Towards Optimizing Place Experience using Design Science Research and Augmented Reality Gamification

Vasilevski, Nikolche; Birt, James R.

Published in:
Intersections in Simulation and Gaming: Disruption and Balance

DOI:
10.1007/978-981-32-9582-7_6

Published: 06/08/2019

Document Version:
Peer reviewed version

Towards Optimizing Place Experience using Design Science Research and Augmented Reality Gamification

Nikolche Vasilevski[1][0000-0003-3356-0090] and James Birt[2][0000-0002-0422-4867]

[1, 2] Bond University, 14 University Drive, Robina Gold Coast 4226, QLD, Australia

Abstract. Studies suggest that augmented reality and game mechanics can lead to increase sense of place. This is important as sense of place provides many benefits ranging from personal place significance, to increase interest and stewardship at the place. These benefits combined can lead to enhancement of an offered service. Therefore, the question asked in this research is how to effectively design an experience using these emerging technologies and optimize for successful outcomes? In this study we outline the design and development process of a pervasive mobile application solution using design science research methodology guidelines to answer this question. Specifically, the application solution replicates a human guide and narration experience in the exhibition of indigenous artworks in a university place by integrating augmented reality, micro location, audio and enhancement through gamification service to increase engagement and experience value. We present observation result data from the first iteration of the design science research methodology by analyzing qualitative usability testing of the application by expert stakeholders. The results indicate that the performance usability of the app is satisfactory, and it provides solid base for the next iteration of the development process.

Keywords: Sense of Place, Augmented Reality, Gamification, Design Science Research.

1 Introduction

The concept of Place in the literature is challenged, however generally defined as a location that has a meaning [1]. Sense of Place (SoP) is a scientific construct that undergoes much debate in the academy and has been defined from different perspectives and in various disciplines [7].

For the purpose of our research we look at SoP from the attitude theory perspective, where Jorgensen and Stedman [12] define SoP as "multidimensional construct comprising: beliefs about the relationship between self and place; feelings toward the place; and the behavioral exclusivity of the place in relation to alternatives". These three dimensions are evident in the literature as *place identity*, *place attachment* and *place dependence*.

SoP therefore, attaches meaning to a place and provides many benefits to the place itself, such as caring for the place, prolonging the stay or investing in the place [5]. Increasing SoP will lead to increase in the benefits for the place.

The literature shows that performing activities at a place increases SoP, and even more if these activities are joyful and engaging with the place. Performing augmented reality (AR) activities or having gameful experiences at place can also increase SoP [5, 17]. These two methods, AR and gamification are the primary focus of this research.

AR as the name suggests is referred to as a structure of overlaying virtual objects over real-world objects, attached to and bound by the three dimensions of the real world and which is in the same time interactive [2]. The advances in the technology led to miniaturization and increase computational power to run the AR applications on handheld smartphone devices and wearables such as AR glasses. AR requires a link to the real world to work, and that link is provided by the three essential technologies for AR, which are tracking, display and input [3].

AR has been shown as a way for pointing to real world objects and as a precise location system, Google Maps app is using for precise navigation as their Visual Positioning System (VPS) at places with low GPS signal reception, such as city centers [13]. This system is independent and free from some major GPS location shortcomings, such as indoor positioning and granularity [14].

The system also employs iBeacon [14] technology for micro-location and proximity computation. This technology uses small devices called beacons, which act as lighthouses transmitting signal that can be detected by Bluetooth Low Energy capable devices and computed into distance from the beacon. This usable distance varies from few centimeters to ~50 meters depending on the surroundings and the obstacles. The distance to a beacon is divided into three distinct proximity regions: immediate, near and far. This type of micro location technology has been successfully applied in various gamification scenarios within different implementations [21].

The other concept that may lead to increase in SoP is gamification. Gamification is referred to as using game like features in non-gaming context [6]. Furthermore, Huotari and Hamari [10] ground the definition in service marketing, defining it as, “a process of enhancing a service with affordances for gameful experiences in order to support users’ overall value creation”. This perspective has many implications of how gamification can be used towards specific goals related to service enhancement.

Service marketing is postulated on Service-Dominant Logic (S-DL) [19], where the value of the product is not created by the manufacturer, but only by the consumers that consumes the products. In this paradigm, the human skills are more valuable than natural resources [20]. “Any intentional act – no matter how small – that assists an entity can be considered a service” [10] and any organized array of services can be considered a service system.

A service system can be considered any partnership, organization, a part of an organization, club and even the basic human organizational unit as the family. To help businesses manage the services, a service package model was introduced to S-DL, which categorizes the services into three groups: core, enabling and enhancing service [8]. For instance, in public transport, the core service is transportation, the enabling service is buying a ticket, and enhancing service is Wi-Fi onboard the bus. As per the

definition gamification is considered an enhancing service of an already present core service. It should also be noted that a game can be considered a gamified implementation if it is used to enhance a core service, for instance playing *PokemonGo* app (www.pokemongo.com) in a retail shop.

Gamification increases engagement and makes activities joyful and interesting. In most of the cases, successful gamification implementations implement treasure/scavenger hunt scenarios, where the main game mechanics used are badges, points and leaderboards [21]. Gamification of micro-location (GM-L) is a subset of gamification of location-based services, which is already a researched SoP predictor [18, 23].

The goals of our greater study are to answer two main research questions; (i) can deploying GM-L increase SoP, and (ii) how designers and developers can optimize for successful outcomes. In this paper we focus on answering the latter of the research questions that is the designing for optimized and successful outcomes. To achieve this, we first present the design science research methodology used in the study, followed by the qualitative usability results and the discussions with expert stakeholders. Finally, at the end we present the conclusions and the future work.

2 Methodology

This section presents the methodology used in this phase of the research, towards answering the research question: "How developers optimize for successful outcomes?". We designed, tested and evaluated our solution in several iterations, by following the Design Science Research Methodology (DSRM) [15]. This approach led to development of a Gamified AR Micro-location (GARM-L) artefact, in the form of a mobile app, that initially deployed iBeacon beacons, smartphone AR, and synthesized voice narration. The human voice narration and game mechanics were added later on in the development process.

2.1 Solution design and implementation

The solution consists of GARM-L mobile app, in which the first component is a narrated AR tour guide solution for an indigenous artwork tour in an Australian university setting. The second component is a gamified solution where the players (users of the GARM-L) have to discover the hidden features on the paintings through AR.

The first iteration of the solution focused on the AR component only, due to complexity of the development of an artifact that will be a high-quality app, which itself would not have any significant effect on SoP. The AR component was developed in the Unity game engine. The application was engineered as a multiplatform app, that can be installed and run on both, iOS and Android OS platforms, and it has identical functionality and aesthetics on both.

The AR component relied on the Vuforia AR engine embedded within Unity, specifically, Vuforia single image targets. To use the engine, a unique API key was used and entered in Unity Editor Inspector. The Vuforia AR image targets were the indige-

nous paintings from the real-world tour. The targets were created by uploading hi-resolution photos of the paintings on Vuforia developer's website where the primary features are identified for augmentation and imported as an image target database in Unity.

The initial design of the application was constructed by following the design of several major AR enabled museum apps that incorporate tour guidance. We scanned the two major app stores, Apple AppStore and Google PlayStore for the baseline application.

We initially searched by the term (museum AND tour AND guide AND AR). This search only returned 16 apps, and most of which were not in the specific context. Therefore, we adjusted the search for the less specific search term (museum AND tour), which returned 214 apps on AppStore and 242 on the Google PlayStore. Most of the apps from the search were available on both platforms. We had to scan the app info and description in the store listings for the apps and determine initial relevant apps. We excluded the payed apps, due to not offering any extra design patterns over the free ones, which was evident from the store screenshots. We selected 23 apps that matched the criteria of having a tour guidance, location awareness, and narration and installed these apps on an Apple iPhoneX smartphone. All these apps were available on both the iPhone and android operating systems. Also, in addition, we downloaded the Mona O app, only available on AppStore, due to the unique micro-location technology implementation.

After performing the testing, we narrowed down the selection to six apps, that were applying design patterns applicable for our specific use case. These apps were: (i) *The O* (mona.net.au/museum/the-o), (ii) *Australian museum* (australianmuseum.net.au/visit/mobile-apps/), (iii) *Palace* (en.chateauversailles.fr/discover/resources/palace-versailles-application), (iv) *Louvre Guide* (www.museumtourguides.com/home/), and (v) *Dali Museum* (www.acoustiguide.com/tours-apps/tour=dali-museum-virtual-tour/) (**Fig. 1**).

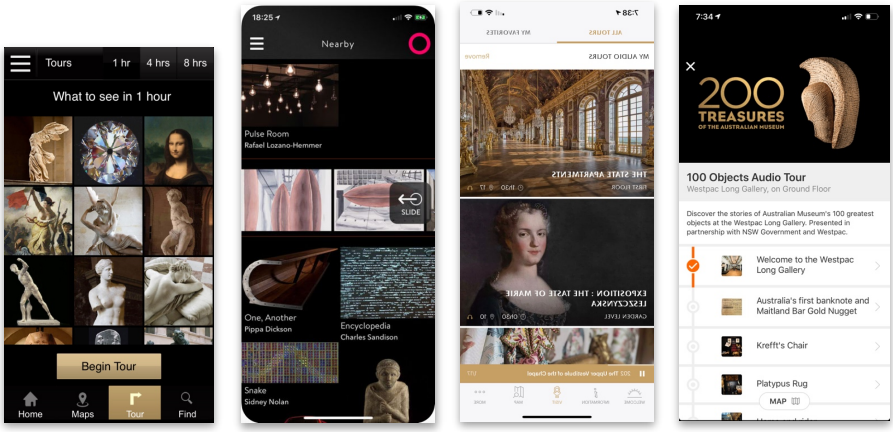

Fig. 1. Screenshots of the selected apps. From left to right: *Louvre Guide, The O, Dali Museum, Australian Museum*.

After the content and design examination of the selected apps, the initial interviews with experts and several prototypes, we came up with the initial design of the app. It should be noted that an indigenous culture expert approved the design of the app as culturally sensitive and sensible. The initial version of the app (V1) consisted of the following screens: Main, Tour, Gallery, Artwork Info, Map, AR, Badges, and About. The wireframes are presented in (**Fig. 2**).

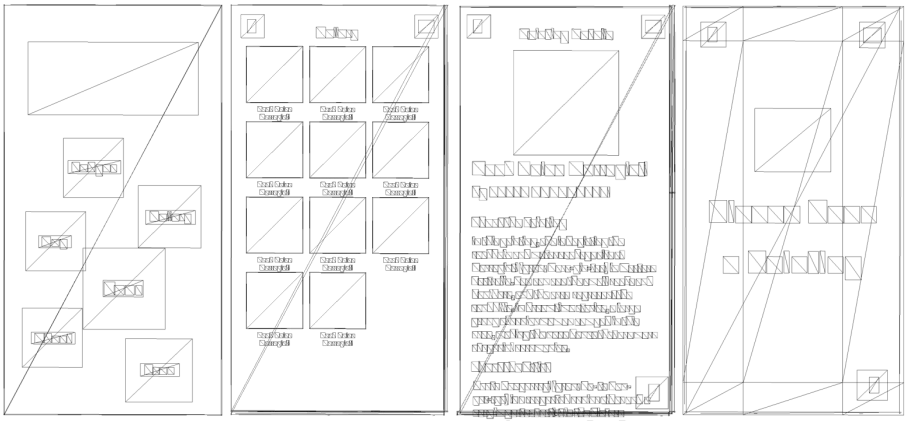

Fig. 2. App v1 Wireframes from left to right: Main, Gallery, Artwork Info, AR

The first version of the app color scheme was black background, with white accents and white typography. The buttons on the main screen were representing motifs from indigenous paintings and also the title font was the Aboriginal Alphabet font by the artist Araki Koman (**Fig. 3**). The fonts used throughout the app were one of the default fonts from Unity Engine called Nexa and Nexa – Bold.

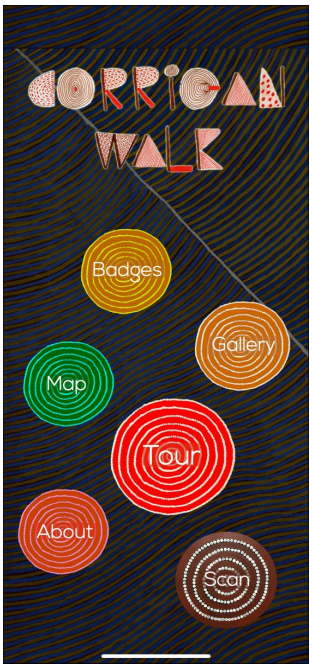

Fig. 3. App v1 Main screen

The logic flow of the first app iteration was as follows; After starting the app, users would be first taken to the main screen, where they will be presented with the circular buttons with indigenous motifs that on click would take them to the respective screens. Every screen has a back to the previous screen option. The flow of the app use is presented on the following flowchart (**Fig. 4**).

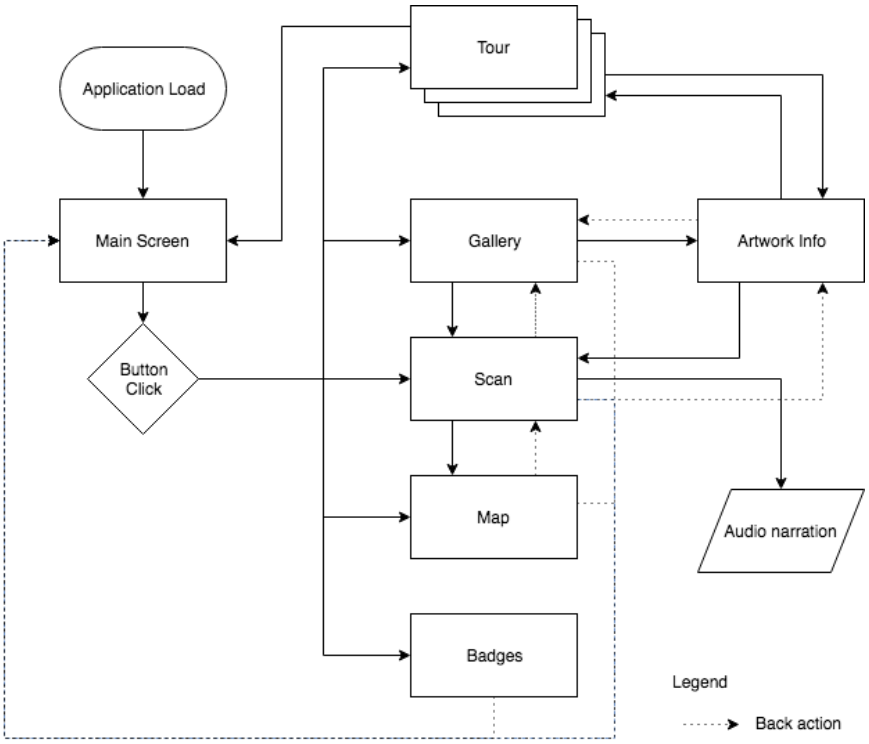

Fig. 4. App v1 Logic Flowchart

The Tour screen presented the user with guided tour, which in essence was a series of the Artwork Information screens, ordered to represent the real-world tour sequence (**Fig. 5)**. On the first, welcome to the tour, screen the user started the tour by tapping on the Start Tour button. Next, the screen for the first painting of the tour appeared, which offered the choice of augmenting the painting through AR, listening to the audio narration, reading about the painting through the artwork info, advancing to the next painting. The choice to use both audio and text was to reduce cognitive load and offer a dual coding scheme to enhance user comprehension.

There was a choice of going back to the previous painting from the second painting onwards. The users would manually advance to the next painting in their own time allowing for a self-directed experience. The tour ends after the user would tap on the end tour button presented on the final painting tour screen.

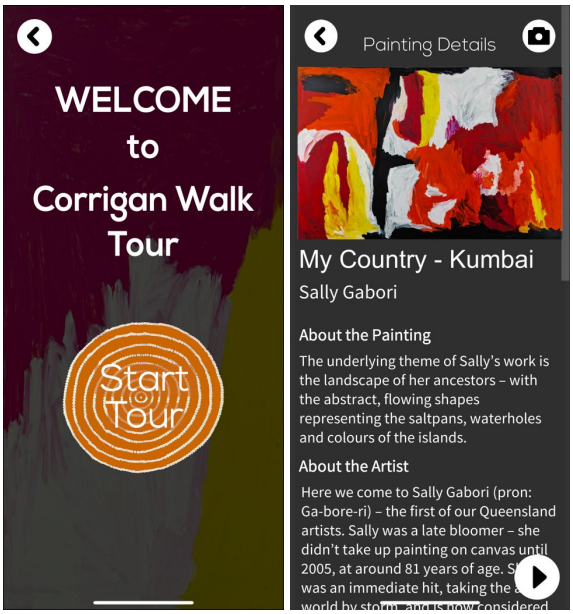

Fig. 5. App v1 Tour and Artwork info screens

The Gallery screen is presenting all the paintings in the walk in three column vertical thumbnails grid, a back button, title and AR scan button (**Fig. 6**). This layout was inspired by the *Louvre Guide* and *The O* apps, and it is a pragmatic take on the presentation of the paintings in the most accessible way to the user. The thumbnails are filled fully by the painting which is resized to fit the square shape.

We experimented with preserving the ratio of the thumbnails, however it is inconsistent and not aesthetically pleasing. A tap on the painting would take the user to the info screen. Artwork info screen is scrollable single column, full width list, that contains the larger image of the painting, and information about the painting (**Fig. 6**).

Initially, there was an option of presenting a fullscreen image of the painting by tapping on the image, however that option was abandoned due to causing copyright infringement. The order of the list is, top-down, the painting image, title of the painting, author name, About the painting section and About the author section. There were also three buttons, a back, AR scan and narration button. Tap on the narration button would narrate the About the painting section with Apple's Karen, Australian female synthesized voice. The background color of this screen is dark gray, which as per Android material design guidelines, gives the feel of depth, as the lighter color than black represents the layer that is closer to the user.

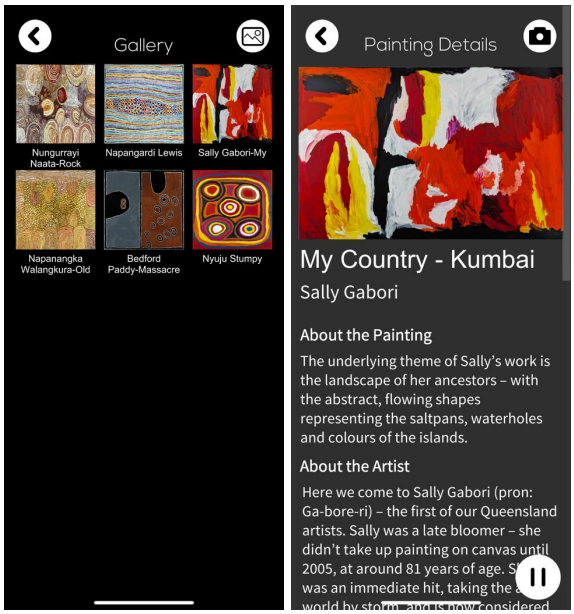

Fig. 6. App v1 Gallery screen and Artwork info screen with audio narration playing

The AR screen was accessible directly from the Main, Gallery and Artwork info screens. Its main purpose was to present to the user the meaning of the features on the paintings from the tour. This was possible by scanning the paintings by the main camera of the smartphone.

The screen had two display options: target-scanning and target-found modes (**Fig. 7**). Both modes had three buttons, two leading back and to the Gallery screen, and one for audio narration. The narration button was only visible in target-found mode. When one of the tour paintings entered in the field of view of the main camera, the Vuforia engine was able to recognize it as a target and trigger the target-found mode. In target-found mode the user was able to see the title of the painting and the names of the painting's features.

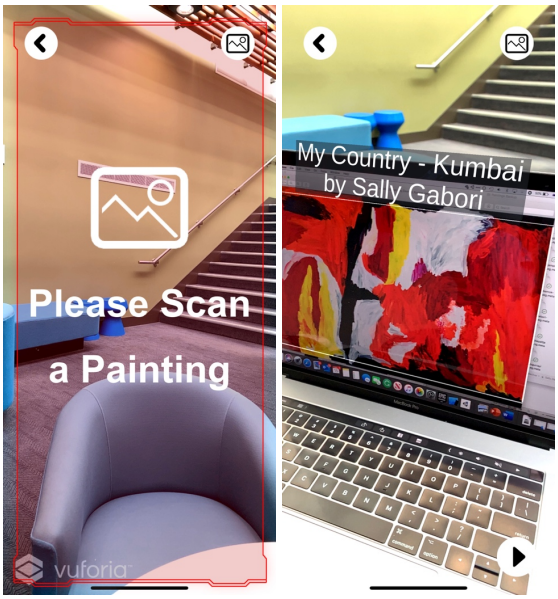

Fig. 7. App v1 AR screen, target-scanning and target-found modes

The Map, Badges and About screens were not developed for this version due the fact we did not consider these features crucial for this iteration of the development process which was to test the augmentation. Placeholder items are presented on **Fig. 8**.

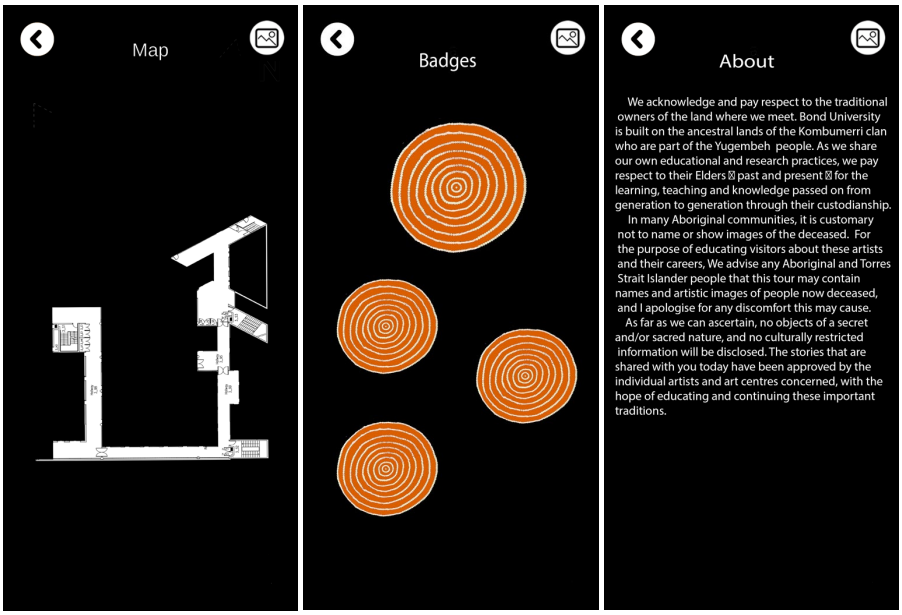

Fig. 8. App v1 Map, Badges and About placeholder screens

2.2 Meetings with the Experts

We organized the initial meetings with the selected experts and the stakeholders from the authors institution, where we presented our initial design ideas, the goal and the objectives of the solution and recorded their feedback which was in line with the DSR methodology.

This iteration sample size was five (n=5) experts, part of the core experts group were, an Indigenous culture expert (Indigenous artist), User-experience expert (Advertisement firm director), Service-marketing expert (Partnerships Manager at the Office of Alumni and Development), Sense of Place expert (PHD researcher and experienced local government representative in the School of Architecture), Exhibit organization expert (Curator of the indigenous walk at the authors institution). This sample of experts represents the larger institutional stakeholder group.

There was no official quantitative usability testing conducted with the stakeholders with only qualitative data recorded in the form of their requirements, expectations, thoughts and important points regarding the app, during open-ended interviews.

2.3 Simulation and Usability Testing

The initial evaluation of the application prior to testing with the experts was performed in a simulated environment by the research and development team. Testing was conducted using both iOS and Android devices, including iPhone X, XS Max, and SE, Samsung Galaxy S6, S7 and S8. Testing was performed to validate the usability of the initial builds of the app and establish the baselines for future usability testing in line with the DSR methodology.

The final build was stable and performed as expected on both platforms optimizing for the experience. Six paintings, of the total 35 tour paintings were randomly chosen and imported into the Unity Project. These paintings were uploaded to the Vuforia developer's website, where it generated the targets and the library, which was also imported into the project. We also used GPS and iBeacon to evaluate the accuracy of the technologies within the building. The GPS proved to be extremely ineffective and inconsistent to be of use, while the iBeacon beacons offered usable performance to associate the user to the location.

After the development of the alpha build of the app v1 as the first phase of the software development cycle where usability testing begins [11], we conducted usability testing with the experts and recorded their feedback. The testing was conducted by using observation and interviews with open-ended questions [16]. We handed the experts the app installed on Apple iPhone X smartphone and presented a portfolio folder containing A4 prints of the six paintings. Following the introduction of the app and presenting the features and how to use them, we observed how the tester used the app. The testers were using the app autonomously and we only intervened when asked to. Once they finished testing all the available features of the app, we conducted semi-structured interviews and recorded the conversations.

Near the end of the interviews we presented the experts with the five sample applications to the experts and recorded their comments in regard to the developed Corrigan Walk tour app and the contrast with the existing applications from the app store.

To assess usability we adapted the usability questionnaire from Hoehle, Aljafari and Venkatesh [9] as a set of ten focal points for the usability testing and interview structure. The concepts that we focused on during the testing are the following:

(i) Aesthetic graphics - regarding mobile application's artwork, rich, beautiful, engaging graphics and good design;
(ii) Color – regarding mobile application appropriate use or misuse of colors and contrast;
(iii) Control obviousness – regarding the mobile app consistent use of controls and obviousness of apps goals;
(iv) Entry point – regarding the ways the mobile app accessibility (icon, menu);
(v) Fingertip-size controls – regarding the mobile app use of controls and buttons in terms of size;
(vi) Font – regarding the mobile app use of a good font and font size;
(vii) Gestalt – regarding the mobile app handling proximity and grouping;
(viii) Hierarchy – regarding the mobile app use of a clear hierarchy and structure;
(ix) Subtle animation – regarding the mobile app use of animations effectively and appropriately;
(x) Transition – regarding the mobile app transitions and flow of the interface elements.

We also adapted several questions from Venkatesh and Davis [22] TAM2 Technology Acceptance Model as guidelines concerning the Usefulness in terms of how helpful, useful and effective the app is for the purposes of the tour.

AR component was further analyzed by following the five main types of AR evaluation techniques [3]: Objective measurements, Subjective measurements, Qualitative analysis, Usability evaluation techniques and Informal evaluations.

The interview data was analyzed by using thematic analysis [4]. Interview transcripts were coded regarding the concepts above, and additional themes were discovered and analyzed; Audio and Gamification.

3 Results and Discussions

In this section we present the results of the observation data and the thematic analysis of the semi-structured interviews conducted during the usability testing of the first build of the *Corrigan Walk Tour* app v1. The results following the previously described usability concepts of: Aesthetic graphics, Color, Control, Entry, Fingertip-size, Font, Gestalt, Hierarchy, Subtle animation, Transition, Usefulness guidelines and coded themes Audio, AR and Gamification.

The observation and the interview data showed that overall usability of the app was excellent. The user perceived quality of the app was on a high level. "It looks really

professional" commented one of the testers. The app was responsive, did not freeze or crash during the testing and had no observable negative effects on the users. "It's very, very quick, very responsive." commented one of the testers, a few moments after using the app for the first time.

3.1 Aesthetic graphics

All of the testers agreed that the aesthetics and graphics used in the app were enjoyable and engaging, by stating comments like: "…that's gorgeous, ... Love it… I love the graphic look of it.", and "I'm very happy with the interface."

3.2 Color

Colors in the app were also praised by the testers, with comments such as "The color is, I think, is excellent." and "… (colors are) representative of all the artwork. I think that's a really good choice." Initially, the testers favored the white on black theme. However, after the comparison with the other apps, some of the testers changed their opinions, favoring the black on white theme. Furthermore, one of the testers expressed concerns about the green color as one "…probably you don't see that as much in, …, in our Western desert." This was addressed by the indigenous art expert by pointing out that "...there is a lot of paintings that have the green (color)…"

3.3 Hierarchy

The users found the hierarchy to be easy to follow, and the app layout to be meaningful. However, one pointed out that there is a need of an integrated onboarding process saying: "I would like to be told, you can go on the tour, you can have audio, you can do that with this. Like, how can you tell some of what the capabilities of the app are before they start the tour?"

3.4 Control obviousness

All of the testers were able to navigate the app, go to different screens and back with no help or extra effort allowing for a self-directed experience. Four of the testers found the navigation easy and intuitive, stating "I like the simplicity of it, and it's clear. ... it seems like it would be easy to use and that anyone could use it." However, one tester had concerns about the layout of the Menu screen and even the need of one. She pointed out that all Main screen icon links may be integrated and available from the Tour screen, which subsequently might lead to shortening of the onboarding time. She also pointed out that there has to be an "acknowledgement about Aboriginal people before anything."

3.5 Font

The results showed mixed opinions about the font size and family, varying from “I wouldn't change anything about that…, …font is big enough.” to “…it should be another couple of points smaller…, …just double check those fonts as well…” For the content text, on the other hand, all agreed that is appropriate, and also needs some separation between the paragraphs.

3.6 Fingertip-size controls

“Good size choice!” commented the UX expert, confirming that the size of the buttons was appropriate, and testers had no difficulties tapping on them, which was in agreement with the observation data.

3.7 Subtle animation and Transition

At this stage of the development, there were no animations and transitions implemented. While some of the testers did not comment on this, some of them missed it “…there's no transition, you could add (it), if you wanted to pretty it up.”

3.8 Audio

Concerning the audio narration, all testers agreed that the computer synthesized voice is not appropriate and that should be a real person’s voice, preferably “…an Aboriginal person saying it…”

3.9 Augmented Reality

The AR component performed as expected. All the tested paintings were augmentable, the target recognition was responsive, and it could be used in different angles: “…it picks up real fast.” and “...the scanning that's really clever.”

3.10 Gamification

Regarding the planned gamification upgrade of the app, the opinions varied to extremes, where some of the testers did not see any value in it, some thought that introduction of game mechanics would vastly improve the engagement and motivation of the players.

3.11 Usefulness

All tests showed that the app was highly accessible. The interaction points and the content were easy to access, and the app suits both, left and right handed users. Testers

were satisfied with the app capability of being able to achieve its goals, from the tour perspective and also from the study perspective.

To summarize, the overall experience and usability of the app was satisfactory, and majority of the testers agreed on that. Before and after reviewing the competitor apps, the experts came up with several ideas for additions or adjustments within the app, such as the color theme and the Menu screen.

Based on the results, presented above we can confirm that the AR component, as the first part of the solution, was conceptually validated by using the five types of AR evaluation techniques [3]. The first version build performed within the expectations, and it would provide a solid base for the integration of the second, the Gamification component. Unity Game Engine proved to be a reliable development tool for development of this type of applications, and testing or release on the both major mobile platforms, iOS and Android OS. The app v1 looks and performs identically on both platforms. The Vuforia AR engine also showed stability and integrity when employed, with fast and reliable recognition of the targets.

As the literature suggested, usability concepts, which we followed as pre-conceptualized guidelines proved very effective in regard of usability testing, as predicted in the literature [9]

The initial plan to place a beacon behind all the paintings proved to be unreliable solution to the micro-location granularity, due to the inconsistency of the transmitted signals and proximity detection, which required the user to bring the device very close to the beacon, to avoid interference from the neighboring beacons. This however would not be possible due to the required distance and field of view by the AR camera to recognize the target, because even the smallest painting is 1.5m high. The unreliability of the beacons is not in complete agreement with the literature which shows various successful gamification of micro-location applications [21]. Probably this is due the specific requirements of this study, which we presented above, such as the minimum required distance from the paintings and the angles of scanning.

However, instead of solely the beacons, AR could be used as a micro-location provider during the AR scanning and then beacons would provide the micro-location within the segment of the space when not scanning. This solution would provide high granularity and precision within the closed spaces. Then micro-location would be used for navigation purposes. Due the shift from the iBeacon to AR as the main micro-location provider, this had strong effect on the design of the whole study, and it required adaptation of the pre and post, control group design, affecting the control group that was designed to use beacons to test the seamlessness of the iBeacon gamification of micro-location technology.

The expansion building works that were conducted at this time, in the building of the Health and Medicine Faculty, where the artworks for the tour are located, also affected the development speed and the real-world testing of the app. The interviews with the experts will influence the development of the next iterative build, with their suggestions about gamification and their separate opinions on the efficacy and necessity of GARM-L.

The app structure did not undergo major changes during the initial testing, and the two-scene approach proved valid, by separating the main content section from the AR

scanning capability into separate scenes in Unity. The consistency between, and the stability on both mobile deployment platforms is a significant advantage.

4 Conclusion

This paper concludes the first iteration of the DSRM process as the last step which is dissemination of the knowledge. We present the development process, from the inception to the development of an alpha release of a mobile application artefact, as solution to the problem of researching the increase of SoP as a whole. The significance of this study can be found in its contribution to IS field by answering the research question "How developers optimize for successful outcomes?" and by providing a verified development procedure by following the DSRM guidelines, as the research methodology developed for IS solution development. This first iteration of the solution and the positive outcomes of the usability testing of the app v1, allow for the start of the next phase of the development.

The next phase will include improvements as result of usability testing and introduction of the second, the Gamification component as part of a GARM-L solution. We propose that the Gamification component to initially employ progress and badges as main game mechanics.

The paintings in AR will have hidden features (small areas) that player will have to discover by following the clues given through the voice narration. By tapping on the feature in AR, the feature will become visible and the player will be awarded a badge. Scanning the painting only, will be awarded as a separate badge. Finding all the badges will lead to receiving of a master badge, one for completion, and one for the features. Aesthetics and positions of the badges is still under discussed. We will also introduce a new Badges screen which will show the badges and the progress.

By taking the app outside the context of the main study, the possibilities of implementation of the app are many. The app is built to be flexible and easily scalable. It can be used in similar applications at places such as heritage sites, museums, galleries, fairs and all kinds of exhibitions. All these scenarios are possibilities of for future work and taking this study on the next level.

References

1. Agnew J, Thrift N: Place and politics. The geographical mediation of state and society. Transactions of the Institute of British Geographers 13(2), 251 (1988). DOI= http://dx.doi.org/10.2307/622518.
2. Azuma R T: A survey of augmented reality. Presence: Teleoperators & Virtual Environments 6(4), 355-385 (1997).
3. Billinghurst M, Clark A, Lee G: A survey of augmented reality. Foundations and Trends® in Human–Computer Interaction 8(2-3), 73-272 (2015).
4. Braun V, Clarke V: Using thematic analysis in psychology. Qualitative Research in Psychology 3(2), 77-101 (2006). DOI= http://dx.doi.org/10.1191/1478088706qp063oa.

5. Chang Y-L, Hou H-T, Pan C-Y, Sung Y-T, Chang K-E: Apply an augmented reality in a mobile guidance to increase sense of place for heritage places. Educational Technology & Society 18(2), 166-178 (2015).
6. Deterding S, Dixon D, Khaled R, Nacke L: From game design elements to gamefulness: defining gamification. In: Proceedings of the 15th …. ACM, New York, NY (2011). DOI= http://dx.doi.org/10.1145/2181037.2181040.
7. Galliano S J, Loeffler G M: Place assessment: how people define ecosystems. Gen. Tech. Rep. PNW-GTR-462, 31 (1999). DOI= http://dx.doi.org/10.2737/PNW-GTR-462.
8. Gronroos C: Service management and marketing: Customer management in service competition. 3rd edn. John Wiley & Sons, Hoboken, NJ (2007).
9. Hoehle H, Aljafari R, Venkatesh V: Leveraging Microsoft's mobile usability guidelines: Conceptualizing and developing scales for mobile application usability. International Journal of Human-Computer Studies 89, 35-53 (2016). DOI= http://dx.doi.org/https://doi.org/10.1016/j.ijhcs.2016.02.001.
10. Huotari K, Hamari J: A definition for gamification: anchoring gamification in the service marketing literature. Electronic Markets 27(1), 21-31 (2017). DOI= http://dx.doi.org/10.1007/s12525-015-0212-z.
11. Standard Glossary of Terms Used in Software Testing Version 3.2, https://www.istqb.org/downloads/send/20-istqb-glossary/186-glossary-all-terms.html, last accessed 5 May 2019.
12. Jorgensen B S, Stedman R C: Sense of place as an attitude: Lakeshore owners attitudes toward their properties. Journal of environmental psychology 21(3), 233-248 (2001). DOI= http://dx.doi.org/10.1006/jevp.2001.0226.
13. Kaware S R: Google Maps with Visual Positioning System. IJSRCSEIT 3(5), 310-315 (2018).
14. Newman N: Apple iBeacon technology briefing. Journal of Direct, Data and Digital Marketing Practice 15(3), 222-225 (2014). DOI= http://dx.doi.org/10.1057/dddmp.2014.7.
15. Peffers K, Tuunanen T, Rothenberger M A, Chatterjee S: A design science research methodology for information systems research. Journal of management information systems 24(3), 45-77 (2007). DOI= http://dx.doi.org/10.2753/MIS0742-1222240302.
16. User Interviews: How, When, and Why to Conduct Them, https://www.nngroup.com/articles/user-interviews/, last accessed 16 June 2019.
17. Potts R, Yee L: Pokémon Go-ing or staying: exploring the effect of age and gender on augmented reality game player experiences in public spaces. Journal of Urban Design, 1-18 (2019). DOI= http://dx.doi.org/10.1080/13574809.2018.1557513.
18. Sigala M: The application and impact of gamification funware on trip planning and experiences: the case of TripAdvisor's funware. Electronic Markets 25(3), 189-209 (2015). DOI= http://dx.doi.org/http://dx.doi.org/10.1007/s12525-014-0179-1.
19. Vargo S L, Lusch R F: Evolving to a new dominant logic for marketing. Journal of marketing 68(1), 1-17 (2004). DOI= http://dx.doi.org/10.1509/jmkg.68.1.1.24036.
20. Vargo S L, Lusch R F, Archpru Akaka M, He Y: Service-dominant logic. Review of Marketing Research. Emerald Group Publishing Limited, 2010, pp. 125-167. DOI= http://dx.doi.org/10.1108/S1548-6435(2009)0000006010.
21. Vasilevski N, Brand J, Birt J: Analysing micro-location beacon gamification: scenarios, types and characteristics. In: Proceedings of the 30th Australian Conference on Computer-Human Interaction, pp. 484-489. ACM, New York (2018). DOI= http://dx.doi.org/10.1145/3292147.3292210
22. Venkatesh V, Davis F D: A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. Management Science 46(2), 186-204 (2000).

23. Xu F, Tian F, Buhalis D, Weber J: Tourists as mobile gamers: Gamification for tourism marketing. Journal of Travel & Tourism Marketing 33(8), 1124-1142 (2016). DOI= http://dx.doi.org/10.1080/10548408.2015.1093999.