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Service Design of AR Mobile Application for a Museum/ Case Study "Aviation Museum"

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Augmented Reality (AR) technology offers a lot of potential to museums. A number of museums worldwide and in Finland, adopting AR technology, is constantly growing as it offers more opportunities to enlarge current exhibitions with virtual content that doesn't occupy physical space and can include videos and animations. This allows to achieve a better level of visitors' involvement and offers an element of gamification.

For Aviation Museum, Augmented Reality provides an opportunity to enrich main exhibition with the museum's collection of historical photos and videos.

The aim of this work is to identify a demand for AR service in Aviation Museum and understand how main targeted audiences – Families with Children and Senior Males can handle the technology. How easy and intuitive for them will be the process of downloading and using an AR application.

In this work Augmented Reality technology in museum industry was studied and concepts of Service Design were described.

Service Design approach was used for developing the prototype (AR mobile application) and mixed methods approach in a form of Focus Groups and Self-Completed questionnaire was used to test visitors' behaviour and receive valuable insights for further stages of AR mobile application development.

As a result, strong demand was found among all targeted audiences, which was confirmed by similar results form use cases of some of museums worldwide, using the same technology. However, for Senior visitors, assistance would be required - such as tablets or AR guided tours. Mobile application was not intuitive for this group of people. The rest of targeted audiences were able to use AR mobile application and view the augmented content.

Keywords
Augmented Reality, Service Design, Museums

Contents

1 Introduction

Recent research predicts an increase of the market of Augmented Reality (AR) in nearly 33 times by 2025 *(Augmented Reality, 2019).* This means that it will penetrate many industries including museums and galleries, where its adoption rate is already steadily increasing (tom Dieck and Jung, 2017)

Augmented reality (AR) is becoming one of the most popular technologies among museums as it allows to engage with customers, involve them with a certain level of immersion. It is cheaper than developing immersion, based on Virtual reality and doesn't require a lot of special equipment. It also provides an amazing platform for creativity of museum curators and artists.

All these factors make Augmented Reality extremely interesting for museums to adopt.
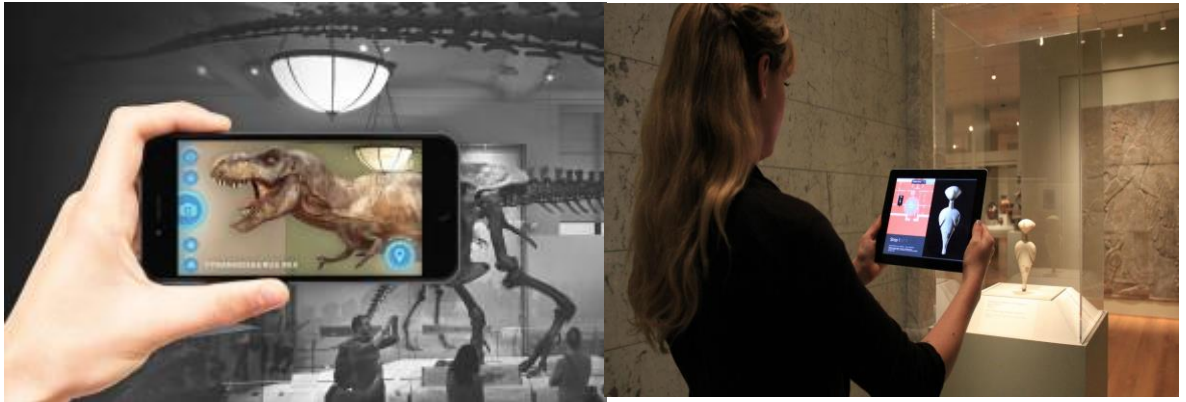
AR (Augmented reality) app development company | Mobile app development Android & iOS - Queppelin, 2018

Photograph: pinterest.com/pin/354025220693413784/

Figure 1. Example of Augmented Reality in Museums

Aviation Museum

Finnish Aviation Museum is located in Vantaa close to the Airport. The Museum offers two exhibition halls with different kinds of historical aircrafts and aviation-related exhibits. Besides the exhibition, visitors can experience airplane simulators and go for a virtual flight as a pilot.

The museum also offers rich aviation-themed archive of publications, documents, books, magazines, pictures and videos. Many of those materials, like photos and videos are available in digital format. This collection has a good opportunity to enrich the current physical exhibition by augmenting some of its digital materials on actual exhibits.

Augmented Reality provides a new dimension for visitors to visualize the history of aviation and a tool for museum curators to educate in an engaging and entertaining way.

1.1 Relevance of the topic

Augmented Reality and Virtual Reality recently became a trend in museum industry. Yet it has not penetrated museum industry massively, the results of exhibitions with AR elements are resonating in press and social media attracting more attention to these technologies.

Implementing of AR technology has been made quite easy by an increasing number of platforms that offer creating augmented objects. Some of them offer adding augmented content without even coding skills. Many of them are adapted for specific industries, among them we can even find platforms designed specifically for museums and galleries.

Augmented Reality is seen as a technology entertaining for public, which also offers an opportunity to educate museum visitors in an exciting way.

To sum up, museums should pay attention to Augmented Reality as it is an engaging and exciting way to present their exhibits on one hand and a relatively easy solution to implement on the other hand, which doesn't require large investments or, in some cases, even coding skills, when using specialized platforms. All these factors make it worth testing already now and plan further development of AR solutions in the museum, before its forecasted viral adoption *(Augmented Reality, 2019).*

1.2 Purpose of the study

Purpose of the study is to develop an understanding of whether a new AR service will be relevant and demanded for Aviation Museum and test hypotheses and concerns of museum management. This information will help to understand whether the museum shall invest its resources in this technology and what exactly shall they focus on.

Service design was chosen as a research method for the development part. With the help of service design, it is planned to develop a prototype – a solution, suitable to the current situation in the museum. The solution (or the prototype) will be tested to check hypotheses and get insights from visitors for further considerations**.**

1.2.1 Objectives

- Describe Augmented Reality, current market, opportunities and aspects for consideration
- Review case studies of how AR has already been implemented in museums

- Describe the process of AR App development from business point of view (by means of service design tools)
- Create a prototype of the application and test hypotheses

1.2.2 Expected outcomes

Before proceeding with any further decisions regarding implementation of Augmented Reality in Aviation Museum it is necessary to understand whether museum visitors will actually use it. Currently we can suggest that new service will be positively accepted, however, for further development it is necessary to carry out a research which will provide reliable ground for these suggestions. Current work is expected to test the following hypotheses:

- H1 Augmented Reality will be positively accepted among museum visitors, or there is a demand for AR technology in Aviation Museum
- H2 Visitors will be able to download and use an Augmented Reality application on their mobile phones

Based on results of the research and tested hypotheses, the museum can decide whether to continue development of AR solution for the rest of exhibition or not and whether the mobile application is a suitable solution or tablets will be required.

1.2.3 Research questions

Based on suggestions and consequent hypotheses, the following research questions have been developed:

- RQ 1. Is there a demand for AR technology among visitors of Aviation Museum?
- RQ 2. How likely are visitors to download the application when visiting the museum? Will there be a need to invest in tablets or AR mobile application is enough?

1.2.4 Scope

The research will be carried out in several stages. Based on the functionality of AR platform it will be possible to decide on the type of augmented content for the exhibits and create a prototype. Meanwhile, we can work on suitable for the case customer journey and prepare for focus-group interviews. After implementation of focus-groups the results will be analyzed and recommendations for the museum will be provided. The whole process is divided into four steps:

1. Choose an AR platform and create content

2. Analyse the case and design customer journey with the help of service design tools
3. Carry out focus-groups
4. Analyse the results

2　Theoretical framework

2.1　Augmented Reality and Museum Industry

Augmented Reality has not received a commonly accepted definition. It is often defined by different authors with a perspective of their research topic. One of the most general definitions is offered by Van Krevelen and Poelman (2010) who see Augmented Reality as a system which shows computer-generated items in real-time view.

To complement this definition, we can refer to Paul Milgram's (Milgram et al., 1994) visualization of what is the place of AR between two worlds - real and virtual (Figure 2).

Figure 2. Paul Milgram's Concept of Mixed Reality (Milgram et al., 1994)

Ronald Azuma (Azuma, 1997) suggested that Augmented Reality incorporates the following attributes:

1. "Combines real and virtual
2. Interactive in real time
3. Registered in 3-D"

For cultural heritage museums Augmented Reality can be seen as a tool that helps curators to present history in a new engaging and entertaining way, which positively impacts the level of visitor's understanding of museum's artefacts (Nechita and Rezeanu, 2019).

On the other hand, museums appreciate the fact that they can apply augmented objects without any physical impact to artifacts. In other words, it doesn't take any space, which especially benefits small museums (van Krevelen and Poelman, 2010), (Kyriakou, 2018). It also brings value for operational costs reduction as less installation equipment and printed materials is needed for its implementation (Nechita and Rezeanu, 2019). In some cases, Augmented Reality can become a solution for fragile exhibits or exhibits with other kind of access regulations (Kyriakou, 2018).

For Aviation Museum Augmented Reality offers a great opportunity to present their rich archives of aviation-themed photos and videos to exhibition visitors and create a deeper level of époque immersion.

2.1.1   Size of Augmented Reality Market in Museum Industry

For choosing and successful implementation of new technologies it is important to understand the size of its market, its maturity and how well the technology has already been adopted. If we look at the current size of market for Augmented Reality and compare it with the forecasted market in 2025 (Figure 3) we can see a dramatic growth from 5,91 billion U.S. dollars to 198.17 billion U.S. dollars. It shows that currently the market, demonstrates a very high interest to AR and is about to adopt it on a much greater scale.
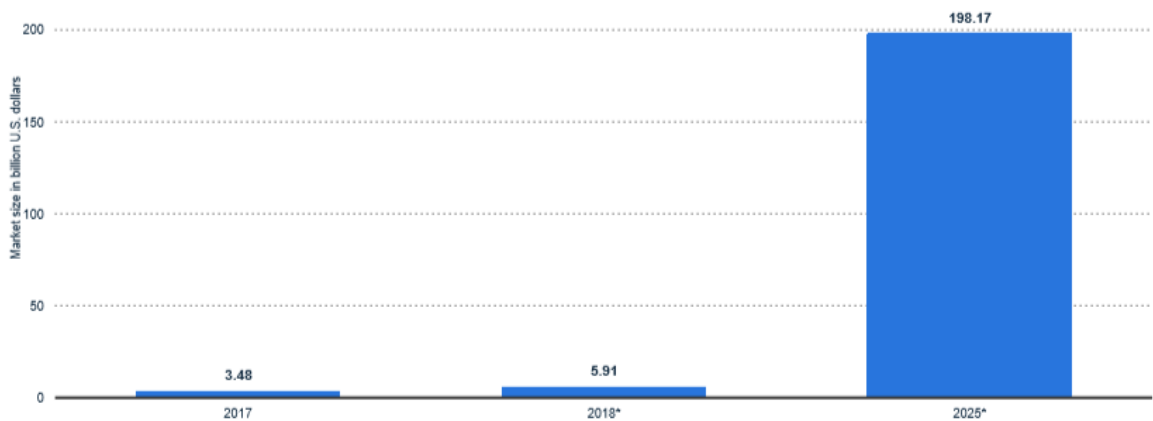
Figure 3 Augmented reality market size worldwide in 2017, 2018 and 2025, (Augmented Reality (AR), 2019)

By comparing AR to VR (Figure 4), its closer competitor on immersion technologies market, we can see that AR content/mobile apps are provoking much higher interest than VR content/mobile apps and location-based VR. We can also notice that the gap between them has a tangency to grow in coming years, as AR's share grows faster that VR's. One of the reasons for AR technology becoming so popular is that two giants of digital technologies Google and Apple released their free platforms for developers - ARCore and ARKit, which makes creating AR based applications more affordable for larger audiences. Thus, the availability of cutting-edge tools will help this technology to go viral in just a few coming years.
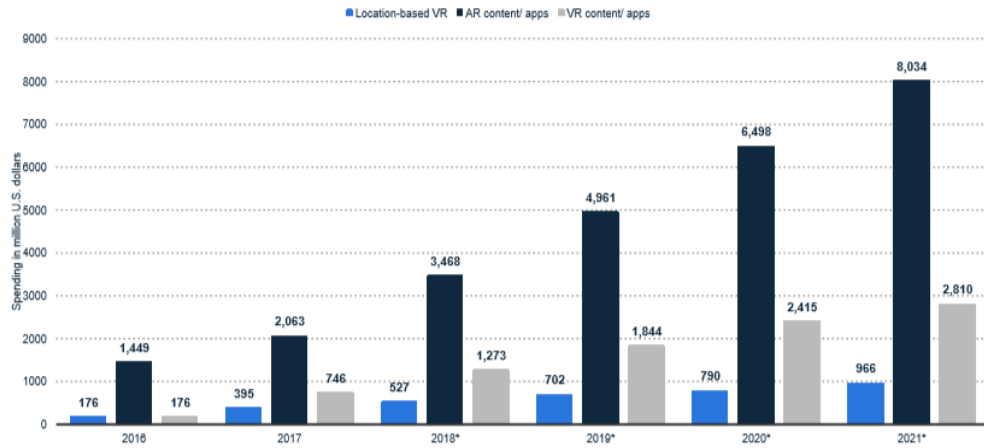
Figure 4. Consumer Spending on AR and VR content and apps worldwide from 2016 to 2021, (Augmented Reality, 2019)

Considering our domain - museums and exhibitions, it is interesting to see that industries which benefit most from AR are Entertainment and Education (Figure 5). Both of these industries have a very close relation to museum industry and it confirms the necessity to start developing AR-equipped exhibitions now.
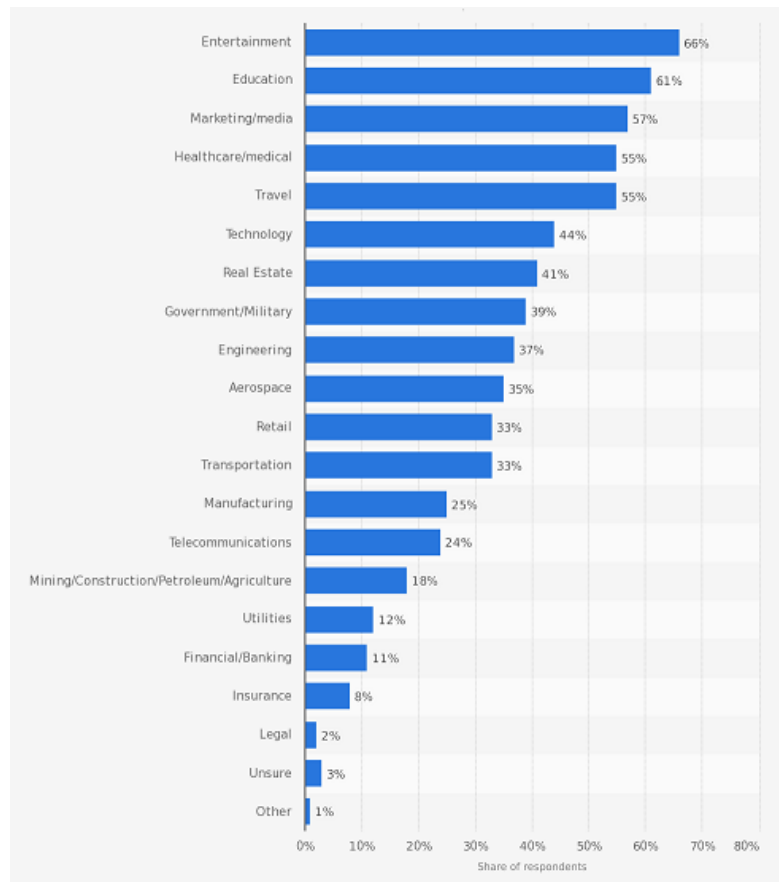
Figure 5. Ranking of Industries that would benefit most from AR in Europe in 2016, (Augmented reality (AR) in Europe - Statistics & Facts, 2017)

Looking at adoption levels with the help of Gartner's Hype Cycle for Emerging Technologies (Panetta, 2018), (Figure 6) we can notice that AR in 2018 was already at the stage of "Trough of Disillusionment", which means that the technology has already passed first generation of products with high prices and multiple customizations, mass media hype, negative press and developed second and third generation products, with better functionality, more affordable for customers and ready for real world experience.
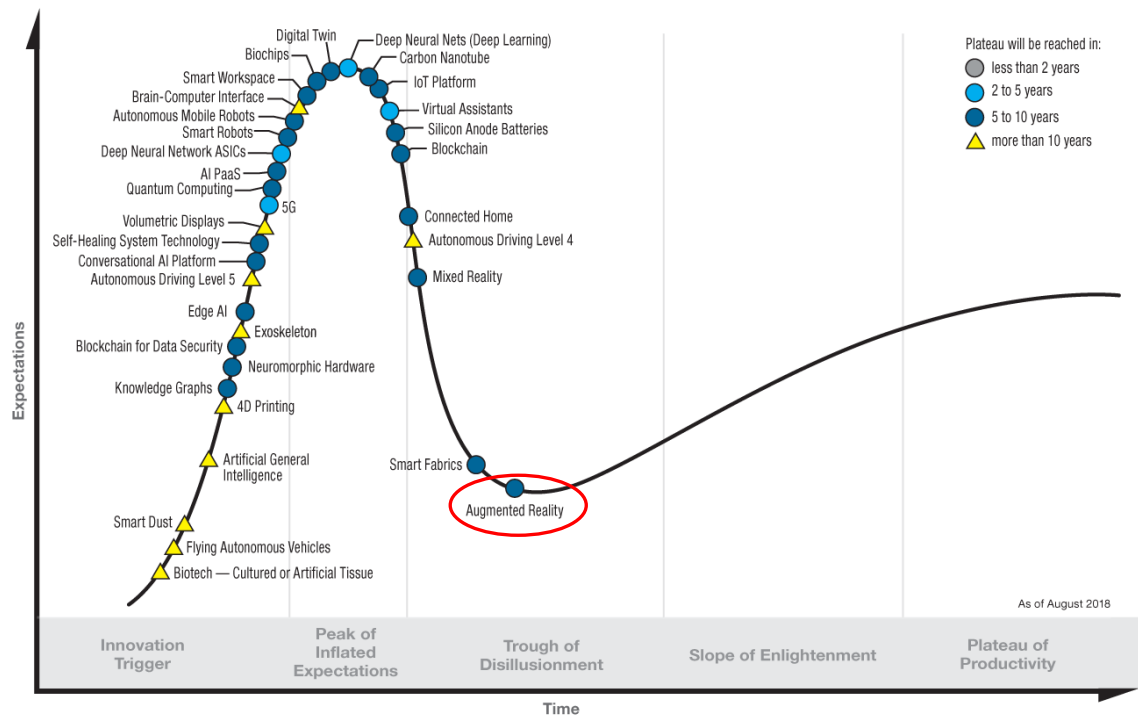
Figure 6. Gartner's Hype Cycle for Emerging Technologies, (Panetta, 2018)

At the current stage penetration to the market is from 5% to 30 %, which is just on the edge to become viral, considering the demand on the market for AR for 2025 (Figure 3). It is a good opportunity for any museum or exhibition to start implementing AR now, right before it becomes mainstream and by that time to be ahead of competition, have tools tested, collect the statistics and learn about the technology from own experience.

2.1.2   Impact of Augmented Reality on Visitor's Engagement

The topic of how virtual technologies impact student's engagement, commitment and learning outcomes has been well researched and represented (Martín-Gutiérrez et al., 2016); (Kerawalla et al., 2006); (Chen and Tsai, 2012); (Nechita and Rezeanu, 2019); (Martín-Gutiérrez et al., 2016). It is known that students become more engaged in the educational process if a technology is involved (Benckendor, Tussyadiah and Scarles,

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2018); (tom Dieck and Jung, 2017). However, not only students, but small children are often the ones who enjoy the technology the most (Cianciarulo, 2015); (Liarokapis et al., 2008).

For many museums (including Aviation Museum) young audience and school groups is one of the largest targeted audiences.

In order to stay interesting, relevant and engaging to them, museums need to adjust their customer journeys to new technologies, make them faster and more personal; and enhance educational presentation (Pedersen et al., 2017).

However, not only children value educational and entertainment aspects of Augmented Reality. As the second largest targeted audience for Aviation Museum is senior males it was very interesting to come across a discovery made by M. Claudia tom Deik et al. (tom Dieck and Jung, 2017) about this segment of visitors. It showed that senior focus-group members appreciated that with the help of AR, information can be saved for later review and reflection and makes it easier to memorize.

As we can see, a possibility to learn in an entertaining way is what visitors of all ages value the most in museums. In other words, an entertaining format of knowledge presentation creates a deeper level of engagement. Visitor involvement is a difficult task and Augmented Reality can help solving it. With AR technology, it is possible to create a more entertaining experience comparing to traditional passive display of exhibits, as it adds an exciting new dimension to learning process in museums. (Nechita and Rezeanu, 2019); (Moorhouse, tom Dieck, and Jung, 2017); (Yoon et al., 2012)

A key to enhanced engagement belongs to empathy. It is empathy, which has a deeper impact on the ability to memorize material (Panciroli, Macauda and Russo, 2018); (Nechita and Rezeanu, 2019). Augmented Reality has a great potential to connect with customer on the level of empathy as it offers another dimension of visibility and presentation. This unique ability to combine real-world view and augmented objects adds an element of gamification, which makes AR application also a good tool for active learning in museum environment (Dunleavy and Dede, 2014).

2.2   Service Design

Service Design is a relatively young concept. First definitions of the term Service Design considered it either as a service idea that is presented in charts and drawings (Gummesson, 1991) or as an entire process from ideation to implementation of a service (Martin et al., 1993). Before that only products were considered to be designed (Shunli and Muhammad, 2018).

Later definitions of Service Design were more focused on stakeholder's points of view, and the central part was given to customers. They described it as an activity aimed to improve the quality of communication between customers and providers (Brown, 2008), (Mager, 2008).

At about the same time an understanding of context, that surrounds both customers and service providers was added to the definition of Service Design (Patrício et al., 2011).

Latest definitions of Service Design (Rose et al., 2019); (Prendeville and Bocken, 2016); (Andreassen et al., 2016), refer mostly to Schneider & Stickdorn (2011) understanding and interpretation, who also interviewed 150 practitioners and formulated the most common understanding among them of this concept. The definition is: *"Service design helps organizations see their services from a customer perspective. It is an approach to designing services that balances the needs of the customer with the needs of the business, aiming to create seamless and quality service experiences. Service design is rooted in design thinking, and brings a creative, human-centred process to service improvement and designing new services. Through collaborative methods that engage both customers and service delivery teams, service design helps organizations gain true, end-to-end understanding of their services, enabling holistic and meaningful improvements."* (Stickdorn, 2018)

They also noted that over a decade from 1990-2000 an approach of creating a service grew into a methodology. However, it still remains as just one of the multiple ways of working on a service. (Stickdorn, 2018)

Besides Design Thinking, Service Design involves many other aspects, such as branding, marketing, customer service, design, engineering and other, and considers a service from all of the appropriate angles. (Stickdorn, 2018)

2.2.1 Digital Service Design

Digital Service Design is even newer concept that now often arises in the context of digital services. Fast development of technologies has its impact on the way services are presented today. A share of the market that is occupied by digital services has grown tremendously over the last two decades and this growth will continue with further development of technologies (such as Artificial Intelligence, Machine Learning, etc).

One of the reasons for such growth is that Digital Services offer a deeper level of personalisation, which became possible to achieve with automation of processes. Digital Services can also offer more freedom, such as freedom of time – clients don't need to

follow the opening hours of the service provider, nor line up waiting for their turn to be served – it is always available at any time. These and other factors are convenient for both – clients and service providers, and make digital services so popular.

Digital services as opposed to traditional services lack a factor of human interaction. When there is no human who serves a client the communication process is different. It doesn't require as much of emotional, social, cultural and other aspects of communication and relies more on functional aspects of the service. (Weightman and McDonagh, 2003)

Williams, Chatterjee and Rossi (2008) distinguish Digital Service from traditional service according to the following parameters:

- "Being digital, at least for a portion of the interaction.
- A different sense of tangible vs intangible.
- Often the 'digital service' is a coordination or arrangement of something physical" (Williams, Chatterjee and Rossi, 2008)

Digital Service is defined as "an activity or benefit that one party can give to another, that is, provided through a digital transaction." (Williams, Chatterjee and Rossi, 2008)

As Augmented Reality is planned to be tested for a part of the exhibition and is supposed to be provided through a mobile phone application, it can be also qualified as a digital service according to the given definition.

Digital Services have developed very fast and their infrastructure now differs a lot from traditional services, therefore, specific principles of digital service design, as well as specialized tools, frameworks and methods are required, however, they have not been yet fully developed (Cronholm and Göbel, 2017); (Williams, Chatterjee and Rossi, 2008); (Lyytinen et al., 2004) and traditional service design principles and tools are used for designing both digital and traditional services. Nevertheless, some of prerequisites for Digital Service Design principles, which partially overlap with traditional Service Design principles, have been already formulated by Rose et al. (2019):

 • "SD (service design) 1 - Originate from user needs, culture, circumstances when identifying, designing and implementing digital services
• SD 2 - Keep users in focus in order to think outside the box and across organisational borders
• SD 3 - Interact with users of services in order to enable value creation
• SD 4 - Focus on a holistic user perspective in order to facilitate and enable service innovation

• SD 5 - Make the intangible tangible by visualising types of results and parts of the process
• SD 6 - Maintain a holistic process view by (for example) combining manual and digital elements of service as required." (Rose et al., 2019)

For the current project – testing Augmented Reality application in Aviation Museum – we will apply principles, tools and methods of traditional Service Design, which are currently used for these purposes, however, at the same time we can keep in mind the difference between Service Design and Digital Service Design and adapt some of the tools to our purposes by aligning them with elements, offered by Rose et al. (2019).

2.2.2 Service Design Principles

The process of designing a service can best characterized by its principles. Many authors after 2010 (Rose et al., 2019); (Prendeville and Bocken, 2016); (Andreassen et al., 2016) refer to Service Design principles formulated by Stickdorn and Schneider (2010). In 2010 they described five characteristics of Service Design which are currently cited by most of the Service Design-related articles: user-centred, co-creative, sequencing, evidencing, and holistic (Stickdorn and Schneider, 2010). However, later, in 2017, they added a principle of iteration as one of the most important principles that impacts the process of designing a service. Another aspect that they have later highlighted throughout most of the principles is practical approach. (Stickdorn, 2018). In other words, Service Design is now considered as an action-based approach to designing a service. The process of development of Service Design principles is best described by the following chart. (Figure 7)

2010

1. USER-CENTERED

Services should be experienced through the customer's eyes.

2. CO-CREATIVE

All stakeholders should be included in the service design process.

3. SEQUENCING

The service should be visualized as a sequence of interrelated actions.

4. EVIDENCING

Intangible services should be visualized in terms of physical artifacts.

5. HOLISTIC

The entire environment of a service should be considered.

2017

1. HUMAN-CENTERED

Consider the experience of all the people affected by the service.

2. COLLABORATIVE

Stakeholders of various backgrounds and functions should be actively engaged in the service design process.

3. ITERATIVE

Service design is an exploratory, adaptive, and experimental approach, iterating toward implementation.

4. SEQUENTIAL

The service should be visualized and orchestrated as a sequence of interrelated actions.

5. REAL

Needs should be researched in reality, ideas prototyped in reality, and intangible values evidenced as physical or digital reality.

6. HOLISTIC

Services should sustainably address the needs of all stakeholders through the entire service and across the business.

Figure 7. Development of Service Design Principles. Source: Stickdorn (2018)

2.2.3   Service Design Procedures and Tools

Service Design counts multiple methods and approaches. Many attempts to systemize these methods have been done. Stickdorn (2018) provides some of examples of how Service Design can be approached:

1. "Discover, Define, Develop, Deliver
2. Explore, Create, Evaluate
3. Exploration, Creation, Reflection, Implementation
4. Identify, Build, Measure – or – Orientate and Discover, Generate, Synthesize and Model, Specify, Measure, Produce, Transfer and Transformation
5. Insight, Idea, Prototyping, Delivery
6. Discovering, Concepting, Designing, Building, Implementing" (Stickdorn, 2018)

After analysing these approaches Stickdorn (2018) concluded that all of them have three common patterns which are: research, ideation and prototyping. Therefore, these three stages of designing a service are considered as core stages.

According to Stickdorn (2018) besides these three core stages, there is one more stage to be considered to complete the process – implementation, which is supposed to finalise the Service Design process. Therefore, the full approach to core procedures of Service Design involves the following stages:

1. Research
2. Ideation
3. Prototyping
4. Implementation (Stickdorn, 2018)

Each stage of the process has certain tools to facilitate the process. Generally, there is countless amount of Service Design tools and practices, which have to be chosen with regards to multiple factors, such as industry, target audiences, type of service, channels of distributions and many more. Therefore, for each service there will be chosen individual set of tools; in other words, the process will be tailor-made specifically for the goals of each project.

One of the best ways to present the interconnection of tools and goals of Service Design on each stage of development is done by Stickdorn (2018) in the following chart (Figure 8)
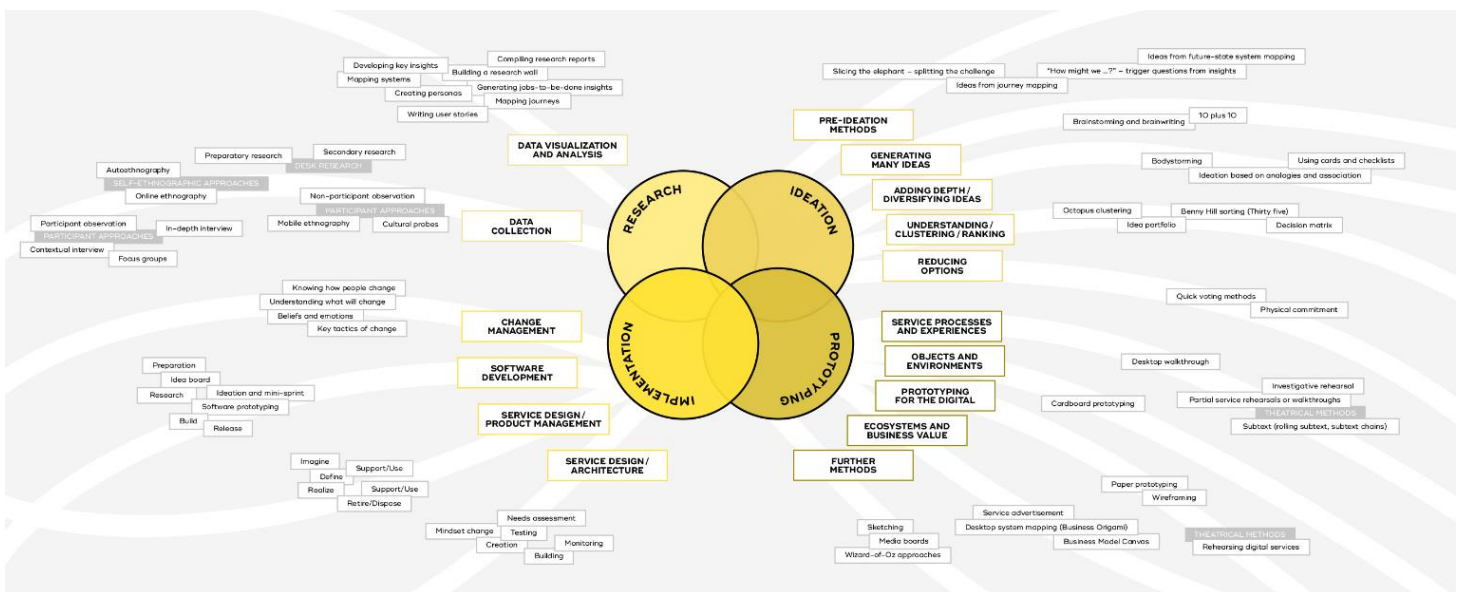

Figure 8. Service Design Tools. Source: Stickdorn (2018)

Considering the scope of this work, the following tools will be used: Desk Research (which included such tools as Immersion, Brainstorming, User Personas, Customer Journey) and Testing (which includes such tools as Focus Groups and Questionnaire). More about Testing will be discussed in Part 3. Methodology.

Desk Research

"Desk research is a research strategy in which the researcher does not gather empirical data herself or himself, but uses material produced by others." (Verschuren, Doorewaard, and Mellion, 2010)

Verschuren, Doorewaard, and Mellion (2010) distinguish the following characteristics of desk research:

1. "the use of existing material, in combination with reflection;
2. the absence of direct contact with the research object;
3. the material is used from a different perspective than at the time of its production." (Verschuren, Doorewaard, and Mellion, 2010)

As a part of desk research Immersion Canvas will be used. Immersion Canvas will help to navigate Desk research as it helps to answer questions and visualize the context around our service, such as what are alternatives to the current services, what can potentially disrupt this service, competition and debates around this topic.

Immersion Canvas is a starting point of the desk research that visually summarizes areas of focus of the Desk research.

- *User Personas*

"A persona is a profile representing a particular group of people, such as a group of customers or users, a market segment, a subset of employees, or any other stakeholder group." (Stickdorn, 2018)

User personas are based on organisation's key segments and in general represent company's target audience (Tuomi, 2020).

With the help of "Personas" we can create a better understanding of our target audiences, get useful insights about their motives and find new ways to improve our service according to the needs of a specific target audience.

- *Customer Journey*

"A journey map visualizes the experience of a person over time." (Stickdorn, 2018)

"Journey maps help us to find gaps in customer experiences and explore potential solutions. They can be used to visualize existing experiences as well as potential future experiences." (Stickdorn, 2018)

Data for customer journey map can be collected from various sources. Depending on a service (or a product) some of them are:

- "Internet
- Mobile apps
- Social media
- IOT-devices
- Self-report data
- Commercial Data
- Open data repositories" (Tuomi, 2020)

On the other hand, data can be generated with the help of customer observation, customer questionnaires, focus groups and other forms of customer research.

As for the data categories, depending on a product (service) the following types of data can be useful for creating a journey map:

- "Behavioural data
- Transactional data
- Geospatial data
- Biometric data
- Audio-visual data" (Tuomi, 2020)

Customer Journey analysis is needed to help us to analyse Service Experience for each of our target audiences and find ways to improve it.

Service Experience is "the period during which all service encounters relevant to a core service offering may occur" (Voorhees et al, 2017). Voorhees et al (2017) developed further their concept of service experience and divided it into three stages: pre-core, core and post-core (Figure 9). This way it will help us to think about each stage separately and find gaps or bottlenecks in the service journey.

Pre-Core Service Encounter

Communications

Information search

- Competitor websites
- 3rd party websites
- Offline and online
- recommendations

Initial contact

- Face-to-face
- Telephone
- Internet

Onboarding Activities

Core Service Encounter

Core Interactions

- Employees
- Other customers
- Technology

Environment

Post-Core Service Encounter

Service recovery efforts

Customer Feedback

- Post-transaction Survey

Reviews

Crowdsourcing for new service development

Recommendation

SERVICE EXPERIENCE

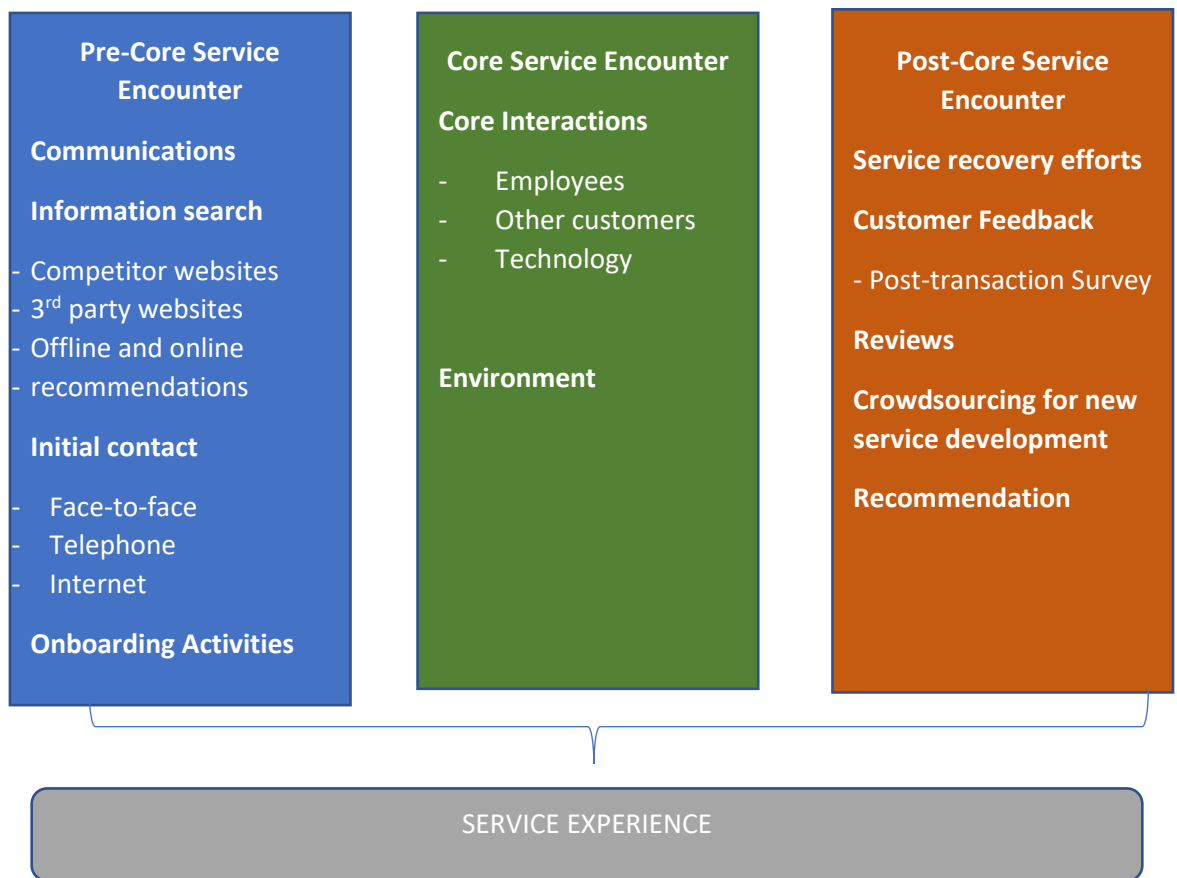*Figure 9. Model of service encounters throughout the service experience (Voorhees et al, 2017).*

3 Methodology

3.1 Research Method and Approach

Currently Aviation Museum is looking into opportunities of Augmented Reality for its exhibitions. In order to understand whether this technology will be in demand among museum's visitors and whether they can manage with an AR mobile application - it was decided to use Service Design approach.

Service Design approach suggests that research will be carried out in several stages: preparatory stage – where market and customers are analysed; and main stage of the research – where the service will be tested. The research will be carried out with the help of Service Design tools, which include a mixture of qualitative and quantitative research methods (or mixed methods). In fact, "Service Design approach puts emphasis on complementing quantitative research with qualitative methods" (Reason et al., 2015), which characterises best the nature of this work.

3.1.1 Mixed methods research

Preparatory part of the research requires observation of the current market and customer behaviour which can be achieved best with the help of qualitative methods. Qualitative methods are used when it is necessary to go beyond the numbers and find out motives that lead visitors to certain types of behaviour (Reason et al., 2015). This information will be used to build up a prototype (AR mobile application). On the final stage (prototype testing) a qualitative approach, and one of its tools – focus groups, will help us discover valuable insights from visitors' feedback.

The main reason for quantitative research is that it allows to test hypotheses via statistics (Antonius, 2003), which will provide answers to research questions. Quantitative research gives measurable, objective and reliable data (Carr, 1994) that can be used further, to determine the final design of AR application.

The combination of these two methods will provide deeper and more credible data for further development. In this work mixed method approach is chosen as it allows to:
1. Collect reliable statistical data to prove hypotheses. This will be achieved with the help of quantitative approach (by means of questionnaire)
2. Confirm these results and get insights from visitor's feedback. For this purpose, qualitative method (focus groups) will be used.

Interconnection between goals of this work and research tools, as well as development of the process, is also described later in *Table 1. Research Development.*
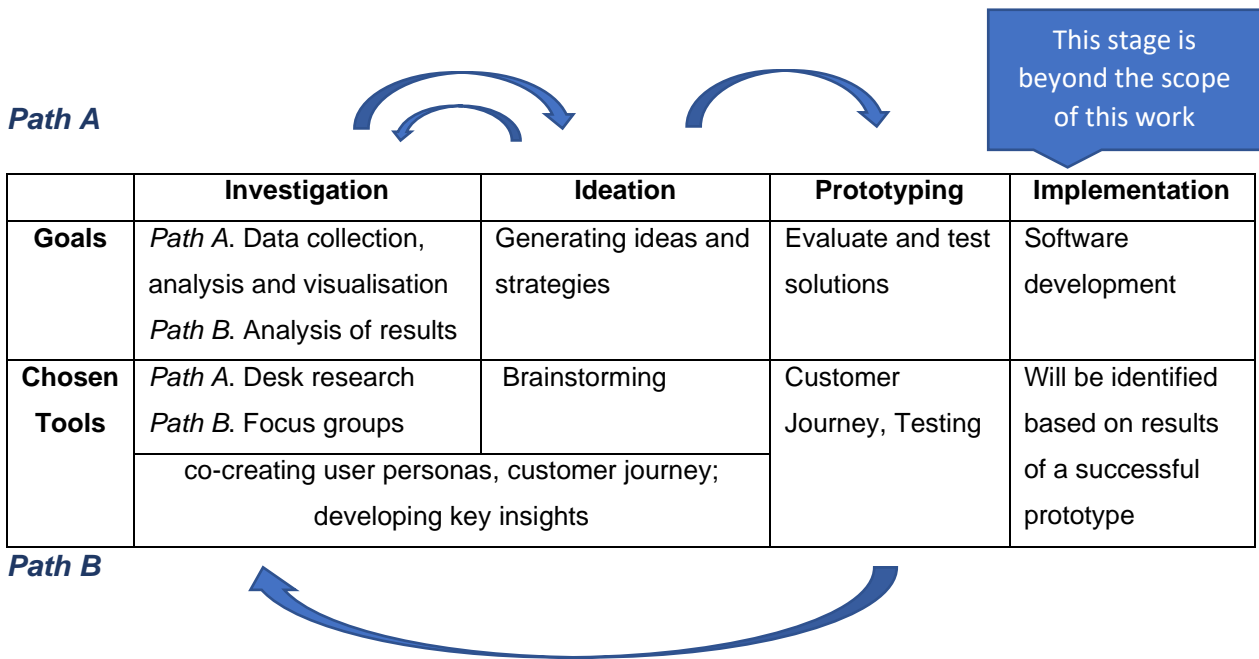
3.1.2 Service Design Approach

As the project is aimed at development of an existing service, Service Design Approach will facilitate this process, which suggests the following core stages: investigation (or *desk research*), ideation, prototyping and implementation (Stickdorn, 2018).

Each of the stage has specific goals and, therefore, specific set of tools to achieve intended goals (Table 1):

1. Desk Research or investigation stage – this stage implies user-centred principle of Service Design and is aimed to getting a perspective of a visitor. However, while keeping a visitor perspective, it is also important to identify and include other stakeholders' needs to get a deeper understanding of a projected service.

2. Ideation – this stage iterates with investigation stage, as ideas may come not only during brainstorming sessions, but also during the investigation and prototyping stages which in turn might require extra investigation. (Stickdorn, 2018). In this work the process of ideation is planned to be performed through brainstorm meetings and is aimed to create a prototype that can be later tested in order to find answers to our research questions.

3. Prototyping – this stage is the main focus of this work, as with the help of prototyping and letting visitors use the service it will be possible to understand their behaviour (Stickdorn, 2018) and answer research questions.

4. Implementation – this is the final stage of designing a service, that makes a prototype a "running system" (Stickdorn, 2018). This stage is outside the scope of this work as it requires answering other questions that are not included into current research agenda.

Due to iterative nature of Service Design process implementation stage will be achieved after several rounds of investigation – ideation – prototype sequence. The process will repeat even after implementation stage is passed. As the number of users will scale and more information for analysis will be available, it will eventually turn the process back to investigation stage to achieve continuous improvement of the service and keep it relevant. To answer given research questions, initial circle *investigation – ideation – prototype – investigation* will be used (Table 1). *Implementation stage* and further rounds of service development are outside the scope of this research.

Table 1. Research Development

Path A

	Investigation	Ideation	Prototyping	Implementation
Goals	*Path A.* Data collection, analysis and visualisation *Path B.* Analysis of results	Generating ideas and strategies	Evaluate and test solutions	Software development
Chosen Tools	*Path A.* Desk research *Path B.* Focus groups	Brainstorming	Customer Journey, Testing	Will be identified based on results of a successful prototype
	co-creating user personas, customer journey; developing key insights			

This stage is beyond the scope of this work

Path B

3.2 Data Collection

Service Design approach allows us to use variety of tools and methods. By applying several methods, we can achieve a deeper understanding of the researched topic as well as confirm our findings from different sources. A research based on a combination of several methods originated from a concept of triangulation (Denzin, 1978) and is a recommended way of carrying out Service Design research (Stickdorn, 2018).

Different tools and methods offer, in turn, various data for creating a service. Generally, data is divided into *primary and secondary*, depending whether a researcher collects it himself or analyses researches implemented by others (Stickdorn, 2018).

As in this case, the research process is divided into two stages - preparatory and main stage, the approach to data collection is a combination of *primary and secondary data*:

- *Preparatory stage* will be carried out as a descriptive research of the market and customers. During market research successful use cases of other museums, that have implemented AR technology will be collected, which is a source of *secondary data.* It will be done in order to learn from their experience and gather useful insights. During preparatory stage we will also describe customer journey for Aviation Museum.

- *Main stage* of the research will be performed using both quantitative and qualitative methods -interviews and focus groups, which are sources of primary data.

In data collection process it is important to define sample selection, or parameters of selected audience, such as age, occupation, behavioural characteristics and many more. It is done to avoid "sampling bias" (Stickdorn, 2018), which can be characterised, for example, by too narrow age group (Stickdorn, 2018). As museum's two main target customer groups are characterised by age (parents, children and elderly male visitors), it is planned to include representatives of three age groups. Thus, focus-group will involve children, adults and senior visitors.

Considering sample size, the best practice is to choose a sample which will define a trend, where any subsequent research will only confirm that trend. Then we know that we have reached "theoretical saturation" (Stickdorn, 2018). Therefore, it is planned to use a sample of 30 people among them 10 children, 10 adults (parents) and 10 senior visitors. In case the trend will not be identified, or the target audiences will equally share their opinions about research questions, the sample should be increased and the research should be continued.

3.3 Developing Themes for Focus Groups and Questionnaire.

When developing a research tool, a mix of qualitative and quantitative methods were decided to be used, such as Focus Group Interviews followed by a Questionnaire, for several reasons:

1. Each research method has its own advantages and disadvantages and separately can lead to a certain level of bias, for example answers might be affected by the personality of an interviewer or just by the fact of being observed, also known as Interviewee or Response bias. (Stickdorn, 2018), (Saunders et al., 2019, p. 437).
2. According to method of triangulation a researcher identifies better own position (or finds research answers) based on at least two other coordinates (Stickdorn, 2018), in this case, based on two research methods – Focus Groups, which represents qualitative research method and Questionnaire, which represents quantitative research method.

Combined these two methods will help to avoid potential bias and confirm data for better credibility of the research. Using mixed methods will also allow to benefit from advantages of both, such as receive trends form quantitative data and deeper insights about the service from qualitative data.

Focus Groups

Focus groups were chosen as a tool for qualitative research in order to collect insights, which will help us to understand better some of bottlenecks, that visitors might come across while using AR service.

Saunders et al. (2019) refer to Focus Groups as non-standardised, one-to many (or group), type of interview, which usually involves such components as a guiding moderator and objective to discover respondents' perception about researched question (Puchta and Potter, 2004)

Focus Groups are commonly used for such cases as new product development, studies of behaviors, habits, usage, attitudes, motives and idea generation (Greenbaum, 1998).

Focus groups can be formed based on individual characteristics, such as culture, social status, age, ethnicity, gender, personality, etc. (Fern, 2001). For the purpose of this work such characteristics as age, gender and having children were considered to compose two types of Focus Groups – Families with Children and Senior Males.

As a form of interview Focus Groups can be categorized according to the following chart (Figure 17).
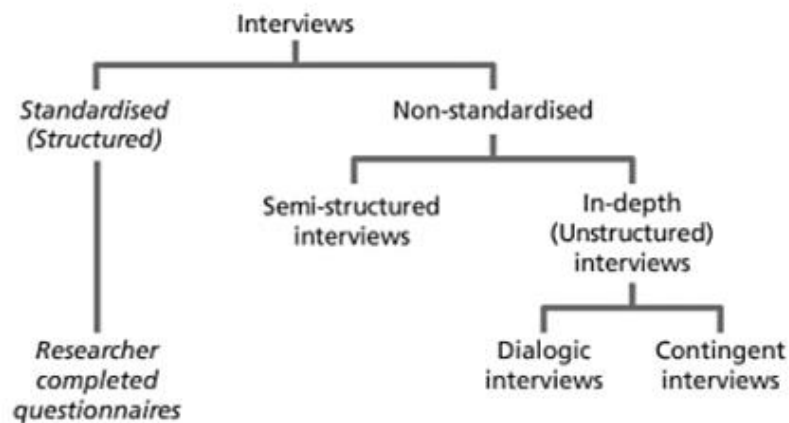
Figure 17. Interviews Classification. Source: Saunders et al. *2019, p. 437*

For the purpose of this work Non-standardized Semi-structured type of interview was chosen. Unlike Standardized type of interview, which supposes a strict use of a previously developed questionnaire and has a quantitative nature, Non-Standardized interview has a qualitative nature, suggests a guiding list of questions and offers more room for conversation, sharing opinions and delivering insights (Saunders et al, 2019, p. 437).

Semi-structured type of interview helps best to test a theory (or hypotheses) as well as discover new facts (Saunders et al., 2019, p. 437). Unlike In-depth interview which explores a topic or an event in broader scope, the scope of this work is bounded by specific hypotheses that we are aiming to test.

Focus Group interview themes and questions were developed based on two main research questions of this work:

- RQ 1. Is there a demand for AR technology among visitors of Aviation Museum?
- RQ 2. How likely are visitors to download the application when visiting the museum? Will there be a need to invest in tablets or AR mobile application is enough?

Table 3. Focus Groups themes and questions, developed based on Saunders et al. (2019, p. 515)

Themes and Questions	Variables	Goals and Research Questions	Relation to key concepts
1.Mobile Apps and AR technology – difficulties to download and use. (Were you able to download the App and see Augmented Content?)	Behavior	How likely is a visitor group to download an AR App? (RQ 2)	Service Design Principles, Customer Journey
2. Preferred Customer Journey of a visitor group. (Was it easy to download?)	Behavior	Will tablets be required or mobile App is enough for this visitor group? (RQ 2)	Customer Journey, Service Design Principles
3. Fluency of a visitor group with mobile apps (Have you downloaded any museum or exhibition Apps before)	Behavior	Is this visitor group intuitively familiar with mobile Apps in general? (RQ 2)	Customer Journey, Service Design Principles
4. Current awareness and fluency of a visitor group with AR technology. (Have you already used AR?)	Opinion/ Attitude	Is this visitor group intuitively familiar with the AR technology? (RQ 1)	User Persona, Customer Journey, Service Design Principles
5. Demand (What do you think about AR? Did you like it? Would that be an interesting option for visitors?)	Opinion/ Attitude	Will AR technology be in a demand among current visitor group? (RQ 1)	User Persona, Customer Journey

Questionnaire

Self- Completed Questionnaire is a great tool to collect quantitative data and avoid interviewer and response biases, described earlier, as it provides same questions in the same conditions and excludes bias connecting to the tone of voice of an interviewer or environment changes. (Saunders et al., 2019, p. 504).

Quantitative types of research are often used for "finding and fixing usability problems and describing the usability of an application using metrics" (Sauro and Lewis, 2012).

However, at the same time the limitation to this method is absence of opportunity to ask additional questions and find real motives behind an answer. (Saunders et al., 2019, p. 504). This fact imposes a lot of responsibility on the quality of questions, whether they are able to describe a phenomenon and how well.

To ensure that required data can be collected by a questionnaire extensively, it was decided to use a guide, offered by Saunders et al. (2019, p. 514):

1. Identify whether the research is descriptive or explanatory
2. Develop investigative questions using aims, objectives and research question
3. If investigative questions are not precise enough, they should be repeated
4. Develop variables for investigative questions
5. Develop the level of deepness for each variable
6. Identify measurement questions (Saunders et al., 2019, p. 514)

Table 4 Questionnaire themes, adapted from Saunders et al. (2019, p. 515)

Research aim/objective/questions: To identify whether there is a demand among visitors for an AR technology and whether they will be able to download and use a mobile application/ will tablets will be required				
Type of research: Descriptive				
Investigative questions	**Variables**	**Detail in which data measured**	**Relation to key concepts**	**Measurement questions**
Was it easy it to download the AR App?	Behavior	Able to download and view/Not able to download and view	Customer Journey, Service Design Principles	From 1 to 5 Very Difficult/ No problem downloading the App

How interesting was Augmented Reality experience for you?	Opinion	AR app Should be implemented/Shouldn't be implemented	User Persona, Customer Journey, Service Design Principles	From 1 to 5 I prefer to keep it simple, without extra equipment/ I enjoy new technologies, it was an interesting experience
Would you like to see more exhibitions with AR objects in Aviation Museum?	Attitude	Enjoyed/ Disliked	User Persona, Customer Journey, Service Design Principles	From 1 to 5 No, I don't want any extra downloads/ Absolutely! There is a lot of potential in it
Would you recommend this exhibition to your friends?	Attitude	Enjoyed/ Disliked	User Persona, Customer Journey	From 1 to 5 No, I didn't like it/ Sure! Some of them might be interested
Your gender	Demographic	Male/Female	User Persona	Male/Female/ Don't want to answer
Your age group	Demographic	Family with kids/Seniors	User Persona, Customer Journey	Age groups
Is there anything else you would like to share with us about your experience?	Opinion	AR app Should be implemented/Shouldn't be implemented	User Persona, Customer Journey	Open-end question

3.4   Data Analysis

Due to the nature of the research which combines quantitative and qualitative data, it was decided to use the following concepts for data analysis:

1. Quantitative data will be analysed with the use of an approach of Exploratory Data Analysis (EDA). "This approach emphasises the use of graphs to explore and understand your data" (Saunders et al., 2019). The approach also implies the use of research

questions and objectives (Saunders et al., 2019). Therefore, quantitative type of data, received from Questionnaire (primary source), will be analysed from the perspective of research questions for each of targeted audiences separately for further comparison, and confirmed with qualitative data analysis method.

2. Qualitative data in this work consists of primary source (Focus Groups) and secondary sources (Desk Research) and is being collected to enrich and confirm prior quantitative research. For that purpose, Assorted Analysis is planned to be used which "combines secondary analysis of research data with primary research and/or analysis of naturalistic qualitative data" (Heaton, 2004). This method is often used when it is necessary "to provide additional comparative or collateral evidence using different sources of data" (Heaton, 2004).

In this work results, obtained from quantitative data analysis of the Questionnaire will be compared to Focus Groups results, local and global museum analysis and customer journey map in order to confirm the trends and get credible outcomes.

4   Implementation and Analysis

4.1   Investigation (or Desk Research)

The implementation of the project starts with the preparatory research (or desk research). Desk research represents open sources search and will provide valuable insights of how Augmented Reality is adopted by direct and indirect competition. Museums will be considered on the local and global levels in order to get an understanding from different angles:

- *local museums* will be investigated to analyze how AR technology was implemented in order to compare this information to the subject of this work.
- On the other hand, *globally*, museums that have implemented AR technology and shared this experience in peer reviewed articles will be analyzed with the perspective of research questions. Additionally, valuable insights will be collected to be used for designing the prototype for Aviation Museum.

Desk research starts with Immersion Canvas, that helps to guide the research and summarizes main areas of focus (Figure 10), which will be discussed later in the following chapters.

IMMERSION – To know where you are and to build on top of others work.

Your best guess of the customer's problem

Educational purposes:

- Educating themselves and their children about the topic
- Better and more interactive approach to education / gamification
- How an object is made (ex. What is inside an airplane (engine, etc)
- How an object was used
- Deeper historical context around the object
- Looking for entertaining content
- Looking for WOW-factor

Alternative solutions from the customer's perspective

- Guides
- Description boxes
- Video content (monitors next to an object)
- Demo-objects
(All of these is already implemented in the museum)

Competitors within our business domain :

Museums in Finland that have already AR exhibitions:

- Digimuseo
- Finnish National Gallery Ateneum
- HAM
- Amos Rex
- Tuusula
- Fiskars Village

Museums in Worldwide that have already AR exhibitions:
- Casa Batlló Museum, Spain
- Leventis Museum in Nicosia, Cyprus
- Royal Ontario Museum
- Athens Numismatic Museum, Greece

Hottest start-ups:

- https://www.guidigo.com/ar?lg=en
- https://www.museum-solutions.com/en/functionality#augmented-reality
- https://overlyapp.com/augmented-reality-solutions/museums-art-exhibitions/
- https://www.wikitude.com/store/
- https://unity.com/unity/features/ar

How could current business be disrupted:

- Virtual tours
- Virtual Reality Museums
- On-line/Virtual Museums
- Museums in Virtual Glasses

Hot names, known experts, people to listen to:

- Steve Wozniak
- Simon Moores
- Nicholas Thompson

Inspiring services & products:

https://www.wikitude.com/blog-augmented-reality-museums/

https://arilyn.com/

https://sparkar.facebook.com/ar-studio/

https://artivive.com/

futurice   LEAN SERVICE CREATION

Public debate around the topic:

Charlotte Coates' (Coates, 2019) "How Museums are using Augmented Reality".

Miranda Katz (Katz, 2018) "Augmented Reality is Transforming Museums"

Questions:
• Who owns virtual space?
• Can museums avoid "trespasses" on their virtual space?"
• or Should museums embrace unauthorized augmentations and make the most out of it?

Figure 10. Immersion Canvas. Adapted from futurice.com

4.1.1 Analysis of AR Implementation in Local Museums

As the major focus of this work is to understand whether visitors of Aviation Museum will be interested in the AR application (or whether there is a demand for this service) and will

they be able to use AR application on their smartphones, the following aspects will be investigated:

- Which museums in Finland are already using AR technology?
- What kind of devices do they suggest to use for viewing augmented objects? Whether they require visitors' own devices (such as smartphones) or do they provide tablets, AR masks, etc.?
- Do they require visitors to download an AR app on their devices? And what kind of instructions do they provide for visitors. Whether it is clear for visitors how to use AR service.

Table 2. Comparison of AR service instructions in Finnish Museums

Museum or exhibition	What type of device is required	Need to download a special app	Instructions are provided on website	Additional information
Digimuseo	Smartphone, tablet or computer	No, as they offer exhibition using WebAR, browser-based AR. The visitor needs to open required AR exhibition from museum's website	No, only usage of devices (smartphone, computer, tablet) is briefly mentioned in FAQ section. Visitor is led on museum's website through several links	Digimuseo also recommends a high-speed internet connection on visitor's device. It reminds more of VR experience rather than AR
Finnish National Gallery Ateneum in partnership with Helsingin Sanomat	360° experience is available on all devices	yes	Yes, in a form text, video presentation is also provided, as well as direct links (buttons) to AppStore and Google Play (Appendix 1)	

HAM, Helsinki Art Museum	Suggest to use mobile phones to download the application	yes	Yes, instructions are given as text, accompanied by picture (Appendix 1)	
Amos Rex and Danske Bank	Mostly focused on mobile phones	yes	Yes, instructions are given as text along with AR object icon. Additionally, a map with AR objects is provided (Appendix 1)	AR objects can be also scanned from flyers, window stickers and coasters at surrounding cafes
Tuusula	Smartphone, tablet or computer. No AR app is needed	No, as they offer exhibition using WebAR, browser-based AR. The visitor needs to open required AR exhibition from museum's website.	Instructions are not provided; however, visitor is led on museum's website through several links. (Appendix 1)	It also reminds more of VR experience rather than AR
Fiskars Village	Mostly smartphones are targeted	yes	Not available on the website.	Instructions are given only on information stands around village, no prior explanations

Museums in Finland (mostly in Helsinki) have actively started implementation of AR technology in their temporary and permanent exhibitions. Most of them use the same logic – AR application is supposed to be downloaded on visitor's device, predominantly,

smartphones. In order to accustom visitors with the new technology most of the museums give written instructions accompanied with a picture, video or map of the museum where AR icons are located.

The most detailed and understandable instructions were provided by Finnish National Gallery Ateneum. This museum accompanied text instructions with a short video, which makes it understandable for a visitor, who is not accustomed with AR technology. This simple and short presentation may answer potential questions and can help in taking decision to download an application.

4.1.2   Use Cases of AR Implementation in Museums Globally

Looking into experience of other cultural heritage museums on a global level gave valuable insights and, to some extent, helped to resolve some of concerns, stated in research questions. They will be taken into consideration for creating augmented content and customer journey for Aviation Museum visitors.

Casa Batlló Museum, Spain (Gimeno et al., 2017) respondents appreciated the opportunity to see something that doesn't exist anymore with the help of AR. It was also discovered that visitors enjoyed animations the most, which kept them more engaged with an exhibit as they replayed animations for several times. Users of TombSeer, Digital Cultural Heritage application at the Royal Ontario Museum (Pedersen et al., 2017) noted that their attention was focused on the details of exhibits (old furniture elements).

Leventis Museum in Nicosia, Cyprus (Kyriakou, 2018) discovered that around 80% of respondents enjoyed their AR application experience and the majority of them (around 70%) were willing to install it. Willingness of visitors to install an AR application on their mobile devices is one of the most important aspects that currently rises concerns and needs to be tested in Aviation Museum.

Their experiments also showed that it takes about a minute for visitors to figure out how to use the application. After that their customer journey was pleasant and intuitive (Kyriakou, 2018).

Similar focus was in the centre of attention of Royal Ontario Museum (Pedersen et al., 2017). They also noticed that at the beginning visitors were confused about how to operate their AR application and a group that was left without any instructions disregarded it at all. Therefore, (Van Der Vaart, 2014) stresses on clear and user-friendly type of instructions that will motivate visitors to use the application.

Athens Numismatic Museum, Greece (Chasapis, Mitropoulos and Douligeris, 2019) found that visitors were not willing to pay for a museum application and expected it to be free of charge, however, if the application involves a guided tour, visitors would perceive it as a good enough value to pay for it.

4.1.3   Risks connected with Augmented Reality implementation in Museums

Some of the risks were very well described by Charlotte Coates' (Coates, 2019) in her article "How Museums are using Augmented Reality". As a first risk she mentioned how PAMM art museum in Miami had concerns that high immersion level in the technology will lead to customer's isolation and losing part of what artist wanted initially to achieve. However, in reality at their exhibitions with AR technologies people were sharing screens and discussing, sometimes even strangers were involved.

Another concern of PAMM was older people who might struggle and feel left out because of the new technologies, however PAMM curators were surprised to discover that one of the target groups - people aged 55+ reported that they had a positive experience using AR.

Charlotte Coates (Coates, 2019) also mentions cases of unauthorized augmentations, when visitor, upon downloading the app saw guerrilla artists' works - initial works in AR were vandalized. This happened to MoMAR Gallery in New York.

Another example of unauthorized augmentations was described by Miranda Katz (Katz, 2018) in her article "Augmented Reality is Transforming Museums" for wired.com and it concerned unofficial tours in AR in galleries and museums.

Now, with a rapid development of AR and appearance of different platforms, it became easy to create AR objects. With this in mind Miranda Katz (Katz, 2018) in her article raised very important questions:

- Who owns virtual space?
- Can museums avoid "trespasses" on their virtual space?"
- or Should museums embrace unauthorized augmentations and make the most out of it?

Virtual trespassing is a very poorly researched and described topic, however, with the future development of this technology it will be a necessity to describe from the legal point of view the boundaries of putting an AR object on someone's physical property.

4.1.4 User Personas

As for Aviation Museum, the management distinguishes two largest B2C target audiences – families with children (which is a common largest audience in museum industry) and senior males, as they are usually the ones interested in history, World War II, mechanics and aviation.

Both of target audiences have different needs and motives for visiting the museum. A closer look to both of the audience is represented in Figure 11 and Figure 12 – Persona Canvases.
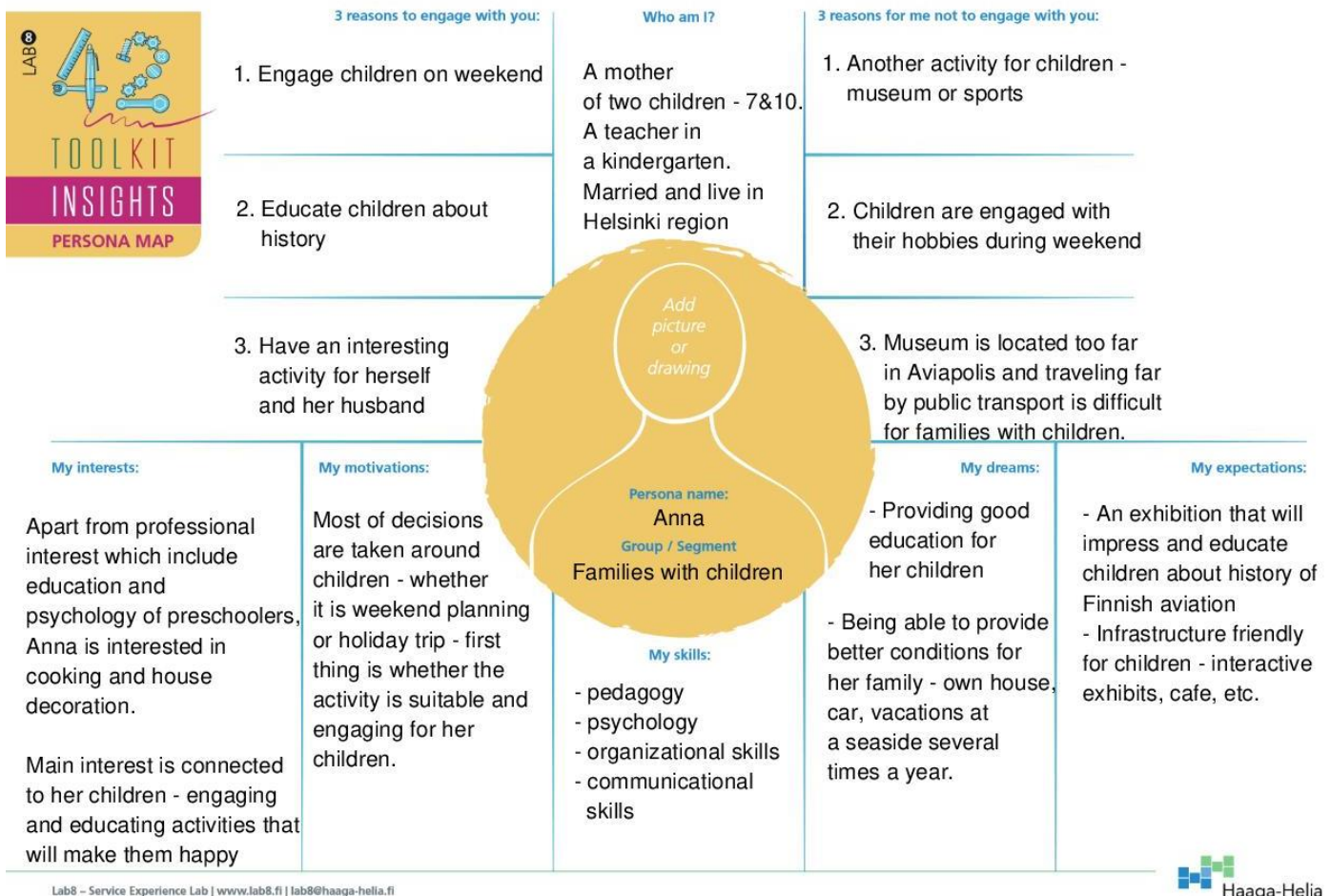
Figure 11. Persona canvas "Anna", audience "Families with children". Adapted from lab8.fi

For target audience "Families with children" persona "Anna" was used. From that canvas we can see that main motivation for Anna is meeting the needs of her children. She will be looking for family activities which are interesting and interactive enough for her kids. She will also pay attention to whether the infrastructure of the museum is appropriate to visit

with children, for example, there is a café or restaurant that can offer food options suitable for children.

Anna also wants a family activity to be meaningful and offer an opportunity to learn something new for her children. That is why museums offer a great activity option for her family.

Second largest target audience is senior males, represented by Persona Canvas "Alex".
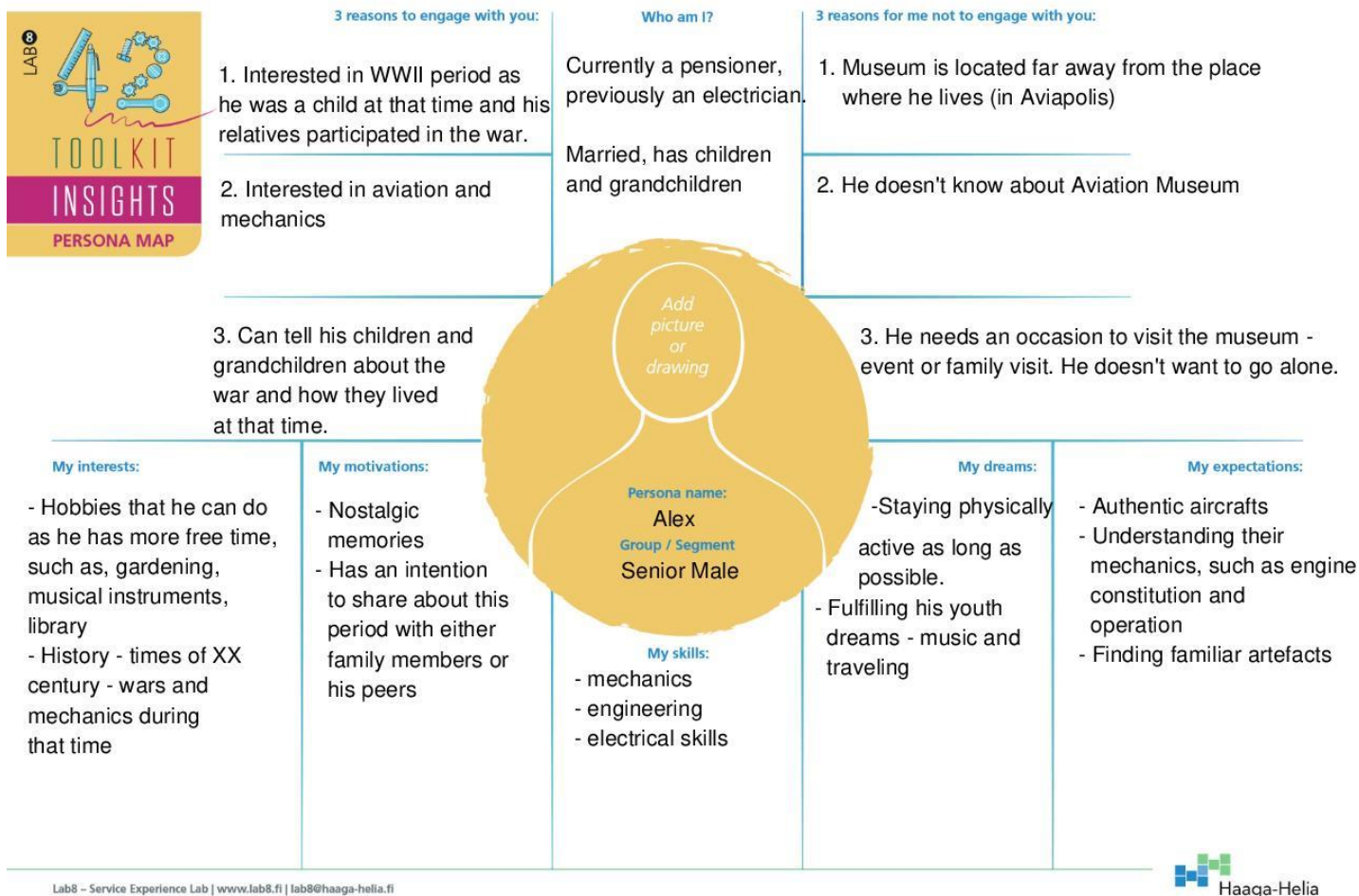
Figure 12. Persona canvas "Alex", audience "Senior males". Adapted from lab8.fi

Unlike Anna, Alex is motivated by his own interests, in particular in history of World War II or aviation. This era represents interest to him as he was related directly or indirectly (as most of his generation) to the events of the WWII. He might have family members participating in the war and can have a broad knowledge about this topic. Aviation museum can provide a lot of information for Alex as it offers extensive collection of aircrafts and other artifacts (aviation-related clothes and accessories, photographs and

videos). Another motif for Alex to visit Aviation Museum is being able to share his knowledge with his peers, children or grandchildren.

For Alex, a visit to Aviation Museum involves also emotional element. For him a mix of emotions – good, bad, nostalgic will be a motif to visit the museum.

4.1.5 Customer Journey

Focus groups are planned to answer main research questions of this work, however, they offer far more potential information about the future service. Focus group will let us observe of how visitors will actually use the application (first prototype) and identify first bottlenecks for improvement. Visitors will also be given an opportunity to share their experience with the help of open questions that will provide a source of valuable insights for developing this service. Therefore, prior planning and developing Customer Journey Maps can help us to get maximum benefits from this research.

 At the current stage we don't know whether the museum shall invest to the AR technology, and if yes – would it be a mobile application or a tablet. However, for both scenarios we can obtain valuable information from the feedback of focus group members, as well as from observation of their customer journey.

Both Customer Journey maps were developed based on User Personas "Anna" and "Alex", which are representatives of two main target audiences of the museum – Families with Children and Senior Males. Previous experience described by museums worldwide in peer reviewed articles also provided a source of valuable ideas, such as importance of providing clear instructions. According to Royal Ontario Museum (Pedersen et al., 2017) visitors, that were left without clear instructions disregarded AR application at all. Other museums noted also that at the beginning visitors are confused with what shall they do, however, after about a minute they are able to figure out the mechanism and rest of their journey remains pleasant and interesting. More about instructions will be discussed in chapter 4.2 Prototype.

Customer Journey for "Anna" (Figure 13) showed that she is proactively looking for engaging activities for her children and as she might be distracted by them at the museum, it is necessary to make instructions for the mobile application as short and clear as possible. A combination of infographics and short written description can be used for this purpose. Additionally, a member of staff at the ticket office can provide a brief introduction and a flyer.

As the museum doesn't provide Wi-Fi in both halls of its exhibitions, it was decided to share mobile Wi-Fi for these purposes if anyone needs it in order to ensure smooth operation of the mobile application.

Additionally, during focus group interviews it is necessary to resolve some of "Anna's" concerns about whether children are hungry and whether they will demand her attention. A small snack with coffee, tea, pastries, candies and juice for children as well as colouring books and pencils can be provided to distract children and help "Anna" concentrate. A small snack for parents can also help to create a calm atmosphere for a successful focus group interview.
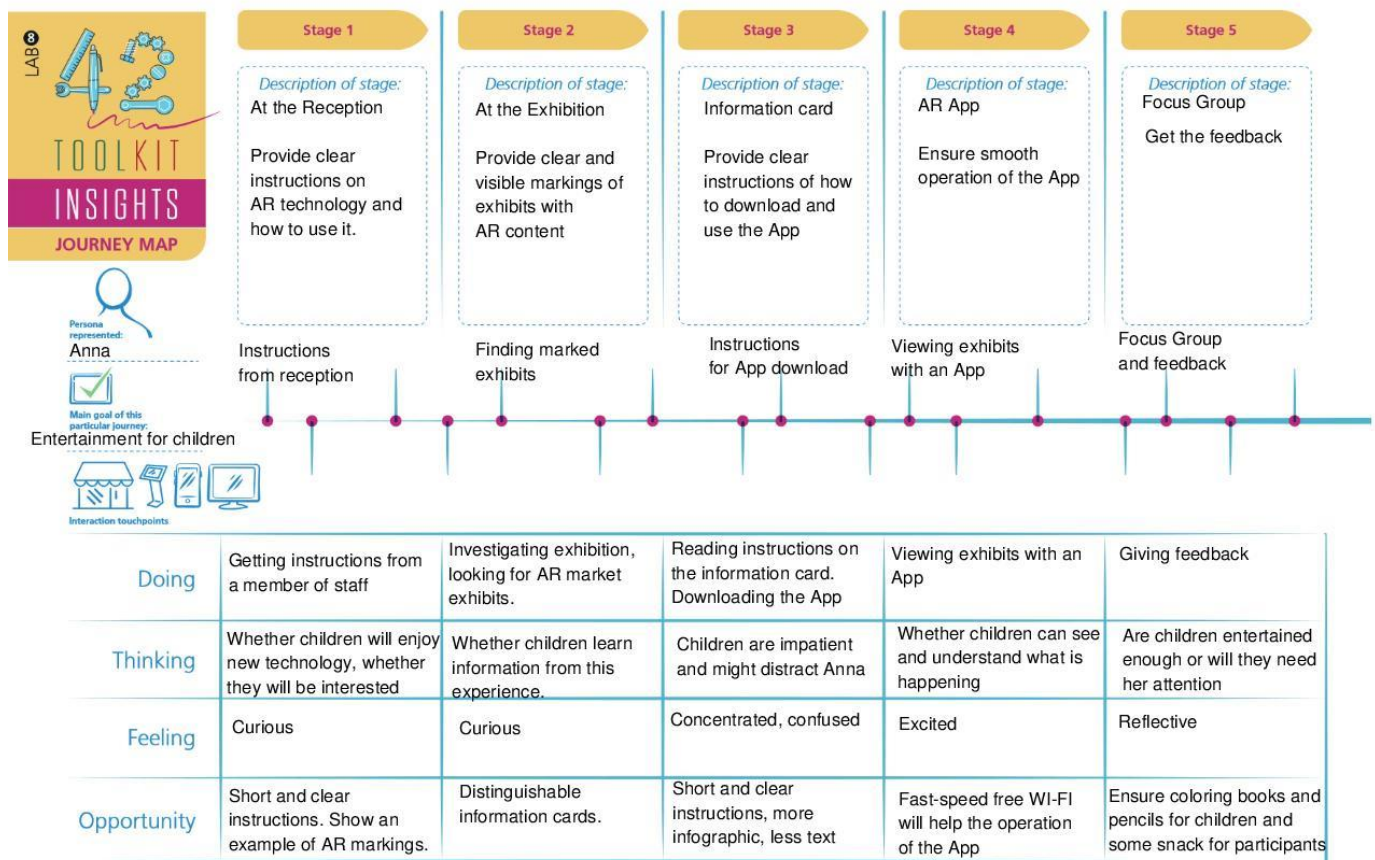

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Description of stage:	At the Reception. Provide clear instructions on AR technology and how to use it.	At the Exhibition. Provide clear and visible markings of exhibits with AR content	Information card. Provide clear instructions of how to download and use the App	AR App. Ensure smooth operation of the App	Focus Group. Get the feedback
	Instructions from reception	Finding marked exhibits	Instructions for App download	Viewing exhibits with an App	Focus Group and feedback
Doing	Getting instructions from a member of staff	Investigating exhibition, looking for AR market exhibits.	Reading instructions on the information card. Downloading the App	Viewing exhibits with an App	Giving feedback
Thinking	Whether children will enjoy new technology, whether they will be interested	Whether children learn information from this experience.	Children are impatient and might distract Anna	Whether children can see and understand what is happening	Are children entertained enough or will they need her attention
Feeling	Curious	Curious	Concentrated, confused	Excited	Reflective
Opportunity	Short and clear instructions. Show an example of AR markings.	Distinguishable information cards.	Short and clear instructions, more infographic, less text	Fast-speed free WI-FI will help the operation of the App	Ensure coloring books and pencils for children and some snack for participants

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Figure 13. Customer Journey "Anna", audience "Families with Children". Adapted from lab8.fi

Due to Coronavirus restrictions, museum representatives had worries about carrying out focus group for Seniors and suggested to replace group visits with individual visits, followed by a questionnaire to fill in. With new restrictions in mind a customer journey for "Alex" was developed.

It is expected in the Customer Journey Map that Seniors might not be very fluent with mobile phones, besides, some of them might not use smartphones at all. Therefore, all Seniors are supposed to be accompanied and offered a mobile phone with previously installed AR application in case of necessity. This experience will be similar to using a tablet in the museum.

Another conclusion from "Alex's" Customer Journey Map is that due to poor vision of many people in this age group prefer larger symbols and signs, therefore, it was decided to develop a larger (A4 - format) information card with large enough font and infographics in order to adapt it to this age group.

For both groups of interviewees safety measures are planned to be organised, such as masks and sanitizers.
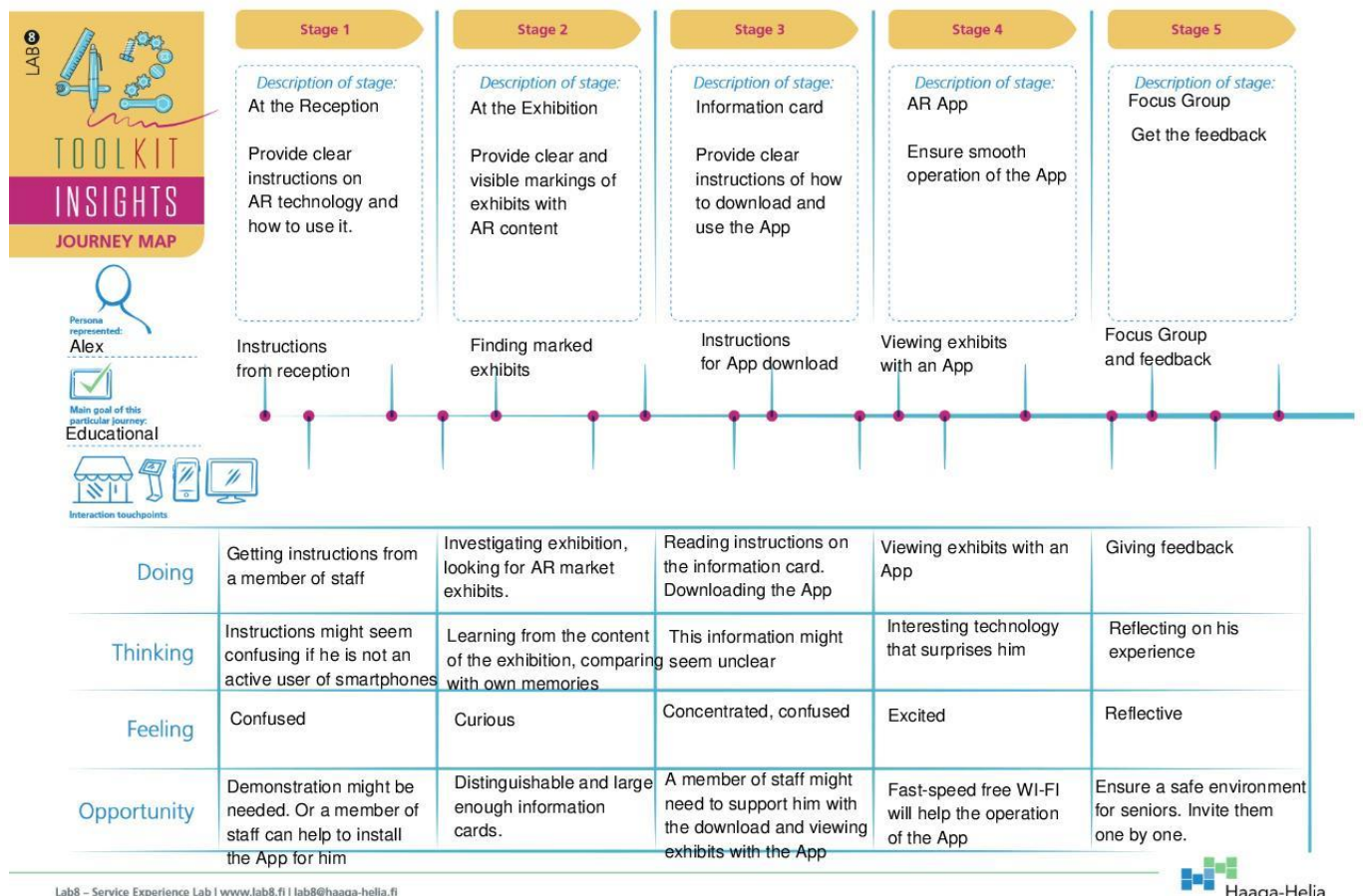

Figure 14. Customer Journey "Alex", audience "Senior males". Adapted from lab8.fi

4.2   Prototype

Desk Research, followed by research of AR technology, its providers and developers were implemented for the first prototype. Following the goals of this work, the focus was

made only on basic features that can ensure a demonstration of AR technology to visitors and be simple enough to implement without coding skills.

Besides the technology, it was also important to develop clear and simple instructions for visitors. Taking into consideration previous Desk Research, we had an opportunity to compare how other museums developed their mobile application instructions and chose best practices for development of current information card. Also, valuable insights for development of information card were obtained from User Personas and Customer Journey Map.

Combined this information helped to develop a prototype of the service that can be tested among targeted audiences and provide answers to research questions as well as valuable insights for the later stages of AR application development.

4.2.1 Choice of a prototype technology and provider

Amanda Edwards-Stewart (Edwards-Stewart, Reger and Hoyt, 2016) suggested one of the most complete classifications of AR technology, where she distinguishes Triggered and View-based categories. Each of the categories fall into several types depending on the purposes of use. The types are: Marker-based (also knowns as recognition-based), Location-based, Dynamic augmentation, Complex Augmentation, Indirect Augmentation and Non-Specific Augmentation (Figure 15).

Category	Type	Examples	Characteristics
Triggered	1a. Marker-based: Paper	String (string.co) Blippar (blippar.com)	Paper marker activates stimuli.
	1b. Marker-based: Object	Aurasma (aurasma.com)	Most objects can be made into markers.
	2. Location-based	Yelp (yelp.com) PAJ (t2health.dcoe.mil/ positiveactivityjackpot) Instagram (instagram.com)	Overlay of digital information on a map or live camera view. GPS may activate stimuli.
	3. Dynamic Augmentation	Video Painter (itunes.apple.com/us/app/video-painter/id581539953?mt=8) Swivel (Motion; facecake.com)	Meaningful, interactive augmentation with possible object recognition and/or motion tracking.
	4. Complex Augmentation	Google Glass (google.com/glass)	Augment dynamic view and pull internet information based on location, markers, or object recognition.
View-Based	5. Indirect Augmentation	Wall Painter (itunes.apple.com/us/app/wall-painter/id396799182?my=8)	Image of the real world augmented intelligently.
	6. Non-specific Digital Augmentation	Swat the Fly (inengy.com/swatthefly) Bubbles (virtualpopgames.com)	Augmentation of any camera view regardless of location.

Figure 15. Summary of AR categories and types (Edwards-Stewart, Reger and Hoyt, 2016)

This classification helps us to understand what kind of virtual objects are currently possible and available for implementation and which of them can be implemented for the prototype of Aviation Museum AR Exhibition. After understanding our creativity opportunities, the next step would be understanding of how we can implement our ideas.

AR technology has been adopted well enough and the market now offers a variety of platforms that developers can use to create AR apps. Those platforms usually include all the necessary features for creating an AR application, such as:

- SLAM (Simultaneous Localization and Mapping), this system can be described as a set of algorithms that solve simultaneous localization and mapping problem

- Image recognition – identifies objects, places and images

- 3D recording and tracking – recognition of dimensions and 3-dimensional objects

- Unity Support – creating special effects

- Cloud Support – storage

- GPS Support - geolocation

The platforms, that developers use for creating Augmented Reality applications are known as Software Development Kits (SDK) and currently the most popular of them are Apple's ARKit and Google's ARCore. Among other popular development kits are also Unity, Vuforia and Wikitude.

With the help of SDK, the process of creating an AR-based mobile app became standardized, and is now widely used among AR development agencies. SDKs help AR-based applications to integrate quickly and smoothly with the current infrastructure.

For creating a prototype for Aviation museum, it was decided not to use AR development agency as development of an actual AR application is a much later stage of this process. Instead, in order to investigate targeted audience opinion, it was decided to use simple marker- based technology that is offered by free on-line platforms such as AR Spark Studio (developed by Facebook) or Artivive (AR platform for artists).

Those platforms don't require coding skills and allow to create trigger-based augmented objects very fast. Unlike AR Spark Studio, Artivive is a platform specifically designed for artists and museums and offers tools adapted for an easy creation of AR objects. Additionally, it offers professionally designed instructions and other materials to support an exhibition. This toolset suits best for temporary, pop-up or short-term exhibitions that

are supposed to be developed fast and have an easy change mechanism. There is no need for coding skills or a dedicated developer. An artist or curator without coding skills can create and change AR objects fast and easy. As that concept fits best the purposes and nature of this research, Artivive was chosen as a tool to create prototype of an AR application for Aviation Museum.

4.2.2 Creating a prototype

For this research Aviation Museum offered its main exhibition to choose some of the exhibits and to put AR objects on them. It was decided to use museum's collection of pictures and videos, placed in online library Finna as augmented objects for current exhibits. This way we can enrich an existing exhibit with additional context, provided by augmented pictures of the epoch of an exhibit.

In total, five aircrafts and a model of airport were chosen to complete the first prototype of Augmented Reality exhibition.

Based on the results of previous desk research (which included Museums with AR exhibitions both in Finland and worldwide, User Personas and Customer Journeys) it was noted that:

1. Content:

   - Visitors enjoyed animations more than static augmented objects. Casa Batlló Museum, Spain (Gimeno et al., 2017)
   - Visitors focused most on the details of the exhibitions (old historical pieces of furniture, for example). Cultural Heritage application at the Royal Ontario Museum (Pedersen et al., 2017)

2. Instructions:

   - It takes a minute for visitors to figure out how to download and use the mobile application (Kyriakou, 2018).
   - If no instructions were provided at the ticket office, visitors disregarded the mobile applications Royal Ontario Museum (Pedersen et al., 2017)
   - User-friendly instructions can motivate people to install and use the mobile application (Van Der Vaart, 2014).
   - All of considered Finnish museums used text instructions with intuitively familiar infographics. (Table 2)
   - Some of Finnish Museums provided a special map with AR-marked objects and instructions. (Table 2)

3. Usability:

- Large font is preferred by senior target audience (Figure 14).
- Wi-Fi or a shared mobile internet will be useful to ensure smooth operation of the mobile application (Figure 13).

As a result, videos and moving slideshows were developed as an augmented content. The preference was given to photos that show details of an aircraft, such as switchboard, uniforms of the crew, a picture of lunch of a passenger, or an interior of a last century check-in desk at the airport.

With the help of Artivive online platform, slideshows were added to each of an exhibit respectively and could be viewed with an Artivive mobile application.

For instructions an information card was developed in an A4 format with large infographics and text instructions on how to use the mobile app. It was important to have an intuitively familiar infographic icons of a mobile application stores, understandable icon of mobile phone and a commonly used icon of a picture.

In instructions the number of steps was limited to three in order to keep it as simple and informative as possible with minimum information that can confuse visitors. It is expected to be beneficial especially for families with children, when children can distract parents from reading thoroughly through the information card (Figure 16).

It was also decided to complement information card with a brief explanation of the service at the ticket office before entering the exhibition.

As the museum had a free Wi-Fi only at the foyer, ticket office and cafeteria, it was decided to offer a shared mobile Wi-Fi for those visitors who might need it.

Two mobile phones with pre-installed AR application were prepared in advance mostly for Senior audience, but would be offered to anyone who would require it.
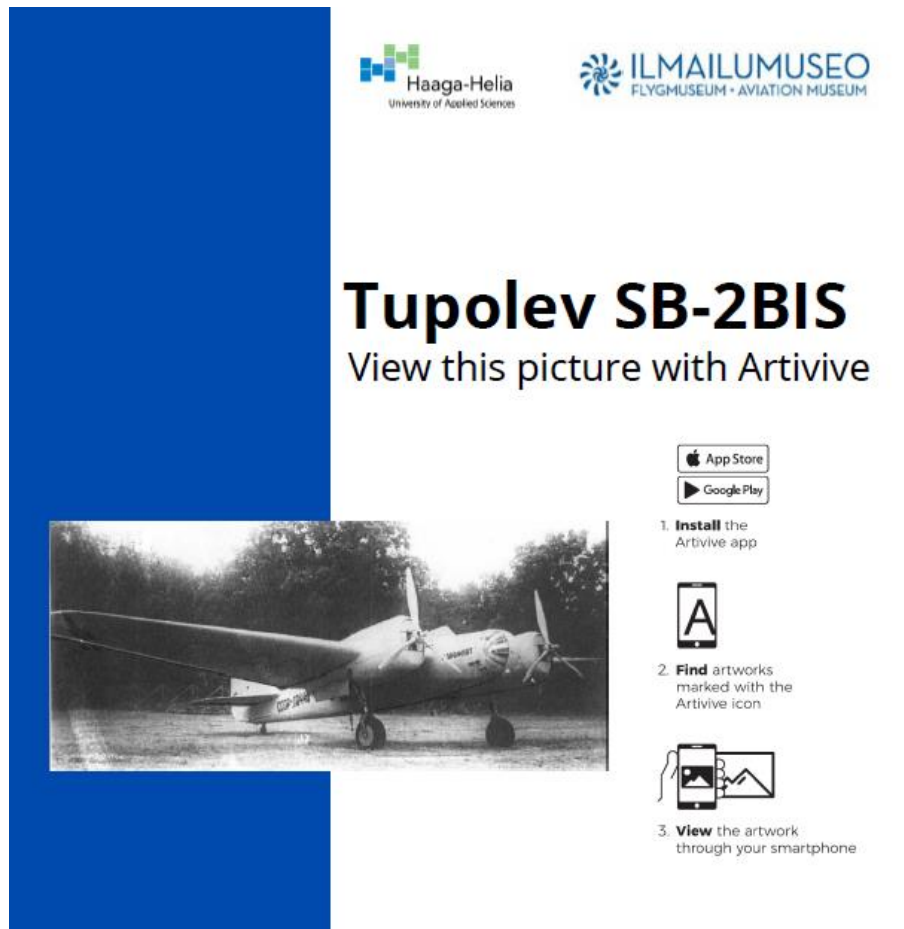
Figure 16. Example of an Information Card

4.2.3   Forming and Implementing Focus Groups and Interviews

A sample chosen for implementing Focus Groups and Interview research consists of 30 people. Among them 10 children, 10 adults (parents) and 10 seniors. In case the trend will not be identified among this sample size and opinions within targeted audience will share equally, the research is planned to be continued until the trend is identified.

It was initially planned to have 3 focus groups – two of them for families with children and one for senior visitors. However, the research took place during the Coronavirus Pandemic and certain restrictions were imposed on museums. From August to December, 2020 museums were open and accepted visitors, however, it was advised by the management of Aviation Museum to carry out focus groups only for Families with children, while Senior visitors were supposed to be invited individually and interviewed with the help of self- completed questionnaire in order to protect this group of people, which is considered as a risk group.

In fact, from September to December it was possible to carry out only two focus groups for families with children in the museum. Two times focus groups were cancelled as not many families were willing to visit public places.

We were also not able to invite Senior visitors to the museum as by that time the second wave of Coronavirus started and museums, among other public institutions were closed. They still remain closed at the time of this writing.

Instead, to collect data from Senior visitors, individual pop-up exhibitions were organised, which represented a temporary exhibition, located outside of the museum, usually in a library or a café (when libraries' working spaces closed due to the Pandemic). For that information cards (Figure 16) were used as exhibits and offered to respondents for viewing with the application. Six cards were developed, in total.

The chosen sample size was enough to answer research questions and identify trends, but during the observation of how families were coping with the technologies, which was not very successful for most of them, the question arose, whether in five years this pattern will still be the case. Therefore, same experiment was also offered to a younger group of people who are in a relationship and either have very young children (around 1 y.o.) or are planning to get married or having children in nearest future. This audience represents a potential "families with children" group in around five years and can offer some insights of whether current research results will be valid for a longer term or not.

The research for younger couples was organised the same way as it was for senior visitors - in a form of individual pop-up exhibitions. Interestingly enough, the results differed a quite lot from our current "families with children" group and it was possible to identify a new trend for the potential "families with children group".

4.3   Analysis

4.3.1   Research Results

Questionnaires, carried out during focus groups and individual pop-up exhibitions were filled in by 40 people in total, which included children (10 people), young couples (10 people), which can project families with children in 5 years, current families with children/parents (13 people) and seniors (7 people).

The last group "Senior Males" was extended to "Seniors" and included females as the research didn't show much difference in behavior between Males and Females (Figure 18), the largest patterns in behavior were noticed between the age groups. Therefore, as

Senior group was the most vulnerable and difficult to compose, it was extended to include females to confirm the trends.
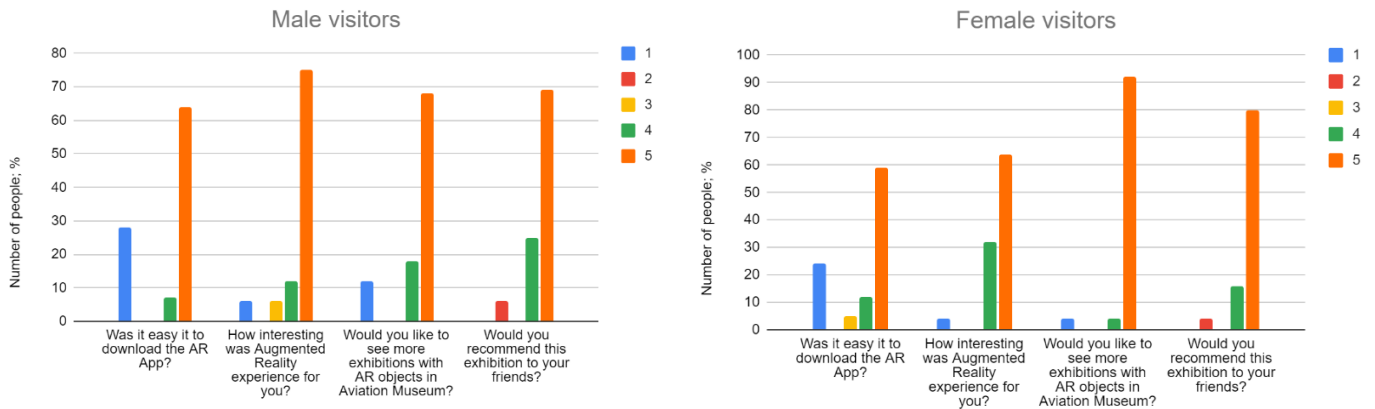

Figure 18. Male (16 people) and Female (24 people) visitors' responses to the Questionnaire

Research Question 1

Considering one of the research questions *"How likely are visitors to download the application when visiting the museum? Will there be a need to invest in tablets or AR mobile application is enough?"* the results showed that in general, for most of visitors (61 %) downloading a mobile phone application (Artivive) was not a problem and it was also relatively easy for 10% of total respondents. However, 26% of respondents declared that they wouldn't manage with downloading the application. All of these respondents belonged to Senior Group.
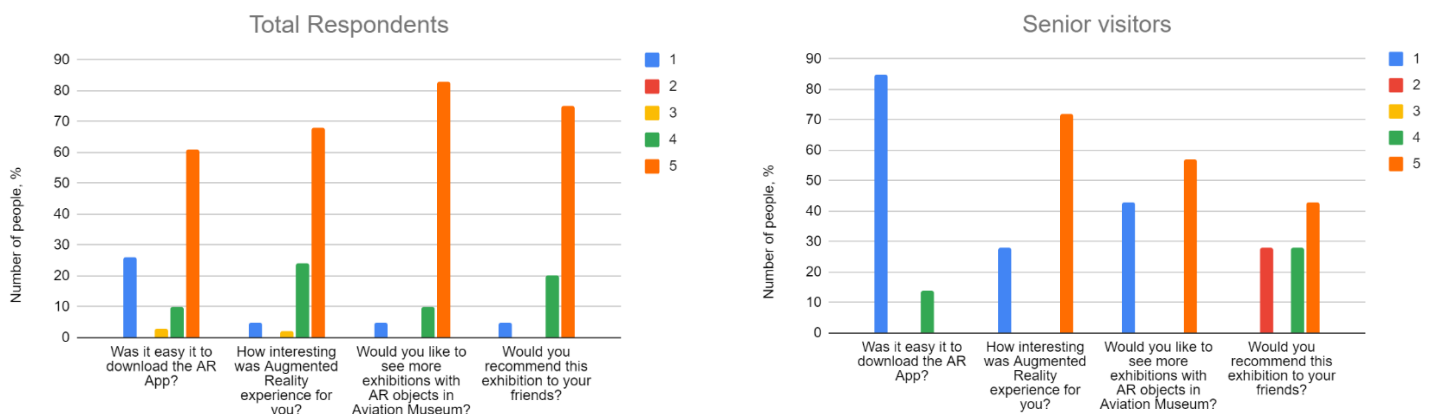

Figure 19. Total Respondents (40 people) and Senior Visitors (7 people) responses to the Questionnaire

From the observation of how **Seniors** were coping with the technology it was clear that even with tablets they will need assistance in a form of demonstration of how to operate it. Once they are able to understand the principle, it was easy for them to continue with the rest of exhibits.

Some of the comments were:

- "Someone has to show me how it works, or I wouldn't be able to use it"
- "I wouldn't even try to install the app myself, there should be some help provided with it."
- "I would recommend it to younger people. Extra information would be interesting. I prefer to use appliances with buttons, something more physical." (Appendix 2)

All of them would prefer a tablet because of a larger screen. AR pictures had quite small details which was not easy for some of them to see on a screen of a telephone.

Other audiences were fine with downloading the application (71%), however, from observation it was clear that **Parents** struggled a little in the beginning, most of them stated that it was because instructions seemed confusing. Some of the comments shared during Focus groups were:

- "We had a bit of trouble starting with the app. We downloaded it onto our own phones and then it said that you have to put the image on screen so what both Chris and I thought is we have to take the display into all that in front of the screen so that to have a photo that wasn't very clear"
- "I would have liked a little icon, that I know I'm downloading the right app immediately"
- I think the instructions could be more explicit – go to Google Play … I mean we know how to download an app, but we don't know how to download the app. "
- "We didn't know what to do with it."
- "I didn't know you have to put it on photograph" (Appendix 2)
- "I would have needed clearer description how to use the app, but with little advice everything went fine" (Appendix 3)

For **Young couples** downloading an app was very easy (90%) or relatively easy (10%). However, they would add either a QR code to make the process faster or an icon of the application to make sure that they download the right one (Appendix 3).

They would use both a tablet or an application, although 2 out of 10 noticed that during pandemic they would rather use a mobile application (Appendix 3).

Research Question 2

Considering the second research question *"Is there a demand for an AR technology among visitors of Aviation Museum?"* it was clear that this service will be in demand – in total 92% of respondents gave 4 and 5 to the question "How interesting was Augmented Reality Experience for you" (where 68% gave 5 and 24% - 4). And for the question "Would

you like to see more exhibitions with AR objects in Aviation Museum" 93% of total respondents agreed that they would (where 83% gave 5 and 10 % - 4).

From the evaluation given by respondents it can be noticed that even those who were not totally satisfied with the current AR experience, would like to see more exhibitions with this technology in future (68% gave 5 for the current exhibition with AR technology vs 83% of total respondents who gave 5 for future exhibitions with AR technology).

As for **Children,** they appeared to be the most loyal audience, who gave only highest rates to the questions about whether they like the current exhibition and whether they would like to see more of exhibitions of such kind. Another interesting fact that Net Promoting Score question of whether they would recommend this kind of exhibition to their friends, 100% of children said yes with the highest rating "5". (Appendix 3) / (Figure 20)
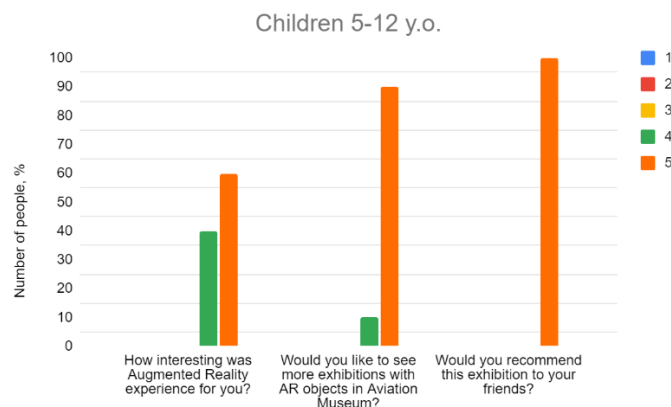

Figure 20. Children (10 people) responses to the Questionnaire

From observation it was obvious that children were quite excited. They also referred to it as a game and were looking for more objects to view with the AR application. Same was also noticed by parents during Focus group discussions. Some of their comments were:

- "kids would do it. Kids would be like "Oh, it comes more, comes more"
- "for this age kids who are used to using mobile, for them, it's actually fun"
- "for them it's more like a game – to go and see more"
- "I agree that kids might be excited using their phones" (Appendix 2)

Young Couples and **Parents** responded very similarly to questions about their interest in Augmented Reality (Figure 21). All of them provided high rankings to questions about how interesting was current exhibition (Young Couples - 70%, Parents – 69%) and whether they would like to see other AR exhibitions (Young Couples – 90%, Parents – 85%). Along with the general trend, both, Young Couples and Parents, who were not totally satisfied

with the current AR exhibition would like to see more of AR exhibitions in future (increase in 20% for Young Couples and 16% for Parents).

Both Parents and Young Couples gave high rankings for Net Promoter Score, however, Parents are more likely to recommend AR exhibition to their friends (Young Couples – 60%, Parents – 85%). One of the reasons to this might be a high interest of children to this technology. And as it was discussed earlier, Parents are driven by their children's interests when it comes to organising leisure time.
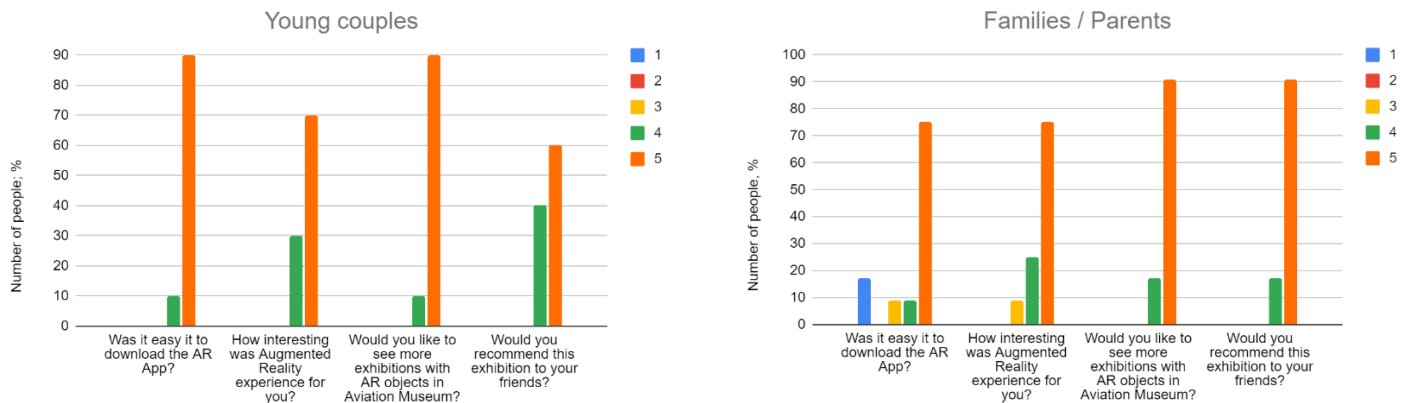

Figure 21. Young Couples (10 people) and Families/Parents (13 people) responses to the Questionnaire

Senior Visitors in general were very interested in the current exhibition (72% gave highest ranking), however the remining 28% (2 out of 7 people) gave the lowest ranking. Two people who gave lowest rankings were in the age group 70+, in fact they are in their early 70s. These and further rankings provided by them were the lowest, which might be an indication that we have found the top limit of age for Senior Visitors audience. It was clear that they couldn't understand the concept of Augmented Reality application. Most probably the reason to it was a necessity to use smartphones. They were not comfortable to use telephones without buttons "I prefer to use appliances with buttons, something more physical" (Appendix 3). Nevertheless, some of their comments were "I would recommend it to younger people" and "Extra information would be interesting" (Appendix 3).

Around 57% (4 out of 7) of Senior visitors would like to visit more exhibitions with AR technology, and on contrary, 42% (3 out of 7) don't want to visit exhibitions where smartphones are expected to be used. It can be connected to the fact that almost all of them were not able to download the application, so most probably they would not be willing to visit exhibition where it is required. From the observation it was clear that as soon as help with a smartphone is provided and it is explained how to see the augmented

content, they find it quite exciting and are able to watch the rest of the exhibits on their own.

Net Promoter Score showed that only 42% on Senior visitors are likely to recommend this experience. As current experiment supposed the use of personal smartphones, most probably Senior visitors will not recommend it to their peers, however, as it was noted above, they would be likely to recommend it to younger generations.
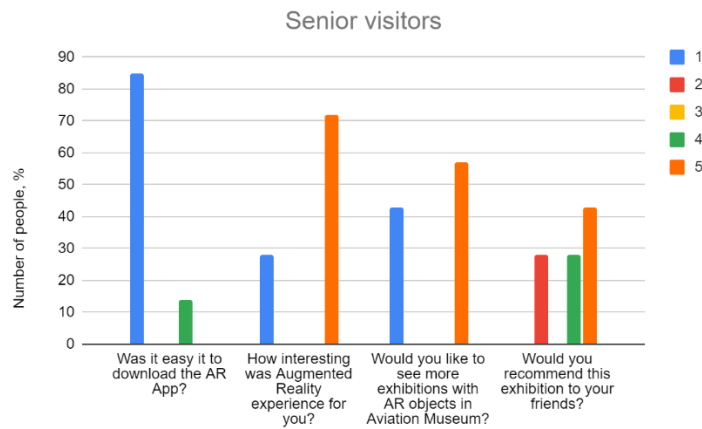

Figure 22. Senior Visitors (7 people) responses to the Questionnaire

Insights

All insights that were received during the research can be divided into two categories – related to content and related to instructions:

1. Content – most of the visitors commented about the content of the prototype. Several people found it inconvenient that only one picture with AR was available per exhibit, which creates a little line when there are several people in front of the same exhibit "when we were more people at the display only one person could have their phone by the picture" (Appendix 2).

Another point brought up by visitors were stories. Three people mentioned that they would like to get more information behind the slideshow "I would love to hear stories, or some history or some writer talking, telling me how the evolution of this particular airplane was", "if you can add to that some either music or even speech, that you can hear a story. For them to look at the pictures and hear the stories would make it more interesting" (Appendix 2). "So much potential! involve graphic design to improve images, add text, e.g. dates and online descriptions" (Appendix 3).

Some of visitors, especially, Parents, would like to see a timer on Augmented content to be able to understand how long will they need to wait or keep children's attention "it would be nicer if the pictures were numbered/time duration" (Appendix 3)

2. Instructions – in general Parents complained more that instructions were not explicit, they would like to have more detailed description of how to download and use the application. Young Couples found it intuitively easier to read and follow the instructions. However, both audiences agreed about having an icon of the application in the instructions "I would have liked a little icon, that I know I'm downloading the right app immediately" (Appendix 2), "Artivive logo can be shown in instructions as it will make it easier to find the App" (Appendix 3),

Three people mentioned using a QR Code "QR code would be better than instructions", "QR code will make it easier to download the App fast", "It is also better to have a direct link, like QR code to the app" (Appendix 3)

One person brought out a concern about the cost of the application "Also, when I read instructions, I thought whether the app is free or how much does it cost." (Appendix 3)

4.3.2 Outcomes

Considering the research questions, it is clear that among Aviation Museum visitors 68% enjoyed current experience and 83% would like to visit more exhibitions with this technology, which indicates that there is a demand for it in museums. That correlates with Leventis Museum in Nicosia, Cyprus (Kyriakou, 2018) experience, who discovered that around 80% of respondents enjoyed their AR application experience and were willing to continue with it during their further visits.

With the predicted growth of market size of Augmented Reality by over 90% by 2025 (Figure 3), it is clear that this technology will get spread on many industries and will become intuitive for most of the audiences in the coming years. Among them are Education and Entertainment that are listed as industries which will benefit the most from AR (Figure 5).

Both factors indicate that it is important to start developing Augmented Reality content for exhibitions already now. In fact, it was noted that Augmented content is able to enrich representation of an exhibit as unlike printed annotations it is not bounded with space of a nameplate and can even include videos and animations that can present a story behind an exhibit and involve visitors on a deeper level.

As for Aviation Museum, where main audiences are Families with Children and Senior Males, higher interest to Augmented Reality was found among younger audiences –

Children, Young Couples and Parents (90% of Children and Young Couples and 85% of Parents would like to visit more AR exhibitions). Only 57% of Seniors indicated that they are interested in more exhibitions with AR, which might be connected to the fact that 86% of them noted that were not able to download an application. From their comments it was clear that they are not comfortable using smartphones or phones without buttons.

On the other hand, 72% of Senior respondents noted that they enjoyed current experience with AR technology, which might be an indication that they are mostly worried about the technical part and instructions.

Therefore, in order for Senior group to benefit from the Augmented technology, it is advisable to use tablets with pre-installed settings and provide a very detailed guidance on how to use them.

At the beginning it was not only Seniors who were confused, also Parents shared in their comments some confusion with starting the application. But once they were able to figure out how it works, the rest seemed quite easy for them.

Two museums Leventis Museum in Nicosia, Cyprus (Kyriakou, 2018) and Royal Ontario Museum (Pedersen et al, 2017) noted the same effect, Leventis Museum in Nicosia, Cyprus (Kyriakou, 2018) also noted that after about a minute of consideration the rest of customer journey was pleasant and intuitive.

An importance of clear guidance and instructions was also noticed by Royal Ontario Museum (Pedersen et al., 2017), who found out that a group of people that was left without any instructions disregarded the AR application at all.

Instructions provided for the current exhibition was easy to read and follow by Young Couples group, which is a projection of Families with Children group in the next 5 years. The group of Parents noted that they would need to have more detailed instructions on how to download and use the application.

Therefore, to help visitors to make the most of their AR experience in the museum it is recommended to provide general instructions at the ticket office for everyone and compliment it with a brochure for more details. For Seniors a tablet and a live demonstration of the service would be advisable.

Following the experience of Casa Batlló Museum, Spain (Gimeno et al., 2017), which found out that animations were enjoyed the most by visitors, it was decided to use a slideshow of photos and videos related to the exhibits, available from the Museums' archive.

Some respondents expressed an opinion that they would be willing to listen to a story behind the exhibit. They noted that both children and adults would benefit from it. Another popular comment was about the length of the augmented content, some of parents, especially with smaller children, would expect to see a timer with a countdown, to be able to understand how long will the augmented content last as they are helping children to keep attention.

Many parents agreed to the comment that finding exhibits with augmented content was perceived as a game by children, which showed a good level of engagement.

And the final insight that was found valuable was the fact that one of the visitors hesitated about whether the application is free of charge. That reminded one of the results of Athens Numismatic Museum, Greece (Chasapis, Mitropoulos and Douligeris, 2019), which discovered that visitors expected an AR application to be free of charge, unless it included the guided tour. With a guided tour they perceived it as a good enough value to pay for the application.

5   Conclusions

5.1   Research summary

The research found a strong demand in Augmented Reality technology among Families with children and Young Couples, which is a projection of Families with children audience in the next five years. There was also a demand in this technology among senior visitors, however, they feared being left alone to deal with it. For them, an assistance from a member of staff who can provide a life demonstration of the service would be expected.

In general, Parents audience found it easy to download and use the application, however in the beginning they experienced a little confusion, trying to understand which application to download and how to view augmented objects with it. For Parents group it was the first time when they were downloading a mobile application in a museum and most of them haven't heard anything about Augmented Reality before. Once they saw the first exhibit with the application, confusion was gone. As for Young Couples, who are the projected audience of Families with children in five years, for them the process was more intuitive as 90% noted that downloading an application was very easy. Therefore, in the nearest future, when the technology gets wider acceptance by museums, using an AR application will become a natural and intuitive procedure to Families with Children. Currently, for this audience it is recommended to have a separate brochure with detailed instructions of how to use the application.

Even though, most of current Senior visitors will not be able to use AR mobile application, this group demonstrated interest in it and in order to engage them a tablet and a demonstration by a member of staff will be advisable.

5.2   Practical implications

Based on the results of current research it is advisable to the Aviation Museum to start developing an Augmented Reality service as it gets a lot of positive feedback and attraction by all audiences of the museum, especially younger ones.

As for the format of the service, it is recommended to have AR mobile application for Children, Parents and other younger audiences as this practice is already spread among other museums in Finland (Appendix 1) and with the development of AR technology will become more intuitive for users in coming years.

However, for current audience of Families with Children a brochure with detailed instructions, an icon of an AR application, QR code and summary of the content will be advisable, as due to the absence of experience and expectations about AR application, extra information will be highly appreciated.

Younger visitor groups are expected to be fine with the short schematic instructions that were used for the current exhibition or similar to those, used by other museums in Finland, that offer AR service (Appendix 1).

As for Senior visitors, one of the options for them would be a guided AR tour where a guide can offer a tablet and assistance with viewing augmented content of exhibits. Otherwise, tablets and life demonstration by a member of staff can help Senior visitors to benefit from this type of exhibition.

5.3 Limitations of the study

The research was undertaken during the Coronavirus Pandemic. Initially, it was planned to be taken in the museum, but in fact it was possible to perform only for Families and Children. For the rest of audiences, pop-up exhibitions with the same materials were offered. Respondents in these cases were briefed that these materials are part of exhibition in Aviation Museum.

This limitation is expected to have very little effect for answering main research questions, as testing AR technology was presented on information cards and remained the same for those who visited the museums and pop-up exhibitions. However, secondary part of this research which was intended to collect insights from visitors' experience could be richer, if it would be possible to keep the initial Customer Journey. Outside of the museum, respondents lacked part of that experience and, therefore, provided less feedback regarding their insights of the service.

5.4 Suggestions for further research

The next steps of this research would be investigation of types of Augmented Reality and providers on the market. Depending on budget and goals of educational curators of the museum it can be performed to match any type of budget, starting form a basic 2D object trigger technology, provided by such platforms as Artivive for museums and galleries. Those platforms don't require any coding skills and objects can be created directly by curators with no need of coding skills, for example when using archive photographs and videos, as it was done for this research. For more graphically complicated slideshows and videos a designer can be involved to develop such kind of content.

Other technologies include 3D object recognition, location-based guides and other more complicated functions and can be designed with the help of an AR development agency. With such kind of technologies, the application can offer larger spectrum of services, including navigation, guiding tours and advertising.

Another point for further research is related to Customer Journey of Families with Children audience. A more specific Customer Journey can be created based on the information from this research and tested again to develop a brochure which will provide initial information about the technology and more detailed instructions which can help to reduce initial confusion that this group experience when dealing with AR technology for the first time.

Depending on the goals of the museums, Senior visitors' audience can be researched more for better determination of the upper limit of the age for this group. For current research Seniors older than 70 years showed little interest in AR technology. This trend needs to be confirmed on a larger sample.

References

Andreassen, Tor & Kristensson, Per & Lervik-Olsen, Line & Parasuraman, A Parsu & McColl-Kennedy, Janet & Edvardsson, Bo & Colurcio, Maria. (2016). Linking service design to value creation and service research. Journal of Service Management. 27. 21-29. 10.1108/JOSM-04-2015-0123.

Antonius, R., 2003. Interpreting quantitative data with SPSS. Sage

Augmented Reality (AR), 2019. pp.4, 11. Available at: https://www.statista.com/study/38227/augmented-reality-ar-statista-dossier/ [Accessed 1 Dec. 2019].

Augmented reality (AR) in Europe - Statistics & Facts, 2017. Available at: https://www.statista.com/topics/3358/augmented-reality-ar-in-europe/ [Accessed 1 Dec. 2019].

Azuma, R. 1997. A survey of augmented reality. Presence: Teleoperators and Virtual Environments 6, 4, 355–385.

Benckendor, P.; Tussyadiah, I.P.; Scarles, C. The Role of Digital Technologies in Facilitating Intergenerational Learning in Heritage Tourism. In Information and Communication Technologies in Tourism: Cham, Switzerland, 2018; pp. 463–472.

Blippar, 2019. What is augmented reality (AR) and how does it work? - Blog - Blippar. [online] Available at: https://www.. [Accessed 1 Dec. 2019].

Carr, L. T., 1994. The strengths and weaknesses of quantitative and qualitative research: what method for nursing. Journal of advanced nursing, 20(4), 716-721.

Chen, C. M., & Tsai Y. N., 2012. Interactive augmented reality system for enhancing library instruction in elementary schools. Computers & Education, 59(2), 638–652. doi: 10.1016/j.compedu.2012.03.001.

Chasapis, P., Mitropoulos, S. and Douligeris, C., 2019. A prototype mobile application for the Athens Numismatic Museum. Applied Computing and Informatics, [online] Available at: <(http://creativecommons.org/licenses/by-nc-nd/4.0/> [Accessed 3 July 2020].

Chesher, M., & Skok, W., 2000. Roadmap for successful information technology transfer for small businesses. Paper presented at ACM SIGCPR conference on Computer personnel research, 6-8 July 2000, Chicago

Cianciarulo, D., 2015. From Local Traditions To "Augmented Reality". The Muvig Museum Of Viggiano (Italy). Procedia - Social and Behavioural Sciences, pp.138 – 143.

Coates, C., 2019. How Museums are using Augmented Reality - MuseumNext. [online] MuseumNext. Available at: https://www.museumnext.com/article/how-museums-are-using-augmented-reality/ [Accessed 1 Dec. 2019].

Cronholm, S. & Göbel, H., 2017. ITIL Compliance with a Service Perspective: a Review Based on Service-Dominant Logic. In 27th Australasian Conference on Information Systems. Wollongong, Australia.

Denzin, N. K., 1978. "Triangulation: A Case for Methodological Evaluation and Combination." In N. K. Denzin (ed.), Sociological Methods: A Sourcebook (pp. 339–357), Routledge.

Ding, M., 2017. Augmented Reality in Museums. Arts Management & Technology Laboratory, pp.1-5.

Dunleavy, M., & Dede, C., 2014. Augmented reality teaching and learning. In M. Merrill, J. Elen, & M. Bishop (Eds.), Handbook of research on educational communications and technology (pp. 735–745). New York, NY: Springer.

Edwards-Stewart, A., Reger, G. and Hoyt, T., 2016. Classifying Different Types of Augmented Reality Technology. Annual Review of CyberTherapy and Telemedicine, p.3. Available at: https://www.researchgate.net/publication/315701832_Classifying_different_types_of_augmented_re ality_technology#:~:targetText=Summary%20of%20augmented%20reality%20categories%20and% 20types.&targetText=based%2C%20Location%2Dbased%2C%20Dynamic,Augmenta- tion%2C%20and%20Complex%20Augmentation.&targetText=behavioral%20healthcare%20and%2 0discusses%20future%20applications.,-Key- words.&targetText=world%20with%20a%20simulated%20one,reproduced%20or%20alternative%20 reality.

Fern, E.F. 2001. Group Composition, Individual Characteristics, and Cohesion. In: Advanced Focus Group Research, Thousand Oaks, CA: SAGE Publications, Inc. pp. 23-48. Available at: <http://www.doi.org.ezproxy.haaga-helia.fi:2048/10.4135/9781412990028> [Accessed 20 Mar 2021]

Ghouaiel, N., Jessel, J., Cieutat, J. and Garbaya, S., 2016. Mobile Augmented Reality in Museums : Towards Enhancing Visitor's Learning Experience. [online] The International Journal of Virtual Reality. Available at: https://www.researchgate.net/publication/317301714_Mobile_Augmented_Reality_in_Museums_To wards_Enhancing_Visitor's_Learning_Experience [Accessed 1 Dec. 2019].

Gimeno, J., Portalés, C., Coma, I., Marcos Fernández, M. and Martínez, B., 2017. Combining traditional and indirect augmented reality for indoor crowded environments. A case study on the Casa Batlló museum. Computers & Graphics 69, [online] pp.94–105. Available at: <http://www.elsevier.com/locate/cag> [Accessed 3 July 2020].

Goldstein, Susan & Johnston, Robert & Duffy, Jo Ann & Rao, Jay., 2002. The Service Concept: The Missing Link in Service Design Research. Journal of Operations Management. 20. 121-134. 10.1016/S0272-6963(01)00090-0.

Greenbaum, T.L. 1998. Focus Groups: An Overview. In: The Handbook for Focus Group Research, 2nd ed. Thousand Oaks, CA: SAGE Publications, Inc. pp. 1-16. Available at: <http://www.doi.org.ezproxy.haaga-helia.fi:2048/10.4135/9781412986151>

Gummesson, E., 1991. Qualitative Methods in Management Research. Sage, Newbury, CA

Kaplan, I. (2019). How Long Do People Really Spend Looking at Art in Museums?. [online] Artsy. Available at: https://www.artsy.net/article/artsy-editorial-long-people-spend-art-museums [Accessed 1 Dec. 2019].

Heaton, J. 2004. Types of Qualitative Secondary Analysis. In: Reworking Qualitative Data, London: SAGE Publications Ltd pp. 35-52. Available at: <http://www.doi.org.ezproxy.haaga- helia.fi:2048/10.4135/9781849209878>

Katz, M., 2018. Augmented Reality Is Transforming Museums. [online] Wired. Available at: https://www.wired.com/story/augmented-reality-art-museums/# [Accessed 1 Dec. 2019].

Kerawalla, L., Luckin, R., Seljeflot, S., & Woolard, A., 2006. Making it real: Exploring the potential of augmented reality for teaching primary school science. Virtual Reality (Waltham Cross), 10(3-4), 163–174. doi:10.1007/s10055-006-0036-4.

Klapztein, Sol & Cipolla, Carla., 2016. From Game Design to Service Design: A Framework to Gamify Services. Simulation & Gaming. 47. 10.1177/1046878116641860.

Kyriakou, P., 2018. Can I touch this? Using Natural Interaction in a Museum Augmented Reality System. Digital Applications in Archaeology and Cultural Heritage, [online] 12. Available at: <http://www.elsevier.com/locate/daach> [Accessed 3 July 2020].

Liarokapis, F., Sylaiou, S., Mountain, D., 2008. 'Personalizing virtual and augmented reality for cultural heritage indoor and outdoor experiences, In: Proceedings of the 9th International Symposium on Virtual Reality, Archaeology and Cultural Heritage, pp. 1–8. doi: 10.2312/VAST/VAST08/055–062. [Accessed 3 July 2020].

Lyytinen K, Yoo Y, Varshney U, Ackerman MS, Davis G, Avital M, Robey D, Sawyer S and Sorensen C, 2004 Surfing the next wave: design and implementation challenges of ubiquitous computing environments. Communications of the Association for Information Systems 13(Volume 14), 697–716.

Mager, B., 2008. Service Design. In Erlhoff, M., Design Dictionary. Perspectives on Design Terminology. Basel: Birkhauser.

Martin, C.R., Horne, D.A., 1993. Service innovations: successfulversus unsuccessful firms. International Journal of ServiceIndustry Management 4, 49–65

Martín-Gutiérrez, J., Efrén Mora, C., Añorbe-Díaz, B. and González-Marrero, A., 2016. Virtual Technologies Trends In Education. EURASIA Journal of Mathematics Science and Technology Education 13(2), pp.469-486.

McDougall, G. H., & Levesque, T., 2000. Customer satisfaction with services: Putting perceived value into the equation. Journal of Services Marketing, 14(5), 392–410.

Milgram, P., Takemura, H., Utsumi, A. and Kishino, F., 1994. [online] Etclab.mie.utoronto.ca. Available at: http://etclab.mie.utoronto.ca/publication/1994/Milgram_Takemura_SPIE1994.pdf [Accessed 1 Dec. 2019].

Moorhouse, N., tom Dieck, M. C., & Jung, T., 2017. Augmented reality to enhance the learning experience in cultural heritage tourism: An Experiential learning cycle perspective. eReview of Tourism Research, 8, 1–5.

Nechita, F. and Rezeanu, C., 2019. Augmenting Museum Communication Services To Create Young Audiences. Faculty of Sociology and Communication, Transilvania University of Brasov, Bras, ov 500036, Romania

Panciroli, C., Macauda, A. and Russo, V., 2018. Educating About Art By Augmented Reality: New Didactic Mediation Perspectives At School And In Museums. Bologna, Italy: Department Education Studies "G. M. Bertin", University of Bologna

Panetta, K., 2018. 5 Trends Emerge in the Gartner Hype Cycle for Emerging Technologies, 2018. [online] Gartner.com. Available at: https://www.gartner.com/smarterwithgartner/5-trends-emerge-in-gartner-hype-cycle-for-emerging-technologies-2018/ [Accessed 1 Dec. 2019].

Patrício, L., Fisk, R.P., Falcao e Cunha, J. and Constantine, L., 2011, "Multilevel service design: from customer value constellation to service experience blueprinting", Journal of Service Research, Vol. 14 No. 2, pp. 180-200.

PEDERSEN, I., GALE, N., MIRZA-BABAEI, P. and REID, S., 2017. More Than Meets The Eye: The Benefits Of Augmented Reality And Holographic Displays For Digital Cultural Heritage. University of Ontario Institute of Technology ACM J. Comput. Cult. Herit. 10, 2, Article 11 (March 2017), 15 pages.

Peppard, J., & Ward, J., 2016. The strategic management of information systems: Building a digital strategy. Chichester: John Wiley & Sons.

Prendeville, Sharon & Bocken, Nancy., 2016. Sustainable Business Models through Service Design. Procedia Manufacturing. 8. 292-299. 10.1016/j.promfg.2017.02.037.

Puchta, C. and Potter, J. 2004. Focus Groups and Interaction. In: Focus Group Practice, London: SAGE Publications Ltd pp. 2-24. Available at: <http://www.doi.org.ezproxy.haaga-helia.fi:2048/10.4135/9781849209168> [Accessed 20 Mar 2021]

Reason, B, Brand, FM, Løvlie, L, & Løvlie, L 2015, Service Design for Business: A Practical Guide to Optimizing the Customer Experience, John Wiley & Sons, Incorporated, Hoboken. Available from: ProQuest Ebook Central.

Ronald T. Azuma, R., 1997. A Survey of Augmented Reality. Malibu: Teleoperators and Virtual Environments, pp.33-35. Available at: http://www.cs.unc.edu/~azuma/ARpresence.pdf [Accessed 1 Dec. 2019].

Rose, Jeremy & Göbel, Hannes & Cronholm, Stefan & Holgersson, Jesper & Söderström, Eva & Hallqvist, 2019. Theory-Based Design Principles for Digital Service Innovation. e-Service Journal. 11. 1. 10.2979/eservicej.11.1.01.

Saunders, M. N. K. k., Lewis, P. & Thornhill, A., 2019. *Research methods for business students*. Eighth edition. Harlow, England: Pearson.

Sauro, J. & Lewis, J. R. 2012. Quantifying the User Experience: Practical Statistics for User Research. Burlington: Elsevier Science.

Shunli Liu, Muhammad Zaffwan Idris., 2018 Constructing a framework of user experience for museum based on gamification and service design. MATEC Web Conf. 176 04007. DOI: 10.1051/matecconf/201817604007

Steen, M. Manschot, N. De. Koning., 2011 Benefits of Co-Design in Service Design Projects. International Journal of Design, 5(2), 53–61. Retrieved from uuid:eefaaa3c-cc7d-408e-9e00-883c6f2ccb03

Stickdorn, M., & Schneider, J., 2010: This is Service Design Thinking, Amsterdam: BIS Publishers

Stickdorn, M., Schneider, J., Andrews, K., & Lawrence,2011. This is Service Design Thinking: Basics, Tools, Cases.

Stickdorn, M. 2018. This Is Service Design Doing. O'Reilly Media, Inc.

tom Dieck, M. and Jung, T., 2017. Value of augmented reality at cultural heritage sites: A stakeholder approach. Journal of Destination Marketing & Management 6, [online] pp.110–117. Available at: <http://www.elsevier.com/locate/jdmm> [Accessed 3 July 2020].

Tuomi, A., 2020. Customer Journey Module. Session 1 Slides. Available at: https://hhmoodle.haaga-helia.fi/mod/resource/view.php?id=1430746&redirect=1 Accessed 14.11.2020

Van Der Vaart. M 2014. Using augmented reality in the museum material encounters with digital cultural heritage. Retrieved from http://mesch-project.eu/using-augmentedreality-in-the-museum.

van Krevelen, D. W. F., & Poelman, R., 2010. A survey of augmented reality technologies, applications and limitations. International Journal of Virtual Reality, 9(2), 1–20.

Voorhees, C., Fombelle, P., Gregoire, Y., Bone, S., Gustafsson, A., Sousa, R. and Walkowiak, T., 2017. Service encounters, experiences and the customer journey: Defining the field and a call to expand our lens. Journal of Business Research 79, pp. 269-280.

Verschuren, P., Doorewaard, H. and Mellion, M., 2010. *Designing a research project* (Vol. 2). The Hague: Eleven International Publishing.

Weightman D. & McDonagh D., 2003. People are doing it for themselves. In Designing Pleasurable Products and Interfaces pp 34–39, ACM, Pittsburgh, PA

Williams, Kevin & Chatterjee, Samir & Rossi, Matti, 2008. Design of emerging digital services: A taxonomy. European Journal of Information Systems. 17. 10.1057/ejis.2008.38.

Yoon, S. A., Elinich, K., Wang, J., Steinmeier, C., & Tucker, S., 2012. Using augmented reality and knowledge-building scaffolds to improve learning in a science museum. International. Journal of Computer-Supported Collaborative Learning, 7(4), 519–541.

Appendix 1. AR Application Instructions in Finnish Museums

Finnish National Gallery Ateneum in partnership with Helsingin Sanomat

Source: https://blog.arilyn.com/art-beyond-the-frame

INSTRUCTIONS ON HOW TO USE THE MOBILE APPLICATION

1. Download and open the free Arilyn app.
2. Select the Ateneum Art Gate from the application's menu.
3. Stand at the starting point and place the gate following the instructions.
4. Step into the virtual museum experience.

The Art Gate experience is available for most devices. The 360° experience is available for all devices.

Source: https://ateneum.fi/welcome/ateneum-art-gate/?lang=en

HAM, Helsinki Art Museum

The new layers of the frescos are accessible through the mobile application Arilyn. The digital content works best while facing large-scale frescoes, when one can study the many details on an eye level. The application can, however, also be used to dig deeper into an image on a postcard or in a book, for instance. The pilot version is available in the Finnish language.

How to experience augmented reality:
1) Download the free Arilyn application on your mobile device from the App Store or from Google Play
2) Open the application
3) Examine the fresco through the application and start your expedition

Source: https://www.hamhelsinki.fi/en/exhibition/tove-jansson/

Amos Rex and Danske Bank

AR FLASH BACK

Miten pääsen seikkailemaan?

Aikamatkalle tarvitset mukaan vain älypuhelimesi – ja että olet Lasipalatsin ympäristössä!

1. Etsi Lasipalatsin ympäristöstä vieressä oleva tunnus. Kartan löydät tästä alempaa.
2. Lataa ilmainen Arilyn -sovellus
3. Katso sen läpi tunnusta
4. Koe huima elämys läpi Lasipalatsin aikakausien!

Antoisia seikkailuhetkiä!

Source: https://amosrex.fi/ar/flashback/

Source: https://amosrex.fi/ar/flashback/
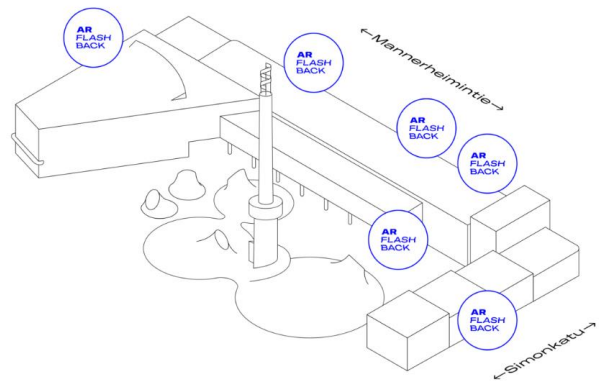
Tuusula

HALO AVOIN ATELJEE

HALO Open Studio has opened

Welcome to the opening of the HALO Open Studio exhibition where you are right now. Take your smart device and go to elamisentaidetta.fi/halo and you can enjoy art at your own pace. Find a surprise hidden in the studio, and you can also take part in the raffle!

Go to the show

Source: https://www.tuusula.fi/index.tmpl#

Appendix 2. Focus Groups Transcript

Focus Group N 1 (5 children and 6 adults)

- **First question is about how was your experience, were you able to use the app and see the augmented content?**
- I'll answer. It was very nice to have that, to look forward to. It's like an extra little nugget, that you get to see what is being exhibited. We had a bit of trouble starting with the app. We downloaded it onto our own phones and then it said that you have to put the image on screen so what both Chris and I thought is we have to take the display into all that in front of the screen so that to have a photo that wasn't very clear, so, and later on, when we were more people at the display only one person could have their phone by the picture. And then I thought it would actually be nice to have multiple pictures displayed, so that if you are there, you can see what someone else is doing and do the same, but also it would make it more clear. And you also not necessary mess the, you know, just having one photo you might mess the photo that was there and just walk past it. But with multiple photos you know already "ah, this is something to take note of" and you can choose whichever one and you can have your phone there and the photo is come up.
- **Thank you, thanks. And the second question is how easy was it to download the app? Were the instructions clear from the paper provided? Was it easy to download the application?**
- Em, I'm a very visual person, so I would have liked a little icon, that I know I'm downloading the right app immediately.
- I think the instructions could be more explicit – go to Google Play, type in name of the app, tadadada. I mean we know how to download an app, but we don't know how do download the app.
- Yes, just to say go to, download this app, but then have a look at picture with this app.
- And then we, like I've said we didn't know what to do with it.
- It kept saying come closer to show the picture and then it's not really getting it, so it's a bit time consuming.
- Also, I didn't know you have to put it on photograph, I thought you have to put it on the whole item, so I have decided, ok, nothing is happening.
- Yes, from graphic designing point of view, my suggestion would be that you frame it and you put little icon – this is the image to look up to.
- Yes, and not on the app, but on the piece of paper - put the app on this.

- **Thanks. Have you had to download apps before, when you were visiting museums?**
- Everyone: no
- No, this is the first time we had this kind of experience
- **And what do you think about Augmented Reality technology? That was the technology we were using for the videos out of the pictures. Did you like this technology and do you think it would be an interesting option for the visitors?**
- It's a bit in the open, and as we also said it takes lots of time to do it, but at the same time maybe our generation will be ok with that, to download, but talking about older generations, they are going to be missing out on that.
- **And what about kids, what do you think about kids?**
- Em, kids would do it. Kids would be like "Oh, it comes more, comes more". For this generation – yeah, but for the older one – maybe not. Some of them are not gonna have that mobile phones what we have.
- **Do you think if we would put the tablets there it would help?**
- That would absolutely help. Because its bigger, you can see bigger, it's better. Because with the phone it's like does it have to be more brighter or does it need to be more bright or light or …
- Yeah, when the settings all ready for the brightness and the size and everything - for sure.

Focus Group N2 (5 children and 5 adults)

- **And the first question is were you able to use the application?**
  Everyone: yes
- **Did you like it?**
- It was easy
- Simple to use and simple to download
- **Have you ever had to download any applications in museums before?**
- No
- Not in the museums
- Not in the museums
- We haven't been to museums so much
- We have been to in Helsinki and in Tallin
- **But they didn't ask you to download any applications before?**
- No

- **Have you heard of Augmented reality before or have you used the Augmented reality before?**
- No
- No
- I have. I didn't use it but I know
- **What do you think about Augmented reality, do you like it and would that kind of exhibitions be an interesting option for the visitors?**
- In my opinion it's quite difficult, because we came all the way to the exhibition to see the exhibits and carrying a phone and start looking for those pictures is going to spoil the current for us, for me, because I can't keep looking at the mobile for a rolling picture, I prefer seeing something on the screen (he meant TV screen) behind the exhibit, something rolling, so that I can look into the exhibit as well as the screen for more pictures. Carrying the mobile in my hand - it's difficult. It's going to really stop me from enjoying the exhibits there, so I prefer a tablet, or a bigger tablet behind the exhibit.
- **But if we have tablets, will it work for you?**
- I would say a larger one at the back of the exhibit, that's going to be better for me. Mobile is definitely not good. Too small and I had to keep it constantly in front of the picture which is going to be painful. Secondly with the kids around I can't keep doing this and I'll be only be able to see it, not the family, they won't be able to see it (too small screen). That way it will block certain entertainment or enjoyment.
- **Do you have any comments for us to improve?**
- I'm thinking for this age kids who are used to using mobile, for them, it's actually fun, to actually go and see – ok I can check again for more pictures and stuff. And even if you can add to that some either music or even speech, that you can hear a story. For them to look at the pictures and hear the stories would make it more interesting. But I'm thinking for this age kids who are used to using mobile phones, for them it's more like a game – to go and see more.
- But you need to keep your mobile phones, so that they can be looking at them
- No I'm thinking about the kids and not myself
- You need to keep it, hold it, constantly…
- But if the picture is bigger than you can actually hold your phone a bit closer, you don't need so yeah…
- Different views, yeah. For this modern generation - tablets and phones. For some of us who are of the older generation, we want maybe bigger screen there would be ok and telling the stories – I love stories I love reading histories, watching the pictures. So even with the mobile I would love to hear stories, or some history or

some writer talking, telling me how the evolution of this particular airplane was, then I get in to the story, I get into the scene, but with the picture alone, then for me it doesn't work, so picture, history combined would be a good experience.

- Another thing – of course I agree that kids might be excited using their phones, but purpose of the exhibition is the exhibits, there will be more focus on the phones and looking at the picture…
- But they are focused on the phones anyway…
- I don't know how many of you seen that there was one engine of the flight that they picked up after 50-60 years from the ocean, it had rust here and there – exciting to see. But people would be looking at their mobiles, so I think that traditional way of looking at the exhibits might be missing in that case.
- But if you don't have too many of those I don't think the aim is having it everywhere, just few spots that you look more into it, into the story of it. I don't know, my assumption.
- An also some of the phones are not as storage efficient so it might be that you have to delete your own apps to be able to use it. Otherwise especially in my experience I just liked the fact that there were images, so I didn't mind the phone just if the image that you have to hold on to would be a little higher so that you don't have to squinch down.
- **How many of you would prefer having a tablet to a mobile app.?**
- Tablets
- Tablets
- Hard to say. Both go
- Both go
- But I think Franklin you meant a TV screen
- That's a tablet. Just a larger tablet behind the … Doesn't matter as long as you don't hold your phone and keep looking at it and then four or five people come around.
- For me something bigger works better

Appendix 3. Questionnaire Results

Total respondents (40)

	1	2	3	4	5
Was it easy it to download the AR App?	26%	0%	3%	10%	61%
How interesting was Augmented Reality experience for you?	5%	0%	2%	24%	68%
Would you like to see more exhibitions with AR objects in Aviation Museum?	5%	0%	0%	10%	83%
Would you recommend this exhibition to your friends?	5%	0%	0%	20%	75%

Male (16)

	1	2	3	4	5
Was it easy it to download the AR App?	28%	0%	0%	7%	64%
How interesting was Augmented Reality experience for you?	6%	0%	6%	12%	75%
Would you like to see more exhibitions with AR objects in Aviation Museum?	12%	0%	0%	18%	68%
Would you recommend this exhibition to your friends?	0%	6%	0%	25%	69%

Female (24)

	1	2	3	4	5
Was it easy it to download the AR App?	24%	0%	5%	12%	59%
How interesting was Augmented Reality experience for you?	4%	0%	0%	32%	64%
Would you like to see more exhibitions with AR objects in Aviation Museum?	4%	0%	0%	4%	92%
Would you recommend this exhibition to your friends?	0%	4%	0%	16%	80%

Children (10)

	1	2	3	4	5
How interesting was Augmented Reality experience for you?	0%	0%	0%	40%	60%
Would you like to see more exhibitions with AR objects in Aviation Museum?	0%	0%	0%	10%	90%
Would you recommend this exhibition to your friends?	0%	0%	0%	0%	100%

Young Couples (10)

	1	2	3	4	5
Was it easy it to download the AR App?	0%	0%	0%	10%	90%
How interesting was Augmented Reality experience for you?	0%	0%	0%	30%	70%
Would you like to see more exhibitions with AR objects in Aviation Museum?	0%	0%	0%	10%	90%
Would you recommend this exhibition to your friends?	0%	0%	0%	40%	60%

Families/parents (13)

	1	2	3	4	5
Was it easy it to download the AR App?	15%	0%	8%	8%	69%
How interesting was Augmented Reality experience for you?	0%	0%	8%	23%	69%
Would you like to see more exhibitions with AR objects in Aviation Museum?	0%	0%	0%	15%	85%
Would you recommend this exhibition to your friends?	0%	0%	0%	15%	85%

Seniors (7)

	1	2	3	4	5
Was it easy it to download the AR App?	86%	0%	0%	14%	0%
How interesting was Augmented Reality experience for you?	28%	0%	0%	0%	72%
Would you like to see more exhibitions with AR objects in Aviation Museum?	42%	0%	0%	0%	57%
Would you recommend this exhibition to your friends?	0%	28%	0%	28%	42%

Comments

Children

nope	Male	<20
it's like magic	Female	<20

Young Couples

QR code would be better than instructions	Female	20 - 29
Generally, I wouldn't like to download a separate app for each museum, therefore, tablet would be better. However, now, during the pandemic, I would prefer to use an app, rather than a tablet.	Female	20 - 29
I would prefer to use an app, as tablet is not quite safe to use because of Coronavirus	Female	20 - 29

QR code will make it easier to download the App fast. Also, Artivive logo can be shown in instructions as it will make it easier to find the App	Female	20 - 29
Nice exhibition. Pictures were little difficult to find time to time	Male	30 - 39
It was a bit time consuming because the app/program couldn't find the pictures. it would be nicer if the pictures were numbered/time duration. Overall, it was a nice experience.	Female	30 - 39

Families / Parents

So much potential! involve graphic design to improve images, add text, e.g. dates and online descriptions	Female	30 - 39
Memory on my phone is full, there is no extra space. I prefer not to download anything on my phone.	Female	40 - 49
I need glasses to see it with the phone, a tablet would be better. It is also better to have a direct link, like QR code to the app. Also, when I read instructions, I thought whether the app is free or how much does it cost.	Female	40 - 49
I would have needed clearer description how to use the app, but with little advice everything went fine. The instruction paper was little unclear	Female	40 - 49
The AR was not a necessity. Carrying the mobile and looking at it was not comfortable. Keeping it stable on a form was not comfortable as well.	Male	40 - 49
I didn't know what to expect but it was a good experience to see these airplanes in an app. Generally, a good experience 70%.	Male	40 - 49

Senior Visitors

Someone has to show me how it works, or I wouldn't be able to use it	Male	60 - 69
Telephone is rather small. It would be easier to see it on a tablet.	Male	60 - 69
If someone would help me, I would use it, otherwise - no.	Female	60 - 69
I wouldn't even try to install the app myself, there should be some help provided with it.	Female	70+
I would recommend it to younger people. Extra information would be interesting. I prefer to use appliances with buttons, something more physical.	Male	70+