VR service walkthrough: A virtual reality-based method for service prototyping

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Abstract

This work introduces a new service prototyping method called the VR (virtual reality) service walkthrough. The VR service walkthrough is a virtual simulation of a service journey, representing how the service unfolds over space and time. The ultimate goal of the method is to enable service designers to increase empathy with the potential customer groups. The goal is pursued by engaging and immersing the service user in a prototyped service journey through the use of VR to gain valuable feedback about the service. To evaluate the service experience coming from the method, a case study on prototyping an audio tour guide service is conducted, focusing on the evaluation of the method's outcome and its experiential factors. The case study shows that the method can communicate the service concept in an engaging and immersive way and foster constructive feedback, though its VR interaction elements can be challenging for novice VR users.

KEYWORDS: experience prototyping, service design, service prototyping, service walkthrough, virtual reality

Introduction

Service prototyping is an integral, significant part of service design aimed at increasing designers' ability to empathise with intended users, customers and other stakeholders of a service (Blomkvist & Bode, 2012; Miettinen, 2011). A service prototype is an important service design tool for making services visible and helping to communicate service concepts, at the early stages of the new service development process (Blomkvist & Holmlid, 2011). Service prototyping contributes to the service design process by defining the service design problems to be solved, evaluating the usability and effectiveness of a service concept, and enabling collaboration among different actors, such as users, stakeholders and service providers (Chasanidou & Karahasanovic, 2014; Simo et al., 2013). To understand service experiences, service designers need to capture both physical and immaterial qualities of services, and portray the sequence of interactions that take place between a service provider and a service user, through service prototyping (Arvola et al., 2012). The most crucial factor in the service prototyping process is the ability to create a realistic sensation for the users and

immerse them in these service experiences (Jung Bae & Seong Leem, 2014; Simo et al., 2013).

Services that can be described as 'journeys' are the most prevalent kind of service (Blomkvist et al., 2012). Service journeys represent a chronological sequence of interactions between users and service providers and contain both physical and immaterial qualities (Blomkvist et al., 2012). In order to present and evaluate a service journey and improve its design, it is necessary for the service to be understood as a whole service experience, thus presenting the whole sequence of interactions or 'touchpoints' with the user as something to be thought of holistically (Arvola et al., 2012; Blomkvist & Arvola, 2014). Therefore, when prototyping service journeys, a holistic design approach should be followed and the experiential, physical and immaterial qualities of the service should be recreated with adequate precision (Arvola et al., 2012; Blomkvist et al., 2012; Boletsis, Karahasanovic, et al., 2017). These requirements pose certain challenges for service designers. One major prototyping issue lies with the significant design choices that must be made during the early stages of the new service development process focused on achieving the highest possible levels of prototype fidelity and development agility at the lowest possible cost (Arvola et al., 2012; Boletsis, Karahasanovic, et al., 2017). These choices concern the use of the appropriate prototyping tools and methods so that the produced service prototype can immerse users in the whole service experience, empathise with them, and ultimately extract useful and high-quality user feedback about the service experience (Jung Bae & Seong Leem, 2014; Simo et al., 2013).

Background and Research Motivation

There are several prototyping methods and tools that can be used when prototyping service journeys. At the conceptual level, tools like customer journey maps and service blueprints can describe the main interactions of a service journey; however, they are limited in their ability to recreate the experiential qualities of the service and relay information associated with service periods and interactions with users at touchpoints (Holmlid & Evenson, 2007; Jung Bae & Seong Leem, 2014). At a more practical level, methods like bodystorming, experience prototyping, and service walkthroughs have been used for prototyping service journeys.

Bodystorming is an interaction design method used in service design for evaluating service prototypes from an experiential point of view (Simo et al., 2013). It enables the user to enact and role-play the service scenario in prototyping environments that resemble the intended use context (Burns et al., 1994; Oulasvirta et al., 2003; Schleicher et al., 2010). Experience prototyping is an approach that attempts to understand the experience of interacting with an artifact, system, or a service (Arvola et al., 2012; Buchenau & Suri, 2000; Simo et al., 2013). This approach is similar to bodystorming, in that it tries to replicate an existing situation or construct a new one in which participants can understand, in an embodied way, what it feels like to interact with something (Arvola et al., 2012). However, these methods are not typically used to understand whole service experiences, but rather to focus on single touchpoints (Arvola et al., 2012; Simo et al., 2013).

By contrast, the service walkthrough is an established service prototyping method specifically tailored for service journeys. This method allows service designers to put themselves in the shoes of the users and, along with the targeted user or customer groups, go through a physical representation of how the service journey unfolds over space and time (Arvola et al., 2012; Blomkvist & Bode, 2012). In service walkthrough, all stakeholders can take part in the service representation and understand the service by being physically and emotionally present in the situation of use. Service walkthrough, as a service prototyping method, originates from the combination of experience prototyping, pluralistic walkthrough, and bodystorming, working as a way of increasing empathy with the potential customer group by going through the whole service and using props to represent certain actions (Arvola et al., 2012; Blomkvist & Bode, 2012). Even though service walkthroughs takes place in the real world, in the actual or similar servicescape, they use physical props and mock-ups that make

it 'difficult to get the feel for how a customer journey would be experienced' when prototyping (Arvola et al., 2012). The use of multimedia is suggested as a way to further improve the service walkthrough method and its experiential qualities (Arvola et al., 2012).

The need for new service prototyping methods that can offer more realistic simulations has been reported, and the use of virtual elements for developing new service prototyping environments has been suggested as a way to address the limitations of conventional methods and to optimize the service prototyping process (Jung Bae & Seong Leem, 2014; Meiren & Burger, 2010; Simo et al., 2013). The need for realistic service representations has been emphasised (Arvola et al., 2012), and virtual reality (VR) has the potential to overcome some of the current prototyping limitations by offering high-quality visual, audio, and haptic simulations (Jung Bae & Seong Leem, 2014; Seth et al., 2011). Over the last few years, major changes in the VR technology field have taken place, thus allowing for the development of low-cost, high-quality, immersive, and collaborative 3D virtual environments and opening the way for the use of VR in service prototyping (Boletsis, Cedergren, et al., 2017; Jung Bae & Seong Leem, 2014; Koutsabasis et al., 2012). Indeed, virtual settings have already been used to analyse and evaluate services in realistic environments, as these technologies can minimise the gap between the actual and prototyped service environments (Boletsis, Karahasanovic, et al., 2017; Jung Bae & Seong Leem, 2014).

This work features an examination of the application of VR in prototyping service journeys by implementing a new way of using VR to recreate service journeys in a highly immersive, agile, and inexpensive manner. To that end, a new service prototyping method, called the 'VR service walkthrough,' is introduced and evaluated. The method is inspired by service walkthrough as described by Arvola et al. (2012) and focuses on prototyping service journeys that use VR environments and digital artifacts. In the following section, the VR service walkthrough is described in detail. Then, a case study of a service prototype, that is, a mobile audio tour guide, is examined and evaluated using the VR service walkthrough method. Finally, the results and future directions of the project are discussed.

VR Service Walkthrough

The VR service walkthrough is a virtual simulation of a service journey representing how a service unfolds over space and time. The method aims to facilitate the development and evaluation of medium-to-high fidelity service prototypes with distinct spatial elements and customer journeys using fully immersive virtual technology. VR service walkthroughs are facilitated by service designers and involves actual service users and potential service stakeholders as prototype testers. The method allows designers to explore, evaluate, and communicate service concepts in a holistic way, capturing the service as a whole. At the same time, the method enables service users to immerse themselves in the virtual prototyping environment, to interact with service components in virtual form and experience the service journey in VR.

The VR service walkthrough is based on the service walkthrough prototyping method, which adopted its elements from the methods of experience prototyping, pluralistic walkthrough, and bodystorming (Arvola et al., 2012). Undoubtedly, these qualities, along with the evaluation protocol, were also 'inherited' by VR service walkthrough, in addition to utilising VR as the enabling technology of the method. Pluralistic walkthrough still provides the interaction components of the main process, allowing the user to explore the prototype. Bodystorming is a necessary element of the process, however the fact that VR service walkthrough can potentially reach high levels of fidelity may minimise the need for role-playing. Experience prototyping, though, is the focus of the introduced VR service walkthrough method, since it is considered extremely important to be able to prototype and capture the experience of interacting with a service, especially when this experience is mediated by VR, thus creating a fully immersive, simulated, and situated experience.

The VR service walkthrough method is designed to enable medium-to-high fidelity prototyping and to be effective in terms of development agility and cost. VR service walkthrough, due to its technical nature, targets agile development and on-the-fly adjustment of the service components based on the service users' feedback, so that more observations and conclusions can be drawn from the service prototyping session. At the same time, the development cost of the prototyped services can be affordable, ranging from low-to-medium cost, depending on the chosen hardware and the simulated scenario. The use of high-quality VR headsets (e.g., HTC Vive headset) and the development of customised, detailed graphic environments can be costly, while the use of smartphone-based headsets (e.g., Google Cardboard) and commercial off-the-shelf (COTS) applications can minimise the cost significantly.

In order to demonstrate an actual application of the VR service walkthrough method and evaluate the service experience coming from it, a case study on prototyping a location-based audio tour guide service is conducted, focusing on the evaluation of the method's outcome and its experiential factors.

The Case: Location-based Audio Tour Guide Services

Tourism is a service-intensive industry that depends on the quality of customer service experiences and customer journeys, thus service prototyping has found an application in evaluating tourism services (Stickdorn & Schneider, 2009; Stickdorn & Zehrer, 2009, 2012). At this stage, a case is built on the development of a mobile, location-based audio tour guide service for the city of Oslo, Norway. The case uses the VR service walkthrough method in the early service prototyping stages to examine the service concept and get valuable feedback from the target group of customers/users on the idea behind it, and to gather suggested improvements and additions.

The qualities of location-based audio guide services have been researched in the past, and it has been suggested as a promising tool for tourism services (Bederson, 1995; D'Auria et al., 2015; Magnusson et al., 2009; Vazquez-Alvarez et al., 2012). However, there is a need for further research on new location-based audio tour guide services that enable tourists to freely explore open, outdoor urban environments in a culturally informative way while also supporting social interaction and shared experiences (Iso-Ahola, 1980; Kečkeš & Tomičić, 2017; Yovcheva et al., 2012).

Service Description

The location-based audio tour guide provides users with audio information about outdoor places of interest (buildings, landmarks, monuments, etc.) that are in their vicinity. The service scenario sets the users as tourists in an open environment, launching the audio tour guide app from their smartphones and wearing their headphones. Based on their location (GPS-based), when they approach a place of interest and within a specific radius, an audio track with various pieces of information about the place begins to play automatically. The prototyped version of the service features audio tracks with durations between 65 and 90 seconds.

After launching the app, the user does not have to check the smartphone again, unless he or she wants to locate and navigate to the nearest point of interest through the service's map function. More specifically, the audio tour guide service consists of two main actions: 1) service users navigate the city as auditory information is presented to them based on their location, and 2) the service users check the map embedded in the app to locate the nearest point of interest and then move towards it.

The design goal of the service is to allow tourists to focus on their surroundings and on the real world, navigating freely based on what they see and like while minimising their interaction with the smartphone. At the same time, as a tourist, it is important to get all the necessary information in time and in place, so it is possible to 'interpret' the environment and find out more about the cultural heritage of the visited place in an unobtrusive and undisruptive way. Thus, auditory information is chosen as a way to augment the service users' perceptions without occupying their visual sense. The interaction design of the tour guide is based on lessons learned from past research in the field, focusing on the principles of minimal design and casual use.

Service Prototyping with VR Service Walkthrough

Figure 1. *Upper image:* The VR view from the VR service walkthrough. *Lower image:* Conducting the VR service walkthrough with the service designer (on the right) "accompanying" the service user (on the left).

VR service walkthrough was used to develop and evaluate the service prototype of the audio tour guide service. Google Street View VR was used to enable the service user to navigate the city of Oslo virtually (Fig. 1). Audio tracks of 65-90 seconds' length related to 15 places of interest were recorded using historical information from educational and reliable sources. Google Street View VR provided the user's location, in order to trigger the relevant audio track when the user was in the radius of a point of interest. The service's map functionality was facilitated by Google Maps, thus allowing the service user to get a map overview of the surroundings and the places of interests in the area. VR hardware consisted of an Android smartphone, a generic VR headset, and a wireless mouse for interaction/navigation purposes (Fig. 1). The service user was also wearing headphones. Ambient sound effects (i.e., people walking in the street) were also added, to provide more realism to the scene for immersion purposes.

At this stage, the walkthrough involved one user per session and focused on individual feedback. The service user had the opportunity to 'visit' several monuments in the city of Oslo, Norway virtually and to listen to historical information about them when he or she was located in their vicinity. At any time, the user could check the VR map, locate the nearest place of interest, and navigate there.

The service designer moderated the VR service walkthrough session, 'accompanying' the service users on the virtual tour by observing their service journeys through screen mirroring (Fig. 1). While navigating, the user was free to express comments, thoughts, and opinions on the service to the service designer and to describe the whole experience. The service designer documented the user's feedback and followed-up on the user's remarks, always in an investigative, discreet, and unobtrusive way without disturbing the flow and distracting the user. When it came to pausing the walkthrough session or not, to collect user feedback (Blomkvist & Arvola, 2014), VR service walkthrough implemented a middle strategy. The designer identified specific use periods when the user was navigating through areas where no points of interest were located, thus the service was less intense and cognitively demanding. Taking advantage of these periods allowed for short discussions, asking questions, and following up on the user's remarks without breaking the immersion for him or her.

Evaluation Study

An evaluation of the VR service walkthrough prototyping method took place based on two factors: 1) the subjective meaningfulness and quality of feedback it can produce and 2) the user experience it offers to the service users. The first factor is an indirect measure of evaluating the method through the quality of its output for the audio tour guide service. The factor was investigated via a semi-structured interview. The second factor is a direct measure of evaluating the method by examining the resulting user experience. In the context of this work, the element of user experience is considered extremely important, since experience prototyping lies at the heart of the proposed method. The second factor was investigated via a semi-structured interview and the administration of a user experience questionnaire.

Data collection was conducted as follows:
- Study consent and demographics (gender, age, education, digital tour guide and VR experience) were collected at the beginning of the session.
- A semi-structured interview took place after the VR service walkthrough session examining two themes, based on the two factors mentioned above.
  - First, the focus was on the audio tour guide service, asking the users what they liked about the service, what they did not like, and what they would improve in the current version (duration: 7-12 minutes).
  - Second, the focus was on the VR service walkthrough method itself, asking the service users what they liked and did not like about the method, focusing on experience, VR, and potential interaction issues (duration: 7-12 minutes).
- The user experience in the VR service walkthrough was captured by an adapted version of the Game Experience Questionnaire (GEQ), which was administered right after the interview (IJsselsteijn et al., 2013). The GEQ has been used in several studies to assess gaming and VR experiences because of its ability to cover a wide range of related experience dimensions (Lee et al., 2013; Meijer et al., 2009; Nabioyuni & Bowman, 2015; Nacke et al., 2010; Proffitt et al., 2015). In this study, the dimensions of Competence, Sensory and Imaginative Immersion, Flow, Tension, Challenge, Negative Affect, Positive Affect, Tiredness, and Returning to Reality (from the In-Game and Post-Game versions of the GEQ) were considered relevant and useful to the evaluation of the method. The questionnaire asks the user to indicate how he or she felt during and after using the VR system based on a series of statements. The adapted GEQ contained 19 statements (e.g. 'I forgot everything

around me'), rated on a five-point intensity scale ranging from 0 (not at all) to 4 (extremely). Its completion time was 5-7 minutes.

Results

Seven users (mean age: 30.43, SD: 4.35, male/female: 4/3) participated in the VR service walkthrough of the location-based audio tour guide service. All participants have used digital tour guides and map services when visiting a foreign place more than once before. Two of them were novice VR users, not having used VR before; three of them were moderately experienced, having used VR applications in the past; and two were very experienced, actively using VR applications and owning VR systems. All participants completed the session successfully.

The first part of the interview regarding the location-based audio tour guide, resulted in the following qualitative remarks. Almost all participants liked the simplicity of the location-based audio tour guide service, praising its minimal interaction. They also found the use of audio to be less obstructing than visual information.

> - 'It's on-the-go and it's audio. I like that… I don't have to check my phone's screen while I'm walking.' (Participant 1)

> - 'It's simple. You run the app and you get the audio information.' (Participant 3)

As for improvements and additions, four of the participants found the audio tracks to be too long (65-90 seconds). After running 'on-the-fly' tests with various track lengths, they suggested 45-60 seconds as the ideal track duration. Furthermore, even though they liked the free roaming functionality, they would also prefer for the service to suggest pre-defined sightseeing routes. Finally, some of the participants also addressed the commercialisation aspect of the service by suggesting the gamification of the tour and the awarding of prizes (e.g., discount coupons, memorabilia) to people visiting the places of interest.

> - 'Going wherever I want is nice but when I am visiting an unfamiliar place I would like to have some suggested routes for sightseeing.' (Participant 3)

> - 'The service can have Foursquare elements. Tourists can gain badges if they visit lots of places. Then they could trade these badges for real prizes, such as discount coupons.' (Participant 2)

The second part of the interview centred on the user experience with the VR service walkthrough method and resulted in the following remarks. Participants found that the VR service walkthrough method managed to present the service concept and demonstrate its functionality at a satisfactory level of fidelity. Participants felt immersed and reported that the navigation was close to the 'real thing,' even though the use of more high-quality VR headsets (e.g., Oculus Rift, HTC Vive) could have achieved even higher fidelity levels, as stated by one experienced-in-VR participant.

> - 'The method showed how the service works in a clear way. I understood how the audio tour guide is supposed to work.' (Participant 1)

> - 'Navigating the streets felt close to the real thing… In this case, I think VR works better than photos or regular Street View [browser version].' (Participant 4)

However, the novice VR users experienced certain interaction issues, experiencing cognitive overload due to the immersive nature of the method and feeling unnatural when using the method's 'teleporting' VR locomotion technique.

- 'This interrupted movement in VR was weird sometimes.' (Participant 7)

- 'I felt a bit strange and disoriented when I got out [of VR].' (Participant 6)

The GEQ displayed high values of Flow and Positive Affect, moderate-to-high values of Competence and Immersion, low-to-moderate values of Challenge, and low values of Negative Affect and Tension. Tiredness was at low levels, while Returning to Reality presented low-to-moderate values (Fig. 2).
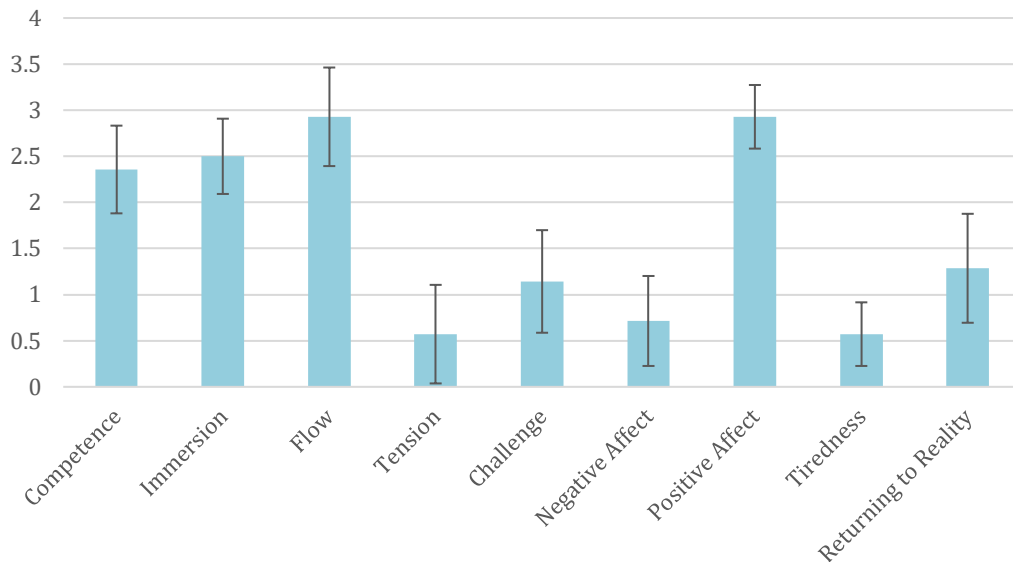

Figure 2. The GEQ mean scores (with standard deviation bars) across the nine dimensions of user experience, for the VR service walkthrough method.

Discussion

The main observation coming from the results of the evaluation is that the VR service walkthrough method managed to communicate the service concept efficiently, providing valuable feedback to the designer. Users were engaged by the audio tour guide service, interacting with the prototype and providing feedback about it. Moreover, users' suggestions shed more light on the further development of the service, raising and addressing important design issues (e.g., adding routes, shortening the tracks, duration, gamifying the service) early on in the design process that otherwise may have required more time to be 'discovered'. The tourism-related case study and the audio tour guide service provided an ideal testbed for evaluating the performance of the VR service walkthrough for prototyping service journeys with strong experiential elements, ultimately showing positive and promising results.

The VR technology managed to immerse the users in the prototyped service while presenting certain issues. According to the GEQ, flow and immersion reached satisfying levels, showing that users were focused on the process. The questionnaire also revealed higher values of positive feelings than negative ones, demonstrating that the VR service walkthrough was an overall pleasant experience. However, the evaluation also showed that VR interaction may be challenging for novice users. The VR service walkthrough immersion may come at a cost, especially to those who are not familiar with VR. Even though, with the passage of time people will become more and more familiar with VR, its intense immersive characteristics may be an obstacle for the novice VR users of the VR service walkthrough method. At this point, it should be noted that the use of both the GEQ questionnaire and

the interviews allowed for the discovery, verification, and documentation of significant experiential issues. The GEQ also managed to provide a general overview of the method's experiential performance, while the interviews shed more light on specific issues the participants faced.

The evaluation of the method allowed the mapping of its current and potential performance regarding significant qualities of service prototyping, such as the prototype fidelity, development agility, and cost. A subjective representation of the method's qualities in the case study, and the potential performance it can achieve are shown in Fig. 3. Regarding the case study, the cost of the audio tour guide prototyping process was very low, using COTS applications, and it is certain that the resulting high-quality feedback completely justified the expense. The overall results of the evaluation process showed that the method reached moderate fidelity levels, and it was agile enough for the designer to be able to test alternative versions of significant service components (i.e., the duration of the audio tracks) on the fly, based on users' comments. This potentially shows that, by creating and using the VR service walkthrough method, a beneficial and effective trade-off among prototype fidelity, development agility, and cost was achieved. The trade-off was achieved on a case-specific basis, meaning that services with different characteristics may require finding a different balance among these three qualities. However, based on the evaluation results and the users' feedback, the potential performance of the method could reach higher fidelity and agility levels, if additional funding was dedicated to technical development, the use of high-quality VR headsets, and virtual models/environments specifically designed for the prototyped service.
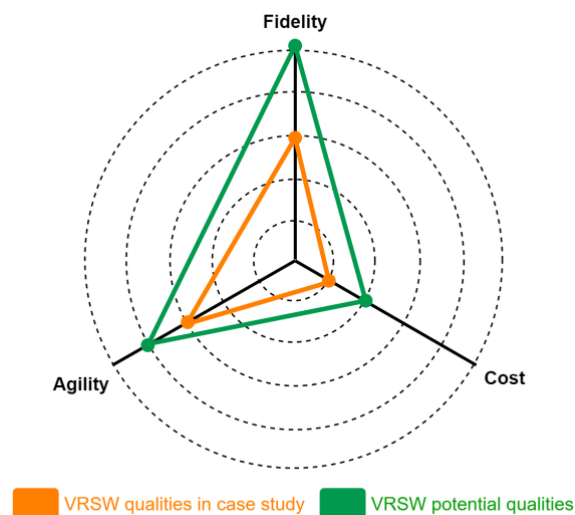

Figure 3. A subjective representation of the VR service walkthrough (VRSW) prototyping qualities in the case study and its potential performance.

Naturally, the VR service walkthrough addresses certain service prototyping conditions and cannot cover the whole range of services or all their development stages. VR service walkthrough targets the representation of service journeys, attempting to capture the sequences of mediated interactions between service providers and customers in a service prototype. The method is shown to be effective for communicating early service concepts and ideas. Tourism and travel services are of strong temporal and sequential nature, involving a series of interactions. This is why the proposed service prototyping method can find wide application in the field, optimising the trade-off between prototype fidelity, agility, and cost in the very early development stages, while also providing a viable way for service designers to empathise with target groups. Similar services from the same or other fields could benefit from the application of the VR service walkthrough method, potentially using

it to communicate their service concepts at an early point of the service design planning process.

Conclusion

In this work, a prototyping method for service design was introduced that applies the service walkthrough concept in fully immersive VR settings. The method aims at enabling service designers to increase empathy with potential customer groups through optimising the service prototyping process to create more immersive and engaging service-simulating environments. The method addresses service journeys, and its evaluation showed that it can be useful for representing services that are still at the service concept stage.

The case study on tourism provided an ideal testbed for documenting the strengths and weaknesses of the method, revealing that it can communicate the service concept in an engaging and immersive way and foster constructive feedback. However, the very same immersive VR feature can pose interaction challenges for novice users, thus revealing the need for further technical adjustments.

Overall, the VR service walkthrough method performed satisfactorily, effectively balancing the trade-offs among prototype fidelity, development agility, and cost. The introduction of this VR-based service prototyping method provides an opportunity for organisations, businesses, designers, and researchers to reproduce, study, and further advance it. Hopefully, this work will further contribute to the discussion around the potential of VR in service design, which, until recently, was an under-researched field (Boletsis, Karahasanovic, et al., 2017; Jung Bae & Seong Leem, 2014).

Future work will focus on a comparative study between the service walkthrough and the VR service walkthrough methods. Furthermore, more case studies will follow in order to further document the method's efficiency in the same or similar fields and enable the formulation of robust guidelines for the method's application in various settings.

Acknowledgements

References

Arvola, M., Blomkvist, J., Holmlid, S., & Pezone, G. (2012). A service walkthrough in Astrid Lindgren's footsteps. In *Proceedings of the Service Design and Innovation Conference (ServDes)* (pp. 21-29). Linköping University Electronic Press.

Bederson, B. B. (1995). Audio augmented reality: a prototype automated tour guide. In *CHI '95 Conference Companion on Human Factors in Computing Systems* (pp. 210-211). ACM.

Blomkvist, J., & Arvola, M. (2014). Pausing or not? Examining the service walkthrough technique. In *Proceedings of the 28th International BCS Human Computer Interaction Conference* (pp. 171-176). BCS.

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Blomkvist, J., & Bode, A. (2012). Using Service Walkthroughs to Co-Create Whole Service Experiences. In *Proceedings of the International Service Innovation Design Conference* (Vol. 3, pp. 1-7).

Blomkvist, J., & Holmlid, S. (2011). Existing prototyping perspectives: considerations for service design. *Nordes, 4*, 1-10.

Blomkvist, J., Åberg, J., & Holmlid, S. (2012). Service walkthroughs to support service development. In *Proceedings of the Service Design and Innovation Conference (ServDes)* (pp. 43-52). Linköping University Electronic Press.

Boletsis, C., Cedergren, J. E., & Kongsvik, S. (2017). HCI research in Virtual Reality: A discussion of problem-solving. In *Proceedings of the 11th International Conference on Interfaces and Human Computer Interaction* (pp. 1-5). IADIS publishing.

Boletsis, C., Karahasanovic, A., & Fjuk, A. (2017). Virtual Bodystorming: Utilizing Virtual Reality for Prototyping in Service Design. In *Proceedings of the International Conference on Augmented Reality, Virtual Reality and Computer Graphics* (pp. 279-288). Springer.

Buchenau, M., & Suri, J. F. (2000). Experience prototyping. In *Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques* (pp. 424-433). ACM.

Burns, C., Dishman, E., Verplank, W., & Lassiter, B. (1994). Actors, hairdos & videotape—informance design. In *CHI '94 Conference Companion on Human Factors in Computing Systems* (pp. 119-120). ACM.

Chasanidou, D., & Karahasanovic, A. (2014). Open Service Innovation Platforms and Experience. In *Proceedings of the Service Design and Innovation Conference (ServDes)* (pp. 440-445). Linköping University Electronic Press.

D'Auria, D., Di Mauro, D., Calandra, D. M., & Cutugno, F. (2015). A 3D Audio Augmented Reality System for a Cultural Heritage Management and Fruition. *Journal of Digital Information Management, 13*(4), 203-209.

Holmlid, S., & Evenson, S. (2007). Prototyping and enacting services: Lessons learned from human-centered methods. In *Proceedings from the 10th Quality in Services conference, QUIS* (Vol. 10).

IJsselsteijn, W., de Kort, Y. A., & Poels, K. (2013). *The Game Experience Questionnaire*. Eindhoven: Technische Universiteit Eindhoven.

Iso-Ahola, S. E. (1980). *The social psychology of leisure and recreation*: WC Brown Co. Publishers.

Jung Bae, D., & Seong Leem, C. (2014). A visual interactive method for service prototyping. *Managing Service Quality, 24*(4), 339-362.

Kečkeš, A. L., & Tomičić, I. (2017). Augmented Reality in Tourism–Research and Applications Overview. *Interdisciplinary Description of Complex Systems: INDECS, 15*(2), 157-167.

Koutsabasis, P., Vosinakis, S., Malisova, K., & Paparounas, N. (2012). On the value of virtual worlds for collaborative design. *Design Studies, 33*(4), 357-390.

Lee, G. A., Dunser, A., Nassani, A., & Billinghurst, M. (2013). Antarcticar: An outdoor ar experience of a virtual tour to antarctica. In *Proceedings of the IEEE International Symposium on Mixed and Augmented Reality-Arts, Media, and Humanities* (pp. 29-38). IEEE.

Magnusson, C., Tollmar, K., Brewster, S., Sarjakoski, T., Sarjakoski, T., & Roselier, S. (2009). Exploring future challenges for haptic, audio and visual interfaces for mobile maps and location based services. In *Proceedings of the 2nd International Workshop on Location and the Web* (pp. 8:1-8:4). ACM.

Meijer, F., Geudeke, B. L., & Van den Broek, E. L. (2009). Navigating through virtual environments: Visual realism improves spatial cognition. *CyberPsychology & Behavior, 12*(5), 517-521.

Meiren, T., & Burger, T. (2010). Testing of service concepts. *The Service Industries Journal, 30*(4), 621-632.

Miettinen, S. (2011). Service Prototyping in Action. *Touchpoint Journal, 3*(2), 64-65.

Nabioyuni, M., & Bowman, D. A. (2015). An evaluation of the effects of hyper-natural components of interaction fidelity on locomotion performance in virtual reality. In *Proceedings of the 25th International Conference on Artificial Reality and Telexistence and 20th Eurographics Symposium on Virtual Environments* (pp. 167-174). Eurographics Association.

Nacke, L. E., Grimshaw, M. N., & Lindley, C. A. (2010). More than a feeling: Measurement of sonic user experience and psychophysiology in a first-person shooter game. *Interacting with Computers, 22*(5), 336-343.

Oulasvirta, A., Kurvinen, E., & Kankainen, T. (2003). Understanding contexts by being there: case studies in bodystorming. *Personal and Ubiquitous computing, 7*(2), 125-134.

Proffitt, R., Lange, B., Chen, C., & Winstein, C. (2015). A Comparison of Older Adults' Subjective Experiences With Virtual and Real Environments During Dynamic Balance Activities. *Journal of aging and physical activity, 23*(1), 24-33.

Schleicher, D., Jones, P., & Kachur, O. (2010). Bodystorming as embodied designing. *Interactions, 17*(6), 47-51.

Seth, A., Vance, J. M., & Oliver, J. H. (2011). Virtual reality for assembly methods prototyping: a review. *Virtual reality, 15*(1), 5-20.

Simo, R., Miettinen, S., Kuure, E., & Lindström, A. (2013). A laboratory concept for service prototyping-Service Innovation Corner (SINCO). In *Proceedings of the Service Design and Innovation Conference (ServDes)* (pp. 229-241). Linköping University Electronic Press.

Stickdorn, M., & Schneider, J. (2009). myServiceFellow: gaining genuine customer insights. In *1st Nordic Conference on Service Design and Service Innovation* (pp. 1-3).

Stickdorn, M., & Zehrer, A. (2009). Service design in tourism: Customer experience driven destination management. In *1st Nordic Conference on Service Design and Service Innovation* (pp. 1-16).

Stickdorn, M., & Zehrer, A. (2012). Service Design for tourism SMEs - The concept of service design and its application on the Alpine Zoo in Innsbruck, Austria. In *Proceedings of the Service Design and Innovation Conference (ServDes)* (pp. 147-148). Linköping University Electronic Press.

Vazquez-Alvarez, Y., Oakley, I., & Brewster, S. A. (2012). Auditory display design for exploration in mobile audio-augmented reality. *Personal and Ubiquitous computing, 16*(8), 987-999.

Yovcheva, Z., Buhalis, D., & Gatzidis, C. (2012). Smartphone augmented reality applications for tourism. *E-review of tourism research (ertr), 10*(2), 63-66.