyss et al., 2018). To achieve longer-lasting effects, repeated interventions are probably suitable as demonstrated in a study by Allcott et al. (2014).

Serious games take gamification to a deeper level. They can be defined as "any form of interactive computer-based game software for one or multiple players to be used on any platform and that has been developed with the intention to be more than entertainment" (Ritterfeld, 2009). They aim to use the entertainment value of games to influence learners' motivation (Charsky, 2010). The mission of these games is to enable change in the real world, whether it be education on nutrition, energy awareness, or city-making. Although their intentions aren't as enticing as their recreational game counterparts, serious games hinge their success on the emulation of the popularity and engaging nature of recreational games (Johnson, 2017). Recent studies show that training with serious games can be more effective to improve knowledge than training with conventional methods (Sitzmann, 2011). However, in order for serious games to be effective,

² <https://amsterdamsmartcity.com>

storytelling is needed. VR is redefining the rules around narrative structure, character development, and storytelling (Shin, 2018). VR storytelling aims to tell a story that will stimulate emotions which will in turn influence action (Shin, 2018). Numerous studies show that narratives and thus storytelling techniques are very important in VR applications. The results of a study indicate that the benefits of VR stories even surpass those of traditional storytelling (Shin, 2018).

All these concepts combined provide a means to accomplish a serious game and educational tool with long term impacts.

4 USER-CENTERED DESIGN METHOD

In order to create the VR scenarios, a user-centered design method is applied. This method, as represented in Figure 2, involves users at the very last stage of the process, where the impact of technology on users is measured and the game design is iteratively adjusted according to user feedback. In a first step, the objectives – e.g. transfer knowledge on energy and sustainability topics and motivate users to engage further with these topics – are defined and the topics included in the game are studied in depth. The game design is then created and developed. This includes the analysis of individual in-game elements, sketching the course of the game, implementing game mechanics and creating different characters and a scoring system. The game then undergoes a testing and evaluation process, in which the game is tested several times through playthroughs with uninvolved users. It is then constantly adapted, improved and debugged until a final version is released.

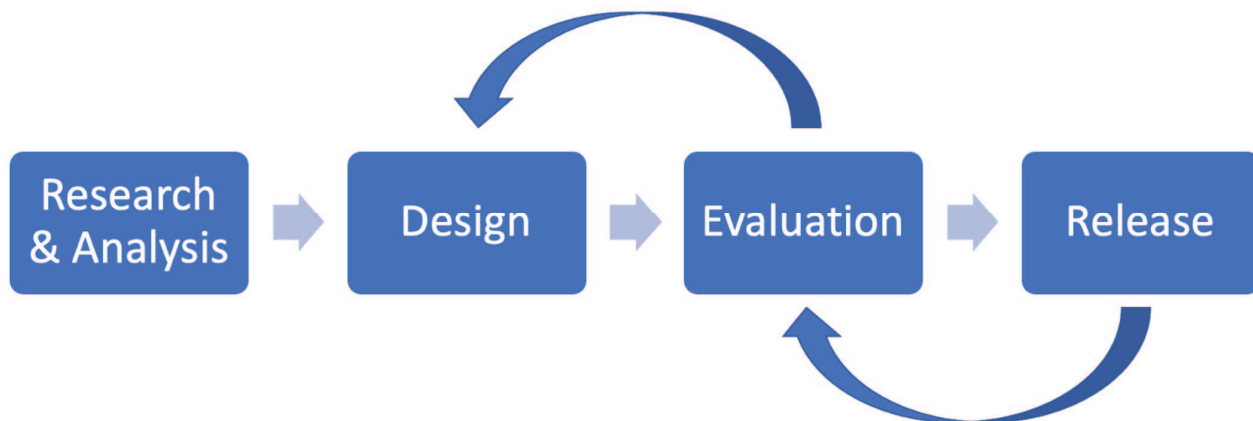


Figure 2: User-centered design method for VR game development (own illustration)

The first game VEH aims to apply immersive storytelling and serious gaming methods to make topics such as energy (the energy strategy 2050 in particular) and sustainability more tangible for the public. The game addresses adults and children from 12 years, with two levels of difficulties. In a first step, theoretical foundations were developed for these topics through desk research. In particular, the local relevance was taken into account (the VR game takes place in the virtual city of Winterthur). Four main topics were set in Winterthur: renewable energy, mobility, waste recycling and education. In addition, topics were included that are associated with energy and sustainability in everyday life, such as the use of public transport, sustainable nutrition or the use of heat pumps as a heating system. A storyline was developed and questions and answers for the quiz phrased. The game was designed with the Gaming Engine Unity®. First, a storyboard was sketched, a script written, 360 degrees photos taken and implemented together with the 3D model of Winterthur and other 3D assets used in the game. The asset of Oscar, the owl, was designed and created as well as the scripts that drive the virtual world. Sound was added, including the synchronisation of Oscar. In the evaluation phase, which was done thoroughly during the whole project, observation, transaction logs, surveys, and interviews were used to record users' reactions. Approximately six months after project start, the game was released to be presented at public events. In addition, more tests were conducted by surveying participants, identifying prominent areas of improvement for further developments of the game.

The development of the second version of the game, the "Virtual Smart City Hero", is strongly based on the learnings from VEH. In this game, current and future Smart City elements – based on real Smart City projects planned or realised for the city of Winterthur – are visualized and designed as interactively as possible in order for players to learn how they can build on the possibilities of new technologies and

participate in the Smart City transformation process. The game will be developed analogously to the first one and expected to be released in July 2019.

5 RESULTS

5.1 VR-Game Prototype “Virtual Energy Hero”

The VR game prototype VEH follows the storyline depicted in Figure 3.

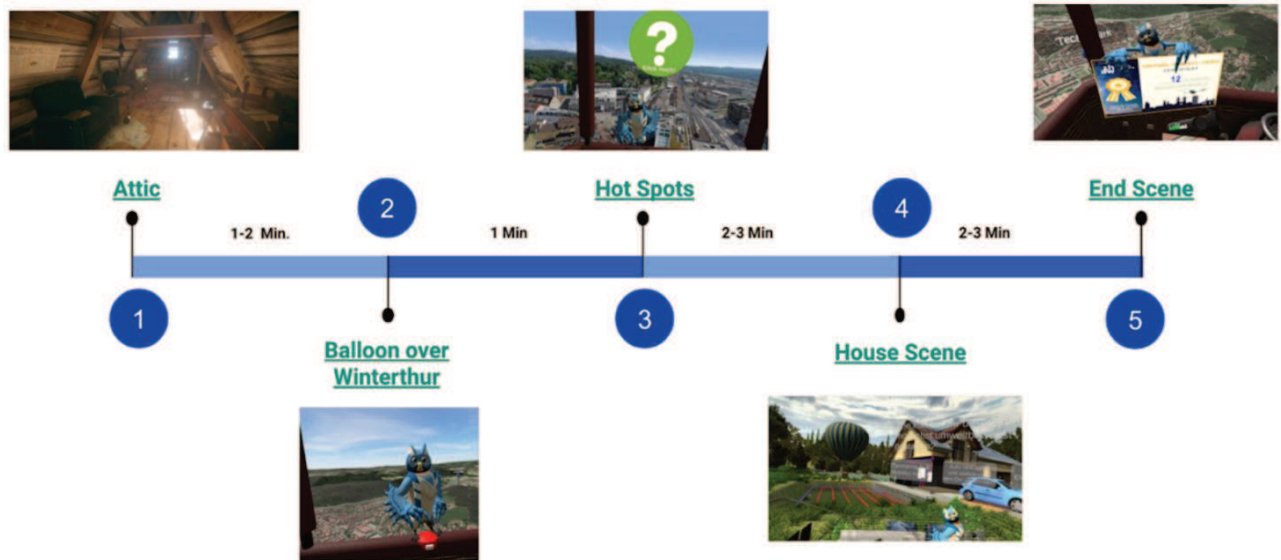


Figure 3: Storyline of the Virtual Energy Hero (own illustration)

Users begin in the attic of the main building ZHAW Technikum, where they are introduced to the talking companion for their journey, Oscar the owl. Oscar explains the importance of the Energy Strategy 2050 and Winterthur’s progression towards becoming a 2000-Watt Society. Afterwards, Oscar and the player set out on an expedition in a hot air balloon. Next, the player sees a view of the city of Winterthur from the hot air balloon, where they see several “hotspots”, as seen in Figure 4. These hotspots represent unique parts of the city, including amongst others the main station of Winterthur and the main building of the ZHAW School of Engineering. The player then chooses a hotspot and is transitioned to their selected spot which has a 360-degree view of the area for the player to experience. The player will then be presented with questions based on energy, sustainability and Smart City topics, with correct answers rewarding two “energy points”. After this scene, the player is taken to a single-family house owned by a friend of Oscar. In order to help his friend and her family become more energy-friendly, the player is faced with more questions. For each, they must choose between three possible measures of improvement, for which they earn between one and three points depending on the effectiveness of the measure. Changes made will be shown visually in the player’s environment, e.g. replacing a gasoline car with an electric version. For the end scene, the player is returned to the balloon over Winterthur, where Oscar presents them with a certificate displaying their final score, indicating they have done a great job yet encouraging them to continue learning.



Figure 4: Left: Oscar, the owl, leads through the game. Right: The player selects a hotspot with a controller. (Own illustration)

The evaluation phase as well as later tests conducted by demonstrating VEH at public events and surveying participants allowed to understand the effect the game has on its user and to identify prominent areas for improvement. By the end of 2018, the game has been played by roughly 250 players and enthused young and old (see Figure 5). During events, bystanders could follow the game on a screen. This ensured at least a certain knowledge transfer to non-players and people were motivated to play the game themselves.



Figure 5: Oldest and youngest player of the VEH

The positive perception of the game is confirmed through surveys conducted at events. More than 90% of the participants ($n = 45$) enjoyed the game and have learnt something new. In addition, approximately one third ($n = 45$) stated that the game encouraged them to engage more with energy issues from now on.

Nevertheless, two main areas for improvement are identified. First, a compelling story is paramount to any game, in order to induce a lasting impact on the player. Through interviews with a serious games expert (Sheldon, 2018) and a literature review, the storyline was quickly identified as an area for improvement in VEH. Next, the game mechanics are similar to those of a 2D quiz, leaving room for improvements to provide an even more appealing and immersive experience. From tests and surveys, valuable knowledge on VEH from a user experience standpoint was gained. Focusing on player immersion, educational value, and the implementation of Smart City elements, this collection of responses helped steer the further development of the game concept into an immersive, comprehensive tool, aiming to enable citizens to participate in the Smart City process.

5.2 New Game “Virtual Smart City Hero”

For the second game, whose development is currently in the design phase, a new storyline is being developed with new scenes to be implemented in the base construct of the VEH. These scenes will fully encompass Smart City topics, embedded as mini-games in a dashboard (see Figure 6) that will be attached to the virtual hot air balloon. They allow for increased interactivity via a greater influence over the game environment, enhanced utilization of VR’s capabilities and more variety in the game’s challenges. An overarching theme to the game concepts is optimizing knowledge transfer. It is important to have a profound effect on players during the short time they are playing the game. Existing trivia questions will be removed or replaced with motivating and effect-oriented questions. Introducing proper game mechanics helps to streamline the interactivity and general aesthetics of the game. While the two dimensional quiz format for the initial game was appropriate, as it develops, the format has to improve concurrently to become more interactive. For example, in one scene, the user will be placed in a virtual residential area, surrounded by different interactable objects and is asked to make the changes that they believe carry the largest impact. Finally, drawing relevant statistical data from the game yields many avenues to explore in the future. With the inclusion of an extractable data system, this can be accomplished. This feedback system will allow for player responses, answers to survey questions, and general data from the game to be taken and utilized in several facets. User data, such as the scored points, will then be transferred to a web-based innovation platform. In this way, the player is motivated to interact with the platform for the first time.

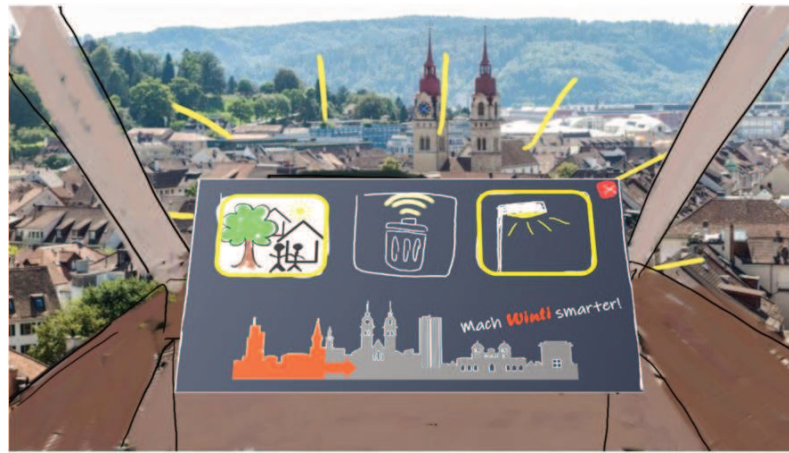


Figure 6: Dashboard with mini-games in the Virtual Smart City Hero (excerpt from the storyboard, own illustration)

6 CONCLUSION

More and more Swiss cities – on the search for ways to reach citizens and increase participation – are organising public events on the subject of sustainability and Smart Cities and asking for the VEH and its sequel to be included in their programmes. The presence on various events organized by cities, companies or universities and the many enthusiastic players of the VEH confirmed the potential of using VR to draw attention to Smart City topics. The first surveys show that the game VEH is also well received by players who were not previously interested in the topic of energy or sustainability. Motivated by game elements such as scores and rewards, people engaged actively with the game and the content. Therefore, it is expected, that VR influences one's perception, learning, and experience. Combined with serious gaming, behavior change can be amplified. In the further course of this project, these effects will be investigated. To measure the impact of the VR game, test persons will be questioned about their attitudes towards the thematic aspects of Smart Cities before and after the VR experience. However, it has to be kept in mind that this project is addressing an emerging field of research, which still needs to be further enhanced methodologically to correctly evaluate its effectiveness, as well as to uncover motivations for change and sustained change (Kjeldskov et. al, 2012).

Aiming to create a long-lasting effect, after the game, the players will be encouraged to join a web based innovation platform. There, they will be able to conceptualize and discuss new ideas and to participate in citizen-centred bottom-up initiatives. It is expected that at least some of the players will be accessing this platform in order to check their highscore from the game which will be transferred automatically. The platform will be filled with motivating content for users to inform themselves about selected Smart City topics. At the same time, users have the opportunity to communicate and evaluate ideas, wishes or projects on this platform. By fostering collaborations with industry partners and other stakeholders, it is expected that promising and highly desired bottom-up projects will be realized. After all, citizen participation should eventually take place outside the platform.

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