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New technologies at the service of Swiss museums: analysis of their potential to improve the visitor experience

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Abstract

For a long time, museums have played major roles in the cultural industry. They are responsible for preserving artefacts, knowledge and cultural heritage. Given that we are currently living in a highly connected world, the implementation of technology within museums can be questioned, specially towards the future generations that will represent the museums' public of tomorrow. Therefore, it is truly essential for cultural institutions to remain attractive in the field and to continuously develop their offerings to meet public expectations. Thus, this study investigates the relationship between museums' exhibitions and the use of technological innovations. More particularly, it aims the latest generation technological tools such as augmented reality, virtual reality, artificial intelligence and holograms.

In order to conduct this research, nine Swiss museums from different regions, typology and sizes were interviewed with the aim of understanding their vision as well as their management of technology as part of museums' exhibitions. Moreover, a comparative analysis of Swiss museums as well as foreign ones was elaborated, thus evaluating the scope of technology within these cultural entities. Overall, findings of the study demonstrated that museums' professionals were aware of the implications of implementing technological tools and provided precious information regarding an effective technological management. As for the comparative analysis, foreign museums are ahead from Swiss ones in terms of technological innovations. In addition, bigger museums tend to have more digital innovations than smaller ones. Ultimately, data resulting from the analysis allowed to obtain several recommendations for the sector.

Keywords: Swiss museums – cultural heritage – digital technologies – visitor experience – comparative analysis

Foreword and acknowledgements

As part of my last year studies in Tourism Management at the University of Applied Sciences of Western Switzerland in Sierre, I am required to conduct a research project of my choice, known as a Bachelor Thesis.

The theme I have chosen to investigate is about the influence of technology within Swiss museums and abroad. More precisely, this research project is not only aiming to look at the presence of usual technological tools that could be found within museums' exhibitions such as audio guides or interactive terminals, but also towards more immersive and latest generation technological tools such as the use of augmented reality or virtual reality. On one hand, this paper has a special focus on the existence of these tools within cultural entities and on the other hand an emphasis on the implications and management of technology by museums' members.

The idea of conducting a research project in that specific field is explained by the fact that I have always been highly attracted by culture since an early age, and I am keen on visiting cultural monuments such as museums. Moreover, I had the opportunity to work for a museum for three years, which let me discover the wings of such institutions. In addition, as some people find museums outdated, which is why I also wanted to examine whether technology has its place and how it could be an added value or not for cultural institutions, particularly in the context of an extremely connected world we live in.

Throughout the entire process, I was able to count on the support of many different individuals that I would particularly like to thank:

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List of abbreviations

AI	Artificial Intelligence
AR	Augmented Reality
FOC	Federal Office of Culture
FSO	Federal Statistical Office
ICOM	International Council of Museums
NICT	New Information and Communication Technologies
SMA	Swiss Museums Association
VR	Virtual Reality

Introduction

According to the Network of European Museum Organisations, digital technologies have not only found their place in our everyday lives but also into cultural institutions such as museums (Network of European Museum Organisations [NEMO], 2020, p. 2). For the past twenty years, they have been used to promote cultural innovations and have been a major focus of museum development (Mairesse et al., 2017, p. 147).

Museums should be committed to adapt to the omnipresence of the Internet in order to offer new services to visitors and improve the impact on their visits. As a result, museums of the 21st century are gradually seen as a places of experimentation in relation to new technologies, enabling them to persist their vocation of preserving, transmitting, promoting and mediating both their tangible and intangible heritage. Consequently, adaptation is needed to meet visitors' expectations that is increasingly connected and that make use of new technologies, while continuing to generate and distribute scientific knowledge (Mairesse et al., 2017, pp. 191-192).

Nowadays, almost every museum makes use of digital tools to complete their tasks either as part of management, communication, or as part of their exhibitions. Tools available have the power to significantly support the work of museums and enhance the public exchange, thus offering numerous opportunities. In addition, technologies provide an interactive approach to cultural heritage for a large public (NEMO, 2020, p. 2).

This research paper is composed of eight different chapters. The first part of the study will include background information, the context of the thesis, containing some facts and figures, the role museums play within society as well as their current challenges. In addition, there will be a brief overview of the tasks that museums possess within the tourism industry and a glimpse at visitors' expectations in relation to technology are also to be addressed.

The third section consists of the literature review that has been used to deeply analyse technologies used in museums along with their advantages and their limitations. This part focuses on one hand on the most usual tools to be found within museums. Yet, on the other hand, there is a special focus on the newest and more immersive technological instruments. In the case of this paper, new technologies mainly refer to augmented reality (AR), mobile applications, virtual reality (VR), artificial intelligence (AI) and holograms.

Moreover, the fourth chapter presents an explanation of the approach led. Included in the methodology, there are nine museums that have been interviewed in order to understand their use as well as their perception of latest generation technologies with the aim of discovering the potential of these tools in such institutions. In addition, a comparative analysis of 60 museums located in Switzerland and abroad has been elaborated. The goal is to have a wide overview of technological instruments used in these cultural entities.

Along with chapter four, several objectives have been defined and can be found in the second chapter of the thesis. The major objective of this research is to assess how technology can be effectively used within cultural organisations, thus enabling to provide some leads and guidance for museums' professionals that wish to (re)-implement technology as part of their exhibitions someday.

Finally, sections five and six depict the analysis of the collected data as well as the interpretation of the results to ultimately address some recommendations, in chapter seven, intended towards museums' professionals. Also, recommendations can serve as a lead for people outside a museum framework yet are interested in the best practices for implementing technology. Chapter eight consists of the limitations and the further research of the study.

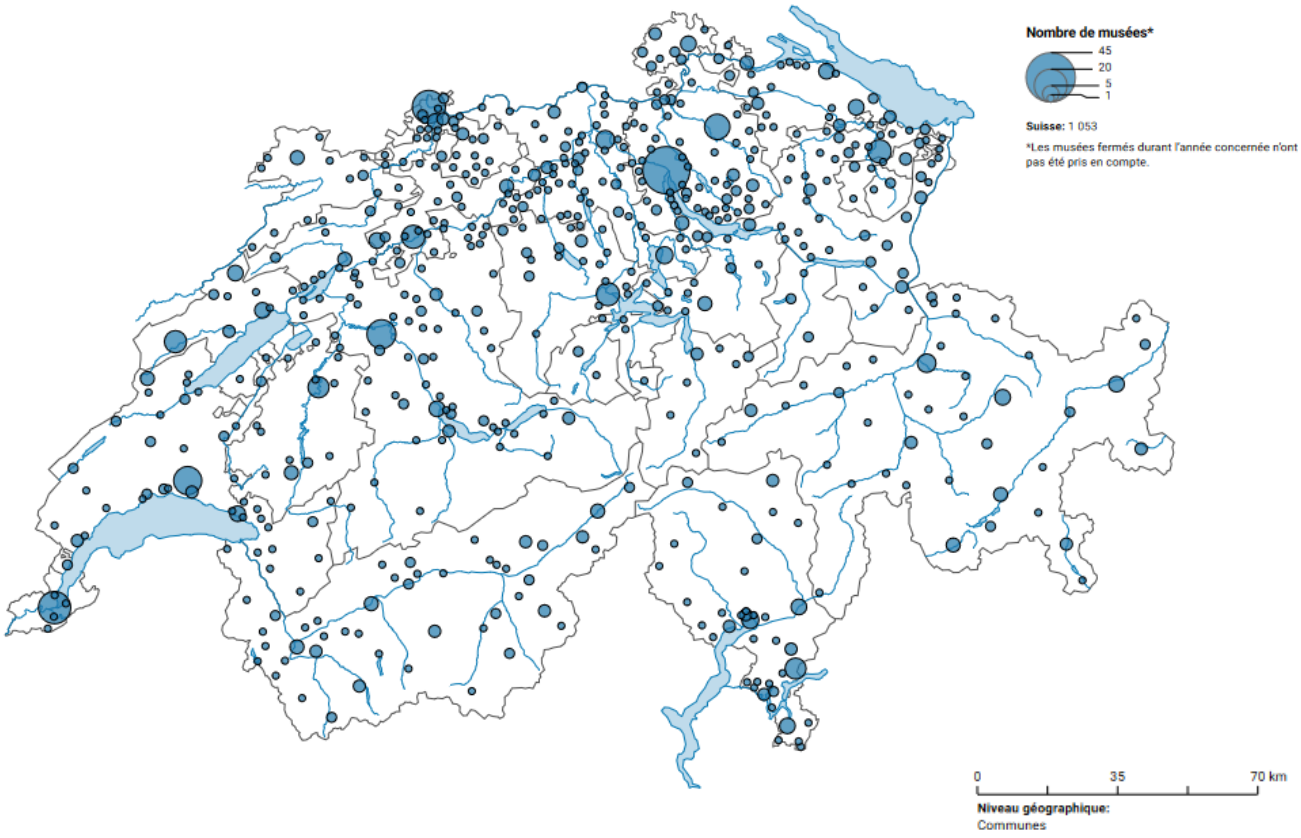
Chapter 1 – Background information and context

Museums in Switzerland: landscape, actors and challenges

1.1 Distribution of Swiss museums on national soil

Museums represent a huge source of information, discovery and knowledge. One can say that the museum landscape is truly important in Switzerland. Indeed, Swiss museums' density is one of the biggest in the world in relation to a population of 8.5 million of inhabitants (Courvoisier, 2020). In 2015, more than a quarter of Swiss municipalities had at least one museum on their territory. As for the repartition in the country, the majority of museums are located in the German region since 72% of museums are located in this area (Federal Statistical Office [FSO], 2021). The Italian-speaking region has the highest museum density in the country, with 25 museums per 100,000 inhabitants (Grand, 2017). Figure 1 shows museums' distribution of entities by geographical area on national soil in 2020.

Figure 1: Swiss museums' distribution by geographical area in 2020



Source: Federal Statistical Office (n.d.c)

In 2020, Switzerland has accounted for 1,053 museums on its soil (FSO, n.d.a). Results in table 1 demonstrate the ranking of various countries worldwide in terms of museum's offerings. The number of inhabitants were put in relation with the number of museums and can be found in the last column of the table. In comparison with other developed countries, Switzerland ranks number two, just after Sweden, demonstrating the importance of culture and therefore museums on national soil. One factor justifying such the latter statement was brought by Georges-Simon Ulrich, director of the Federal Statistical Office, who explained «Les Suisses sont un peuple de collectionneurs qui aiment partager leur passion» (Swiss residents are collectors who like to share their passion) (Le Temps, 2017).

Table 1: Number of museums in various countries worldwide in relation to their population

Ranking	Country	Number of inhabitants (million) [a.]	Number of museums [b.]	Number of inhabitants per museum [c.]
1	Sweden	10.3	1,600	6,487
2	Switzerland	8.6	1,053	8,234
3	The United States	329.7	33,082	9,968
4	Austria	8.9	776	11,511
5	Hungary	9.7	813	11,969
6	Germany	83.1	6,741	12,335
7	Belgium	11.5	912	12,670
8	France	67.6	4,811	14,063
9	Portugal	10.2	662	15,556
10	Canada	38.2	2,245	17,036
11	Italy	59.2	3,195	18,540
12	United Kingdom	67	3,183	21,057
13	Japan	125.8	5,738	21,930
14	The Netherlands	17.4	688	25,400
15	Russia	146.1	5,415	26,994
16	Spain	47.3	1,732	27,325
17	Australia	25.6	919	27,959
18	Poland	37.8	1,233	30,689
19	Argentina	45.3	1,183	38,357
20	Thailand	69.7	1,526	45,740
21	Korea	51.7	1,102	46,988
22	Brazil	212.5	3,906	54,419
23	Mexico	127.7	1,320	96,812
24	China	1 414.3	5,535	255,528

Source: Table by the author with multiple sources

a. Countryeconomy.com (n.d.)
b. Statista (2021)
c. Data collected by the author (2022)

1.2 Inflow of visitors

Over 70% of Swiss citizens visit at least one cultural institution per year, including museums (Swiss Museums Association [SMA], 2020). Such number can be explained due to the diversity of offerings within Swiss museums. In 2020, the most visited cultural institutions are represented by natural science museums. They are followed by art museums, archaeological ones and finally by historical and ethnographical ones. Local and regional museums are the ones who are the less visited (FSO, n.d.a), although they account for one third of national museums (FSO, 2021). In 2019, the total number of entrances in Swiss museums accounted for 14.2 million of tickets sold, providing an increase of about two millions compared to 2015. The average number of visitors in Swiss museums rose from 10,680 in 2015 to 12,575 that same year (FSO, 2021). In relation to the above, the social context is well-anchored as it has been shown that Swiss citizens attach great importance to culture and therefore to museums.

The results shown in table 2 demonstrate the 10 most visited museums in Switzerland in the year 2019. The Museum of Transport in Lucerne contains more than the double number of annuals visitors than the other Swiss museums and it accounts for almost one million entrances per year on a total of 14.2 million of overall entrances for that year. Moreover, six museums out of ten are located in the German part of the country. (Federal Office of Culture [FOC], 2020).

Table 2: Ten most visited museums in Switzerland

Ranking	Museum	Location	Number of annual visitors
1	Museum of Transport	Lucerne	993,775
2	Foundation Beyeler	Riehen	437,000
3	Chillon's castle	Veytaux	431,946
4	Home of Cailler	Broc	417,429
5	The Olympic Museum	Lausanne	319,618
6	Swiss National Museum	Zurich	302,304
7	Natural History Museum	Geneva	297,460
8	Swiss Science Center Technorama	Winterthur	291,706
9	Art Museum	Zurich	270,053
10	Art Museum	Basel	265,981

Source: Adapted from Federal Office of Culture (2020), p. 65

Swiss museums are split into three different categories. There are low attendance museums with up to 5,000 entrances, medium attendance museums with a number of entrances between 5,000 and 50,000 and high attendance museums with over 50,000 entrances a year. Over a total of 1,053 museums in Switzerland, 796 museums are considered low attendance, 225

have medium attendance and only 32 Swiss museums have high attendance. This means the distribution is inequal as 3% of museums receive the most frequentation and almost 76% record less than 5,000 entrances. However, high attendance museums drastically dropped from 60 museums in 2019 to 32 entities in 2020, mostly due to the COVID-19 pandemic and its impact on culture. As a comparison, only 8.1 millions of entrances were recorded for the year 2020, which represents a decrease of almost 43% with 6 million entrances less than in 2019 (FSO, n.d.a). This resulted from the COVID-19 pandemic that stopped the economy and caused the lockdown of institutions for several months.

1.3 Financing of Swiss museums

In Switzerland, most museums are privately owned giving a percentage of 71% of museums. Amongst them, a greater part is possessed by associations counting 31.1%, and foundations with 28.4%. Only 5.6% of museums are handled by private people and 6% are in the hands of enterprises. However, 29% of museums are public and belong either to municipalities, cantons or the Swiss confederation. Regarding the financial aspects, 53.1% of museums indicate that the majority of their budget is financed by the state or municipalities. More importantly, municipalities are the most frequent players as 35% of Swiss museums explained that municipalities are their main financing actors. They are followed by associations, cantons and finally foundations (FSO, n.d.c).

1.4 Different actors in the industry

Multiple actors are involved in the cultural sphere of museums. The first major actor in Switzerland, founded in 1996, is represented by the Swiss Museums Association (SMA) whose role is to represent the diversity of the Swiss museum landscape, particularly towards authorities and the general public. Moreover, this institution is committed to promoting contacts between museums, transmitting cultural richness and disseminating norms and standards. With nearly 800 institutions, the SMA symbolises museums' landscape of the country. Part of their objectives is also to ensure quality in the museum industry, promote exchanges in the country particularly with the organisation of annual conventions aimed at museums' professionals, create advantageous conditions in the sector and ultimately increase the visibility of all museums' members through public relations for instance. The SMA is partnered with the International Council of Museums (ICOM) (SMA, n.d.).

At a regional level, many cantons benefit from their own association, operating at a lower scale. There is for instance the Fribourg Museum Association, the Valais Museum Association or the Association of Museums of the Vaud Riviera among others. These institutions combine most museums of their respective cantons. They associate themselves and create a network

with common purposes and objectives. In addition, their alliance also ease coordination between all actors.

Another important entity in the industry operating at an international level is the ICOM founded in 1946 in Paris, precisely in the Louvre Museum. The initiative of creating a council was born after the decision of many museums' directors and mainly thanks to the American named Chauncey J. Hamlin, who was at that time the director of the Buffalo Science Museum. It was during the post-war period that many individuals wanted to relaunch the worldwide economy and more importantly create an entity to bring museums together. The ICOM is the only international organisation in the museums' scope. At the beginning of its creation, the first concerns of the ICOM were the educational importance of museums, the international flow of cultural goods, and the conservation of those goods. As time passed by, they grew in their development and regrouped more and more museums around the world (International Council of Museums [ICOM], n.d.b). They are committed to maintain research, conservation, durability and transmission of the past, the present and the future knowledge to the society in general. Besides, this is a non-governmental association that establishes professional and ethical norms for museum activities. Today, the ICOM accounts for 44,686 members from all over the world and they are active in 138 different countries. At the 24th general conference in Milan in 2016, the ICOM has elaborated strategical objectives going from 2016 to 2022 that are based on three major pillars: independence, integrity and professionalism (ICOM, n.d.d).

Many other entities exist to support culture. There is for example the Museum Pass which is a foundation based in Zurich that was co-created with the SMA, the Federal Office of Culture (FOC) and Switzerland Tourism. The goal of the foundation is to promote cultural diversity and to encourage individuals to take part in cultural activities at an affordable fare (Museum Pass, 2013). The FOC is also active towards the management and the development of museums, including collections and archiving. They oversee supporting museums to guarantee cultural heritage by allocating funds to develop projects or to financially aid in artefacts' insurances for instance (FOC, n.d.). Also, various associations exist in Switzerland that support museums financially, which are known as *Friends of Museums* and are specific to each museum. Finally, some companies such as the Swiss Raiffeisen bank offer its members free entrances in more than 500 museums (Raiffeisen, n.d.).

1.5 Challenges faced by Swiss museums

Swiss museums face many challenges. The latest most significant issue that impacted museums was the COVID-19 pandemic. Even though this worldwide crisis affected considerably these cultural organisations, museums did not let themselves get disrupted, instead, they counterattacked the pandemic. Indeed, museums started to develop online offers to provide and guarantee some content to the visitors and consequently respond to the ongoing demand. Moreover, this enabled entities to stay connected with their public and to maintain a relationship among them. Offerings can be made through a virtual online visit found directly through the museum's website. In addition, the use of social media was also a great way to transmit information and knowledge to visitors (FSO, n.d.a). The COVID-19 pandemic has emphasised the use of technological tools and museums should take them to their advantage. Such declaration already confirms that technology is an interesting tool for museums when it comes to spread content to the visitors. Thus, museums gain benefits nowadays to implement technologies not only virtually but also within their exhibitions.

Museums also meet other long-lasting challenges. The continual challenge museums usually encounter is the pressure they endure in wanting to always achieve consumers' demand plus, to remain attractive to its public. Indeed, they need to be proactive and anticipate future requirements. Emphasis is focused on understanding visitors' needs to propose a memorable experience (Bagnoud, 2018). Progress and evolution are proceeding at a tremendous speed, in particular technological improvements. Therefore, they must continue to renew themselves and adapt the future and possible shifts of the population' interest.

Another challenge refers to the responsibility of museums to be inclusive, in other words, target every type of audience. As Debenedetti, Debenedetti, and Mencarelli (2011, p.2) explained, one central objective museums have is to make their exhibitions accessible to as many people as possible. This implies more particularly disabled people, either physically or mentally. The SMA is engaged towards this issue. This organisation encourages museums to eliminate possible barriers as well as avoid upcoming ones to guarantee an access to culture for everyone. Barriers entails access to premises but also to content, meaning the language that is used for communication. The SMA provides recommendations for applying inclusion. Guidance is to develop open-mindedness within the museum. It is necessary for all actors of museums to be engaged, whether it is from curators to marketers. In addition, direct cooperation with disabled people can define in a better way what their needs truly are. Finally, before starting to construct buildings, rooms or think about the conception of exhibitions in the most optimal way, it is most important to plan beforehand the accessibility (SMA, 2016a). An interesting support called FALC (Facile A Lire et à Comprendre – easy to read and to

understand) is nowadays widely used by museums who wish to ease the access to their content for disabled people. Also, multiple Swiss museums acquired the label called *Inclusive Culture* (Pro Infirmis, 2019).

Role of museums in society

According to the SMA (2016b), Swiss museums have six fundamentals missions which are to build up collections, preserve, document, study, present and transmit them in relation to past, present and future purposes.

Museums play an important role in the cultural domain since they serve as social and cultural purposes. These institutions represent intellectual places aiming at transmitting knowledge and educating their visitors (Man, 2014). Many events such as *A night in museums,* the organisation of vernissages, special events, workshops, conferences, guided tours or discussion with artists are organised into museums and are an excellent way to learn, discuss and share information. Man (2014) also stated that museums have an educational role for children, which is fundamental for their development.

With more than 82.3 million of objects spread in 1,053 museums in 2020 (FSO, n.d.b), museums have for role to conserve artefacts and store collections. Not only they preserve cultural heritage for public use but they also have scientific goals as they represent a useful source of information for researchers, amateurs, students and children (Man, 2014). The role of preservation consists in acquiring, protecting, cataloguing and restoring heritage. The ultimate goal of preserving heritage is to keep objects for current and future visitors. Indeed, in order to ensure this preservation, objects must be conserved in order to prevent damage, the misuse of objects and it also protects and ensures scientific documentation (Simone, Cerquetti & La Sala, 2021). Once again, technology has a role to play in terms of data conservation as well as transmission.

Cultural tourism and the role of museums in the tourism industry

Cultural tourism is a form of tourism that is in expansion and that benefits from an increasing demand. Museums are highly solicited as touristic institutions and create a strong added value for the tourism industry. Also, they play vital roles in economic development by attracting both local and foreign tourists. Individuals that are not ordinarily attracted to cultural offers do have an interest in culture when travelling outside their country of origin. More importantly, cultural institutions are a motive of travel. While travelling, tourists are willing to learn more about the

region they discover and museums have a big role to play as they can respond to tourists' requirements as a cultural universe (SMA, 2020). However, Jean-Yves Marin, former Director of the Geneva Art and History Museum, argued that too few travellers come to Switzerland to visit museums. According to him, the tourism industry must play a more active role in promoting national culture (Le Temps, 2020).

Museums located in cities benefit from a superior advantage since they are a driver in urban tourism growth. Moreover, local or regional museums that offer specific exhibitions related to their culture or traditions have a strong potential to attract foreign visitors. Furthermore, an unusual building can increase tourist attraction due to its original architecture or its historical interest and it positively affects the desire of visiting it. Therefore, attractive museums can greatly contribute to tourism development (SMA, 2020).

The day that Swiss museums will have the power to attract visitors to a certain destination, it will advantage tourism actors such as hotels, restaurants or transport companies even more. Together, they associate to offer packages including discounts for nearby museums. Such partnership represents a fruitful way for museums to be discovered by tourists, thus resulting in positive outcomes for local tourism actors. To be attractive, museums should have a clear positioning, distinguish themselves to gain competitive advantages and arouse interest from a foreign public by offering adequate content (SMA, 2020). Cooperation between tourism actors and cultural organisations is therefore essential. Museums can join forces and share tasks to be more successful at attracting foreign visitors by creating networks, pools communication means and by following common strategies (SMA, 2020).

Visitors' expectations

Although it is highly challenging for museums to clearly determine with certitude what visitors' expectations are, a few leads have been explored. Visitors are on one hand in search of an enjoyable social outing and on the other hand they wish to gain knowledge and broaden their horizons. By using technological innovations, museums can offer individuals an active visiting experience. Therefore, learning should be embedded in a social activity which regroups conversation, interaction, relaxation, participation and collaboration (Pop & Borza, 2016). Consumers are being more and more demanding in their experience consumption. They are in search of feeling unique emotions and have positive memories to share with their relatives (Elgammal, Ferretti, Risitano, & Sorrentino, 2020). It has also been shown that visitors express a real need to learn, to share knowledge, to interact and to debate when visiting cultural institutions (Mairesse et al., 2017).

1.6 Museums and Generations Y & Z

The Generation Y, also known as Millennials, is characterised by people born between 1980 and 2000 (Gomaere, 2021). This generation is not only technology-oriented but they are in constant search for creativity and new interactive and engaging experiences. They have preferences for activities that propose high selectivity, teamwork or customisation. Moreover, Millennials are considered as more sceptical and impatient than former generations, probably due to an environment surrounded by technology that offers immediate gratification. Nevertheless, this generation is seen as more open to change and more tolerant towards diversity (Bebey, 2018). According to a study led in France between 2016 and 2017, it has been revealed that 91% of respondents estimated that museums were insufficiently adapted to the young public (Hoffstetter, 2018). However, a relatively new phenomenon could have changed the vision young people have in regards of museums, since the arrival of *pop-up museums*. Those entities started to spread in 2016, more particularly in California. They represent itinerant ephemeral museums and attract many onlookers, mostly from the Generation Y, due to their exclusive character as well as their interactive offers. It is without saying that they are criticised by some museum's professionals who do not see them as veritable museums but rather as a fashion trend (Cazenave, 2018).

In regard to the Generation Z, which represents people born starting from the year 2000 (Gomaere, 2021), the most important factor to them is to be provided with technological tools within museums since this generation is permanently connected. A study questioning Generation Z' interests in relation to technologies in museums demonstrated that when a higher level of IT was used, people were more likely to have a better quality perception (Feitosa, 2020). Moreover, it was revealed that in some cases, technologies help to present more attractive content but also a more understandable one.

Amongst visitors, teenagers are generally reluctant to enter museums and find them obsolete and old-fashioned but in fact, they represent the majority of the population visiting museums. Several reasons explain this phenomenon in particular the influence of the family or the school to visit such sites (Timbart, 2013). Therefore, with the Generation Z, a highly connected generation, the presence of technologies in museums would encourage them to visit those places outside a scholar framework, or at least without being obliged, since museums can play an important role in their education. Also, by involving gamified experiences, it has the power to enhance their learning skills.

Chapter 2 – Problem statement, research question and objectives of the research

As it has been explained in the *background information and context* chapter, there is a wide variety of museums in Switzerland with over 1,053 museums all over national soil. Such big number of institutions compared to the number of inhabitants can lead to competitivity in the field. Therefore, museums have the responsibility to remain attractive towards their public and more particularly towards the newest generations characterised by the Generation Y and Z, as they represent the public of tomorrow. More importantly, they have the duty to keep culture alive. Cultural institutions should be committed to regularly adapt their offerings and to constantly evolve in order to always meet public' expectations.

The ICOM is currently questioning the direction museums should take in the future and the definition itself of what museums truly represent. So far, the definition of *museum* that was adopted by the 22nd General Assembly in Austria back in 2007 is the following:

> A museum is a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment. (ICOM, n.d.a)

The ICOM has already led two consultations linked to a possible change of definition for what a museum is, as well as an update of the ICOM Code of Ethics. One study concerning the activities held by museums in relation to the museum definition has been conducted between 2019 and 2020, as part of the first phase of this process. The second part of the consultation carried by the ICOM referred to some propositions of keywords and concepts that the museum definition should include. The next 26th General Conference to be organised in August 2022 in Prague (ICOM, n.d.c) has for goal to come up with a new museum definition proposal that will be submitted for a vote (ICOM, n.d.a).

Included in the topics of the 2022 conference in Prague, the subject of new technologies will be discussed, which were of a major importance for museums during the COVID-19 pandemic lockdowns in order to keep the contact with the public.

In line with the above, this research paper concentrates on the potential of technologies, more particularly latest generation technological tools used as part of museums' exhibitions and will attempt to respond to the following research question:

How can Swiss museums take advantage of technology, especially latest generation technological tools to enrich the visitor experience?

Along with this research question, the four subsequent objectives have been established to lead this study.

Objective N°1 – Understand Swiss museums' motivation or rejection to integrate technological tools

The first objective has for goal to assess whether Swiss museums have the willingness or on the contrary a reluctance towards the implementation of technological tools within their exhibitions. This objective will be achieved by conducting interviews with museums' professionals.

Objective N°2 – Analyse the implications of the introduction of new technologies within Swiss museums

The objective mentioned above aims to define what are the implications to be considered when implementing technological instruments within museums' exhibitions. The implications refer to the potential, the importance and the challenges technology can include. In addition, this objective has for purpose to examine the influence of technological instruments on the visitor experience as well as to understand visitors' expectations. Again, this objective will be attained by interviewing museums' experts.

Objective N°3 – Evaluate the level of use of technology within Swiss and foreign museums

The third objective consists of establishing an inventory of the current technological instruments used within both Swiss and foreign museums through a comparative analysis. This will enable to see what type of technologies are used and to what extent. Ultimately, it will allow to identify current trends in the field. This objective will be reached thanks to the comparative analysis.

Objective N°4 – Formulate recommendations and best practices for museums' managers

The fourth and last objective consists of formulating recommendations about the best practices intended towards museums' managers regarding the implementation of latest generation technological instruments. Moreover, this can not only serve for museums' professionals but also to other industries interested in using technology. This objective will be accomplished thanks to the interviews as well as the documentation used to conduct this paper.

Chapter 3 – Literature review

Overview of new technologies within museums: advantages and limits

3.1 Emergence of non-immersive technological tools

The presence of technologies within museums is not new, but it is a phenomenon in a rapid expansion with a diversity of means. Since the introduction of the Internet, cultural organisations started to communicate through their internet website to present digital collections but also to promote their activities. In addition, the Internet allowed museums to ease online purchases of entrance tickets.

The first technological tools that were used by museums were the analogue cassette audio guides which were an alternative to the presence of physical museums experts (Pop & Borza, 2016). This said, the mentioned device has already been criticised due to the fact that the physical running of the tape was dictating the rhythm of the visit more than it accompanied it. However, audio guides greatly evolved throughout time, and it now offers the possibility to visitors to trigger it when they wish to do so, allowing them to have more autonomy during their visit (Schmitt & Meyer-Chemenska, 2015).

Interactive terminals became a real curiosity in the 1990's. Such device was quickly adopted by museums and by visitors due to its novelty and attractivity at that time. They allow to display a great amount of data and are non-invasive as they emit very few sounds. Visitors had the feeling to be more part of an experience while interacting with a screen and choosing their own content. Yet, at that time, certain difficulties were encountered for visitors as they were not used to it and they had to familiarise with its use and navigation (Schmitt & Meyer-Chemenska, 2015).

Later on, tablets were introduced in museums to facilitate the visit. Similar to interactive terminals, they allow to display a variety of information and encourage autonomy, concentration and satisfaction of the experience. Such tools are widely used in museums for educational workshops with scholar outings (Schmitt & Meyer-Chemenska, 2015).

Schmitt & Meyer-Chemenska (2015) mentioned that what has radically changed with those digital devices is the degree of freedom given to the visitor. Moreover, the features and functions have undeniably highly evolved up until this date.

3.2 Changing tools and environment

Museums are constantly evolving and are facing new challenges regarding the digital era we live in. To remain attractive, they will need to put efforts in that direction to continuously meet consumers' demand, especially with the arrival of the newest generations that are undoubtedly technology-oriented. Therefore, the implementation of new technologies in such institutions makes complete sense. Many museums have already well-implemented digital collections, multimedia terminals, personal digital assistants, software, audio guides or virtual spaces within their exhibitions (Andreacola, 2014). Newest possibilities exist nowadays to provide with even more immersive interactions between museums and visitors.

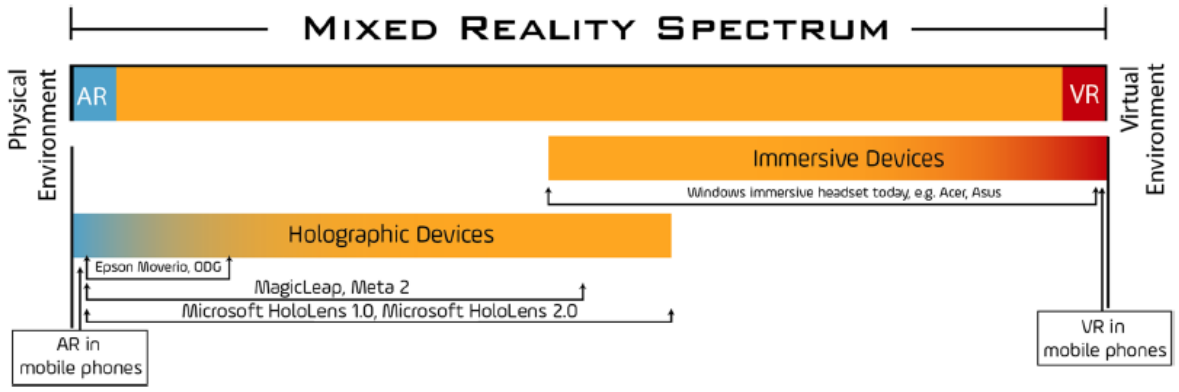
New information and communication technologies (NICT) have started to be preponderant within the cultural sphere, and more particularly within museums (Idjeraoui, 2017). Digitalisation in museums allow to interact with the public, before, during and after a visit plus, it reinforces the educational and entertaining experience. Nowadays, most individuals own a smartphone and are comfortable with technological tools which means that incorporating new technologies within museums would be relevant and appropriate. Amongst the various possibilities to implement digitalisation in museums, AR is often perceived as an interesting opportunity. Other technologies such as applications, video projectors, AI, holograms, immersive experiences, or even the use of the five senses through scenographic installations are part of the newest technologies that can be applied in museums.

3.3 More immersive technological tools

According to Leopardi, Ceccacci, Mengoni, Naspetti, Gambelli, Ozturk and Zanoli (2021), there are three levels of immersions that are characterised by non-immersive, semi-immersive and immersive systems. Nowadays, the most used method is the non-immersive visualisation system with virtual museum systems, also called VM systems, and it is represented by 2D monitor displays or 2D multi-touch displays. Semi-immersive techniques are characterised by large screen movie experiences with the use of videowall projections for instance. This method is also often adopted since it allows an unlimited number of visitors at the same time in an exhibition. However, this system requires tools such as handheld devices that are not intended for multiple users. Finally, there is little use of fully immersive systems represented by AR or VR since material needed and the funds may be consequent for the majority of museums. In addition, such technologies limit the capacity of acceptance in the exhibitions as AR or VR are usually individually used.

The figure demonstrates the array going from a more physical environment to a complete virtual one (figure 2). On the left side, the physical environment allows to place some virtual content and on the right side, the physical environment is replaced by virtual content, the user is not in a physical environment anymore (Hammady, Ma, Ziad, & Strathearn, 2021). Therefore, the reality enables a connection between physical and virtual environment in different proportions, through mixed reality, also called MR (Leopardi et al., 2021).

Figure 2: Mixed reality spectrum and distribution of holographic and immersive devices



Source: Hammady et al. (2021), p. 897

A majority of museums have gone under a modernisation process which allowed them to radically improve their offer for the visitors thanks to the implementation of modern technologies within their exhibitions (Camps-Ortueta, Deltell-Escolar, & Blasco-López, 2021). They are used by museums in order to develop their cultural mediation content. Moreover, the emergence of gamification[1] has transformed the visitor's experience. Camps-Ortueta et al. (2021) stated that "socialisation and play have been key tools in the process of museum change" (p. 194). Therefore, gamification used in museums is a way to entertain visitors through techniques coming directly from video games. When thinking about video games market, it was worth 56 billion dollars to the global economy showing the importance of implementing such tools through museums' technological offerings. Moreover, the arrival of the smartphone allowed people to play anything anywhere and that, boosted the industry. (Camps-Ortueta et al., 2021).

[1] Gamification is defined as follows: "…the intentional use of game elements for a gameful experience of non-game tasks and contexts. Game elements are patterns, objects, principles, models, and methods directly inspired by games" (Seaborn and Fels, in Egger & Bulencea, 2015, p. 29).

Visitors can share new gamified experiences through technologies such as AR[2] or VR[3] that can reproduce techniques from a gamified experience. Through that, museums can connect with visitors by allowing them to be fully immersed in a universe. Still in connection with the process of modernisation of museums, the use of AR or VR is great to display collections in an engaging way. Visitors can in some cases better understand the content of exhibitions. (Camps-Ortueta et al., 2021).

Virtual Reality

VR has expanded significantly since its beginning and is now used in many different areas such as video games, education, real estate, or culture. Its development gained territory in the museum world for several reasons. It allows museums to investigate their educational and recreational potential through its use. Evolution of techniques has brought the need for better communication modes. Therefore, VR interfaces, techniques and devices have been improved greatly to provide even more realistic features. Besides, VR technology has created incredible opportunities for museums to interact with their visitors (Shehade & Stylianou-Lambert, 2020).

Even though there are major drawbacks of VR such as financial costs or accessibility for a large audience, Shehade and Stylianou-Lambert (2020) stated that VR environments for the public need considerable thoughts since they represent powerful tools for learning purposes and more importantly, they allow real time experiences. Attractivity for VR stands in the fact that visitors can travel throughout space and time without leaving museums' rooms and allow complete freedom of movements in a virtual environment. They present a huge potential of entertainment while being educative at the same time. Not only can VR show representations of existing places or people but also ancient heritage that does not exist anymore. Indeed, this can be reconstituted through this tool and it makes it possible by allowing the visitor to see ancient objects or buildings (Pop & Borza, 2016). Moreover, VR created new dynamics in content creation as well as in storytelling. Therefore, VR allow truly immersive experiences in the museums' field (Shehade & Stylianou-Lambert, 2020).

[2] AR can be defined as follows: "Augmented reality refers to a virtual interface, in 2D or 3D, which enriches reality by superimposing additional information. The technology works through a terminal that films the real world and inserts live virtual objects, animations, texts, data and sounds that the user views from the screen" (Futura, n.d.a).

[3] VR can be defined as follows: "The term virtual reality encompasses a series of computer technologies that aim to immerse one or more people in a virtual environment created by software. An environment that more or less faithfully reproduces a real setting. The user accesses the virtual setting through a virtual reality headset" (Futura, n.d.b).

Augmented Reality

AR, like VR, not only aims tourism and culture but it is also used in many different fields such as architecture, medicine or education. It was only since 2009 that the proliferation of smartphones has made AR app accessible to the general public, including museums' visitors. Drawbacks and concerns are linked to the fact that several types of AR platforms exist, and makes it difficult to formulate standards for navigation and interaction due to their substantial differences in terms of visualisation with the real augmented world, thus challenging scientific community with technological interrogations (Damala, Astic, Rovedakis, & Gressier-Soudan, 2013).

Damala et al. (2013) also introduced the term of adaptive AR which goes beyond ordinary AR by explaining that the visitor is not a passive spectator but one that is at the centre of the system by giving greater importance to the visual, acoustic and emotional context allowing for a more immersive and personalised experience. A European project called *ARtSENSE* has for objective to create a prototype, enabling to implement adaptive AR within museums. AR therefore offer significant potential of amusement with a strong educational added value.

Artificial Intelligence

AI also plays an important role in museums' development. According to Zhao, Wu, Liao & Liu (2020), AI is expected to have a huge potential in digitisation. Part of the benefits are an enhancement of collections' museums management as well as visitor engagement. Besides, in case of poor management, it can be a threat and can lead to useless expenses for cultural entities. Careful consideration is therefore essential to manage this technology efficiently.

Holograms

Holographic showcases are also part of the emerging tools for museums. Holograms have been created many years ago, but the novelty stands in the techniques that have greatly evolved, consequently representing an advancement in the museology field. A technique called *The Pepper's Ghost*, is said to have the greatest potential due to its straightforward integration. Advantages of this technology stand in the fact that visitors can be taken to a powerful and lively experience. The goal is not only to surprise and astonish visitors but to deeply grab their attention since the real object can be visible inside the holographic showcase and the attention still remains focused on it. Pietroni, Ferdani, Forlani, Pagano and Rufa (2019) declared that "through holograms we do not immerse ourselves in virtual reality using particular visitors, but it is the virtual reality that enters our space" (p. 4). Holographic use is seen as a tool inside museums for better integration between collections and multimedia. However,

holographic representations can have a significant cost and must take into account many parameters such as the dimensions, quality, effectiveness among others (Pietroni et al., 2019).

Pop & Borza (2016) explained that all of these new technologies, at a certain degree, enable visitors with greater interaction and allow them to be part of the experience by being active users and not just look at information and collection passively. Furthermore, these authors also assessed that technological innovation strategies have positive effects upon museums' sustainability and prosperity. Moreover, the information that is transmitted can be better assimilated when presented in an interesting and attractive way. Hence, it is more likely for the community to have a higher desire to get involved into museums' activities. Finally, pluralistic use of technological strategies enables co-creation and promote better participation between museums and their visitors (Camps-Ortueta et al., 2021).

Evolution of new technologies and their role in museums

Due to the constant evolution of technologies, the offerings in terms of cultural resources as well as cultural mediation in museums is becoming more and more diversified.

Previously, museums looked like places where visitors would go and walk around to contemplate pieces of art, in complete silence. However, since the 1970's, museums have been under a progressive improvement. According to Courvoisier (2020), a noticeable indication that museums are evolving is the fact that the word itself *museum* is sometimes replaced by more evocative names such as *centres*, *spaces*, *world*, or *houses*. Already, there was a shift in the appellation of these entities and this has changed the vision people have about museums.

In 1980's, many museums faced high level of competition and were under strong financial constraints. Professionals then realised the importance of attracting and retaining visitors and to opt for more interactions with the visitors. Thus, interactive technologies characterised by interactive terminals or audio guides was the key for museums and once they understood it, they saw a huge potential to create a relation between museums and visitors with their use. Additionally, with the arrival of the Internet and more particularly with the introduction of smartphones, cultural institutions such as festivals, theatres or museums started to communicate through their websites to promote their entity as well as to present digital content, since people were more and more enthusiast about using technological devices (Courvoisier, 2020). Andreacola (2014) mentioned that digital firstly served museums to digitise online collections in the 1980's before it was used within exhibitions.

Since 1990, Simone et al. (2021) suggested technology has had an influential role on communication, marketing and exhibitions in museums and digital technologies have an important responsibility for enhancement in that direction. It allows museums to remove physical barriers, to be more flexible and ultimately to improve the visitor experience. Moreover, they allow visitors to go from the passive learning stage to active users who are more immersed into the visit and who can be in a participatory process by interacting with the environment. Ultimately, it helps them to better acquire knowledge.

Furthermore, Schmitt & Meyer-Chemenska (2015) mentioned that the itinerant exhibition called *Mémoires d'Egypte* exposed between 1989 and 1991 in Strasbourg, Paris and Berlin was one of the first immersive exhibitions to closely associate exposed works and media with the use of a headset with infrared reception. This type of broadcasting marked a milestone in the use of image and sound within exhibitions since these devices are no longer an accompaniment to the visit, but it constitutes a real way to nourish the visitor experience. This itinerant exhibition has recorded exceptional attendance figures with almost one million visitors. Schmitt (2017) also mentioned that this huge production, at that time, mobilised film directors, actors, natural settings and studios to produce historical fictions that contributed to the deployment of the first digital technologies in museum mediation. This really marked the importance of new digital media offerings within exhibitions.

According to Schmitt & Meyer-Chemenska (2015), for the past twenty years, digital tools such as interactive terminals, tablets, personal digital assistants have been well established within permanent or temporary exhibitions. These authors also suggest that interactivity, often associated with digital, should not be limited to this unique form. They indicate that interactivity has other forms that were already well-developed years ago. As an example, ancient institutions such as the Science Museum in London or the *Deutsches Museum* in Munich already proposed interactive devices, manipulations or games within their exhibitions.

Later on, different types of technologies have emerged such as AR, VR, AV, MR and VM, all of these being part of the so-called X-reality technologies. These technologies have made it possible to connect the physical world with a virtual environment to make the experience in museums even more interesting, and therefore enhance the museum's offerings. Such technological tools enabled a greater immersion in relation to the exhibitions (Camps-Ortueta et al., 2021). Courvoisier (2020) also suggested that technological tools foster edutainment from the public, meaning an educative aspect as well as an entertaining one.

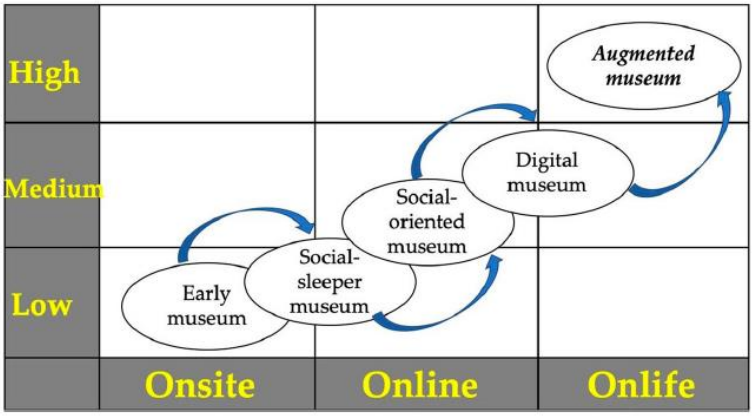
This new boom of digitalisation also changed the way organisation's work. Indeed, once technologies were part of a museum, it needed labour and many jobs were updated or created in order to manage it properly (Courvoisier, 2020).

Nowadays, it is almost impossible to find museums that do not use digital at all whether it is online or within their exhibitions. Many private companies work in developing digital offers and are specialised in the cultural domain, more particularly in a niche market involving museums. The number of enterprises working in this field is in constant evolution. Part of their responsibilities is to create content, databases, tools for AR or VR and they obviously provide after-sales service (Guidi & Jenny, 2021).

According to Simone et al. (2021), the emergence of the infosphere is what drives digital technologies to preserve cultural heritage in museums. Floridi in Simone et al. (2021) defined it as follows: “an Infosphere is an informational environment made of informational entities (informational agents or inforgs) and their properties, interactions, processes, and mutual relations” (p. 324). In other words, it represents the sphere of human activity involved with the process of information, more especially with digital. It is an environment that can be compared to the cyberspace. Regarding the Infosphere, museums represent institutions without barriers and enable connection between the museum and the visitor regardless of a geographical distance. Ultimately, it will have cultural, geographical and socioeconomic impacts. Cultural institutions are not simply a physical place but are becoming a dematerialised space. Museums are interrelated with the Infosphere since technologies have caused a reshape of museums’ roles (Simone et al., 2021).

In addition, the authors stated the edge between the analogue – also known as offline – and the digital world that is rapidly disrupting, meaning that *digital* occupies a more and more important place in today’s world and gently merges with the analogue environment. The tendency suggests that in a near future, there will be no more distinctions between the analogue and the digital. This contrast will eventually disappear, and the interactions will be equally digital. Therefore, online and offline environments merge and gave birth to a new phenomenon called onlife (figure 3).

Figure 3: Museums' main models



Source: Simone et al. (2021), p. 326

To give more precisions about figure 3, there are five different levels of museums. The first typology of museum was known as the *early museum*, where private collections such as rare artefacts of wealthy institutions or individuals were presented to the public. These collections were displayed in what is called a cabinet of curiosities, with no technology involvement (Simone et al., 2021).

The second museum's classification corresponds to the *social-sleeper museum*. They are represented by museums using technologies as a replacement for conventional means of communication. This can be characterised by digital media replacing paper versions. There is little connection with an online environment and investment in new technologies are low (Simone et al., 2021).

The third typology is distinguished by the *social-oriented museum*. Efforts are invested on social media and web services enabling museums to communicate regularly with their followers, thus creating an integrated audience. Technological tools are used only for pre-visit and post-visit stages, but not during the visit itself (Simone et al., 2021).

The fourth museum's classification is characterised by the *digital museum*. Their presence is not only through the web and social media but there is a real use of technological tools within the visit itself. Progressively, cultural organisations have adopted new forms of technology, thus reshaping the interaction between museums and individuals (Simone et al., 2021).

The last typology is represented by the *augmented museum* with an onlife approach, discussed up-above. Based on interactive technologies, there is both a fusion between onsite and online, thus enabling more accessible and hybrid museum experience. Moreover, it allows value co-creation by having the opportunity to interact in different ways with cultural offerings. This symbolised a new information environment, the Infosphere (Simone et al., 2021).

Role of technologies in museums

The role of museums is no longer aimed at collecting, preserving, displaying artefacts and informing visitors but its responsibility has been extended to manage cultural heritage in a broaden way. In other words, this means museums should be more open, more inclusive and more creative by proposing educational content that can be achieved through NICT. Offering experiences to visitors and telling stories what is the most relevant nowadays to capture visitors' interest. Therefore, NICT are valuable tools to enrich exhibitions.

Technologies have at first been used by museums to digitise their collections and therefore aimed at preserving the heritage itself. Due to enhancement of information technologies, it is possible to store, access and classify archived data and without damaging any original artefacts. Also, it can be very useful to have collections digitised, especially when certain

objects are loaned or under restoration. Part of these collections are available to the public through online visits meaning they are directly found on the museum's respective website (Simone et al., 2021). The authors stated that digitised collections were sometimes better to see on screen – through a virtual visit – than in real life given that the user was able to see the objects under all its angles and more distinctly. Indeed, during the exhibition, the visitor can be far from the objects and therefore are not able to observe it as well.

As previously mentioned, during the COVID-19 pandemic, museums were forced to redesign and rethink their services. The pandemic has accelerated the way in which museums should remodel their offerings. The world of culture has not been spared of closure caused by the COVID-19 pandemic and therefore, technologies were of beneficial for museums to maintain a relationship with visitors. For instance, museums make use of social media to communicate with their audience and to deliver online services such as digital exhibitions. According to a study led by the ICOM in Simone et al. (2021), almost every museum was closed all around the world and this lockdown boosted the use of digital technologies. It has been revealed that 47.5% of museums augmented their activity on social media, 18.8% increase live events, 18% proposed online collections and 16.2% proposed online exhibitions.

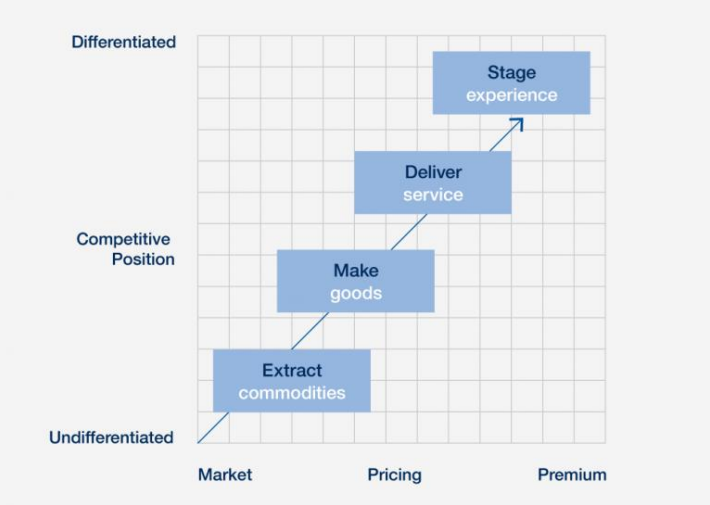
As part of the role of new technologies in museums, a study led by Pop & Borza (2016), proved that museums can handle their collections better, go beyond their physical limits by using online tools and attain a competitive advantage by offering digitised experiences to the visitors. Another major role of technological innovations within museums is to continue creating a demand and to be attracting for visitors.

Customer experience at the centre of everything

Museums' visitors need more than just contemplating artefacts or looking at sculptures or paintings within exhibitions and museums should consider it. Figure 4 demonstrates the progression of economic value, from *extracting commodities* to *staging experiences*. According to Pine & Gilmore (1998), consumers undeniably feel a strong desire for experiences and therefore the four economic offerings below make all their sense. Pine & Gilmore (1998, p. 98) declared: "an experience occurs when a company intentionally uses services as the stage, and goods as props, to engage individual customers in a way that creates a memorable event. Commodities are fungible, goods tangible, services intangible, and experiences memorable." Such statement underlines the duty of businesses to provide users with personalised and delightful experiences in opposition to providing individuals simply with goods or services. Experiences are a very unique and personal meaning. In fact, each individual will perceive the experience differently since it depends on the interaction between the event and one's state of

mind. Moreover, experiences create more value than goods or services (Pine & Gilmore, 1998).

Figure 4: The experience economy



Source: World Economic Forum (n.d.)

Pine & Gilmore (1998) also suggested that new technologies such as interactive games, simulators or VR particularly encourage brand-new sorts of experiences, thus allowing more immersive possibilities for the visitors. These authors also mentioned that experiences do not only concern the entertainment aspect, but it goes beyond within engaging customers towards a personal or memorable manner.

There are two categories of experiences, and they are defined as *customer participation* and *connection*. Respectively, the first type refers to individuals playing a key role in creating the performance, which generates the experience and the second type has to do with individuals being united or connected with the performance. This leads to the four realms of an experience encompassing entertainment, aesthetic, educational and escapist notions. A successful experience needs to include a combination of these four realms (Pine & Gilmore, 1998). To illustrate it, X-reality technologies can be adequately used to create a VM experience that incorporates all these aspects and “they may facilitate the learning experience, satisfy new entertainment expectations, enhance the aesthetic experience and contribute to the escaping of reality” (Leopardi et al., 2021, p. 192).

Regarding museums, these cultural entities should focus on visitors and more particularly on the visitor experience, rather than putting their efforts on collections management or marketing campaigns, intended for augmenting the number of visitors within their premises (Leopardi et al., 2021). These authors referred to the framework of the experience economy, brought by Pine & Gilmore in 1998, and explained that museums should move forward with

this scheme. In other words, museums should not only be concerned about selling products and offering services but also enrich these products or services through the action of a memorable experience for the visitors. From a managerial aspect, museums' managers are becoming more attentive to their visitors and deeply try to grasp visitors' personal feelings, backgrounds, and level of satisfaction during and after the visit (Elgammal et al., 2020). According to Leopardi et al. (2021), numerous studies have underlined the powerful effect of a successful experience on visitor's intentions to recommend and repeat the visit.

Many cultural organisations are granting a huge importance in implementing digital innovations within their exhibitions, thus, to propose a more complete and richer experience for visitors. The main goals are to stimulate pleasure, the five senses, reasoning, imagination, cooperation and autonomy (Jarrier, Bourgeon-Renault, & Belvaux, 2019). According to Elgammal et al. (2020), it has been revealed that an outstanding experience demonstrated more satisfactory results in terms of memories and behavioural intentions, meaning the willingness to repeat or to share the experience.

According to Jarrier et al. (2019), the quest of memorable sensations, imaginary and evasion is prominent in the tourism sector as well as in the cultural field in general. Visitors feel a real need to be part of an experience and want to be immersed as much as possible. The authors also suggested that visitors witness a greater way of learning, to be entertained and to socialise with the use of multimedia tools. For instance, a mobile app would not only reinforce the visitors' interest through its content and visuals but also boost its engagement and increase its general knowledge about the museum itself.

Furthermore, technological tools within museums do not only provide a playful dimension to the experience lived by the visitor but it positively contributes to the visit. Functionalities of the tools as well as the sensation of pleasure when using it influence positively emotional, cognitive, symbolic and social aspects from the experience of the visit (Jarrier et al., 2019).

Museums' challenges around new technologies

As it is the case in many different areas, museums also face new challenges dealing with development and enhancement of new technologies. Nowadays, almost everything is driven and influenced by technology to some extent. As previously stated, the use of technologies in museums support visitors during their visit, and impact the experience offered. Digital technologies have provided cultural institutions with plenty of opportunities to connect with their visitors. Even though the presence of technologies within museums offers many advantages,

there are without any doubts some challenges to handle. The major challenges are related to a lack of resources, either financial or human.

Firstly, there is an increase of online activities due to the COVID-19 pandemic, tasks from employees needed adaptation to fulfil needs. Some employees were even dedicated entirely to a digital department. In such crisis, agility is a must for companies (Simone et al., 2021). In that same direction, when implementing technologies inside an organisation, competent staff is required. From the development to the maintenance of technologies, workforce is vital for its well-functioning. Simone et al. (2021) argued that structural weaknesses have affected cultural organisations for a long time, in terms of resources and employees dedicated to digital activities. Moreover, the requirement of multidisciplinary competences is hard to find and there is a lack in competencies and IT capabilities (Courvoisier, 2020). Strategic planning as well as qualified human resources is therefore of a huge importance when implementing technologies in museums (Simone et al., 2021).

Secondly, some museums are reluctant to use technologies within their exhibitions as they are more conservative and they resist to change. Many museums' professionals are concerned about public's interest to prefer digital or virtual experiences over traditional exhibitions and think technologies can overtake space and its place in this environment and ultimately threaten conventional museums. Thus, it can lead museums' specialists not to take any action towards technological improvements or implementation (Pop & Borza, 2016). These authors also suggested that many museums prefer to maintain low-tech settings as they are as engaging as the possible use of technologies. Moreover, they relate that it is less disturbing, less expensive and also easier to maintain. Simone et al. (2021) even referred to the term *Disneyfication* to mention the progress of technologies and its related threat of a too fast evolution. Clauzel, Riché, and Le Hegarat (2019) mentioned that these new forms of interactivity between museums and visitors would create dehumanisation and risk to alter the character of museal offerings. Not only reluctance of museums can be identified but also reluctance from less familiar technology-oriented visitors can emerge.

Thirdly, another major challenge relies upon the financial aspects to develop, maintain and repair technologies within museums. Important part of budgets must be dedicated to equipment and maintenance (Courvoisier, 2020). Budgetary considerations have therefore limited the willingness and the choice of technologies even though Leopardi et al. (2021) stated that technologies such as VR or AR is accessible at an affordable price, characterised by different devices and various level of interaction, immersion, and presence.

Lastly, another considerable threat of using technology refers to their rapid evolution. Understanding how technology progresses and staying competitive and innovative leads to challenges for museums' supervisors. Once one technological tool is implemented within exhibitions, it can happen that another latest trend has arrived on the market. Consequently, technological tools within museums run the risk to become quickly obsolete if not managed and updated regularly. On one hand, it is the responsibility of museums to propose good quality material and on the other hand, the technology should meet public expectations, whose needs and desires are also changing rapidly (Weiwei, Qian, Yexin, Ying, & Suzhen, 2021). Mismanagement or poor control can sometimes cause dysfunction of tools within exhibitions and therefore lead to visitors' deception or frustration (Courvoisier, 2020).

Chapter 4 – Methodology

Explanation of the approach

To conduct this research, the strategy was twofold. On one hand, a qualitative approach has been used to collect data through semi-structured interviews. Qualitative research has been favoured over a quantitative approach because it enables an in-depth analysis of the subject. Moreover, this approach has been selected due to the quality of data identified over quantity, thus the study prioritises the richness of collected data. By conducting interviews, there is more chance to have valid and reliable data from the interlocutor (Saunders, Lewis, & Thornhill, 2009, p. 318). Furthermore, when conducting face-to-face interviews, it allows to directly bounce on what has been said and there is also a better perception of the message of the interviewee because its behaviour can instantaneously be seen and analysed.

On the other hand, a comparative analysis has been elaborated which would complete the first way of collecting data. The benchmark study enables to quickly understand and see the scope of technologies used within museums in Switzerland or abroad. Ultimately, the purpose of this method will help in identifying current trends in this sector and see to what extent technologies are used in these different cultural entities.

Qualitative research

As stated above, the first methodology used refers to the collection of data through semi-structured interviews. In total, nine interviews have been conducted with Swiss museums.

Before conducting the interviews, a selection of museums have been wisely determined. As a starting point, desk research has been applied to have a look at interesting and various museums in Switzerland that adopted new technological tools within their exhibitions. The goal was also to obtain a representativeness and a diversity of museums on the Swiss soil. Therefore, it was essential to have museums located in the different regions of Switzerland as well as bigger and smaller entities, determined by the number of visitors that are welcomed each year. Also, it was fundamental to find museums with diversified typologies. Once appropriate museums were found, they were selected for being part of the study. Altogether, 14 museums were contacted, either by phone call or by email, on which nine museums responded favourably to an interview request.

As far as possible, the interviewees should have been represented either by directors or by museums' curators. These individuals were the most likely to provide with complete and

relevant insights about the research topic since they have an overview on the activities of their institution, allowing full credibility.

Prior to the collection of data, an interview guide has been elaborated to prepare for the interviews. The guide has been created based on the book of Saunders et al. (2009, pp. 328-339) which gave insights on how to conduct an interview, the steps to be taken and how to act towards the interlocutor. These precious advice have been followed for each interviews led. With regard to the construction of the questions themselves, the manuscript of Fragnière, Tuberosa, Moresino, and Turin (2013, pp. 28-30) has been used to have appropriate and relevant questions for qualitative research.

Two different interview guides have been created. The first one geared towards museums that use technological tools within their institutions (see Appendix I). An English version of this interview guide has also been established and has been used only for one of the nine interviews (see Appendix II). The rest of the interviews were conducted in French to make the process easier for both the interviewee and the interviewer. The second interview guide was addressed towards low-tech museums and has a similar basis as the first one (see Appendix III). Respectively, the first interview guide contains 22 open-ended questions and the second has eight open-ended questions.

In order to have a common thread and because the number of questions was relatively high, key themes have been defined for the interview guide. Moreover, this was certainly easier for the interviewee to follow since categories of questions were defined, thus enabling a better structure. The five themes discussed were related to the use of new technologies within the museum in question, challenges met and limitations of the tools, the relation between the use of new technologies and the visitor experience, the link with the international clientele and finally, the vision of the future of the museum interviewed as well as museums in general. Even though an interview guide has been elaborated serving as a common thread, the order of some questions may have varied and additional questions may have been added or favour over others depending on the conversation with the interviewee.

Furthermore, the interview guide has been reviewed and tested to ensure its adequacy and comprehensibility. All nine interviews have been conducted online, through *Microsoft Teams* or *Zoom*, this for sanitary reasons due to the COVID-19 pandemic. The interviews have been conducted between January and February 2022 and lasted between half an hour and an hour and a half. Furthermore, the interviews have been recorded, after receiving the approval from each interviewee, thus enabling full transcript of the conversation, although language tics had not been transcript. Interviews have been transcript manually in the language in which they were conducted.

4.1 Sampling analysis

The nine museums interviewed are listed and presented below.

The Basel Historical Museum, with the Head of Communication, Mr. Andreas Mante working for the museum since 2017. The Basel Historical Museum opened its doors in 1894 and is a museum of history and culture of the same town. It encompasses three different entities that are the *Barfüsserkirche*, the *Haus zum Kirschgarten* and the *Musikmuseum*. The museum has the largest collection of musical instruments in Switzerland, with over 3,300 instruments. The institution usually welcomes 80,000 visitors a year (see Appendix IV).

The Lagerhaus Museum, with the internship assistant and responsible of AR projects, Mr. Philipp Gross, active since 2021. Additional inputs were received from the Director of the Lagerhaus, Mrs. Monika Jagfeld. The Lagerhaus, located in St. Gallen, is a museum dedicated to art brut as well as naive art, characterised by individuals without any artistic cultural background, but autodidact. The museum is opened since 1988 and accounts for around 3,000 entrances a year (see Appendix V).

The Alimentarium Museum, with the Head of Content & Curator of Natural Sciences, Mr. Nicolas Godinot, employee since 2016. The Alimentarium is located on the shores of Lake Geneva in Vevey and is the first museum in the world to propose nutrition as a thematic. The museum opened its doors in 1985 and the annual number of visitors is around 60,000. The museum organises numerous events and workshops (see Appendix VI).

The Museum of Communication, with the Head of Exhibitions and Digital Museum and Digital Museum, Mr. Christian Rohner, active since 2012. The museum was called this name in 1997, it was before the first Postal Museum in Bern, back in 1907. As the name suggests, its collections are about a variety of communication means, from the oldest to the most recent ones. It is a very interactive museum accommodating around 100,000 visitors a year (see Appendix VII).

The Olympic Museum, with Digital Project Managers, Mrs. Joëlle Bertoncini Moret and Mrs. Silvia Mosca, active since 1995 and 1993 respectively and the Chief Curator Mrs. Anne Chevalley, active since 1993. The Olympic Museum, located in Lausanne, is dedicated to the history of the Olympic Games from Antiquities to nowadays and aims to transmit the Olympic values beyond the celebration of the Games and competitions. The museum was inaugurated in 1993 and is part of The International Olympic Committee (IOC), also based in Lausanne. The annual number of visitors is around 300,000 (see Appendix VIII).

The Fondation Opale, with the Head of Communication, Mrs. Vanessa Pannatier, employee since 2019. Additional inputs were received from the Director of the Fondation Opale, Mr. Gautier Chiarini. The foundation exposes contemporary aboriginal art and is opened since 2018 in Lens. Around 30,000 visitors are welcomed annually. The foundation proposes workshops, yoga classes and owns seminar rooms (see Appendix IX).

The Laténium Museum, with the Communication, Marketing and Public Relations Manager, Mrs. Virginie Galbarini, active since 2001. The institution is the biggest archaeological and museum parc in Switzerland, located in Hauterive in the canton of Neuchâtel. It opened its doors in 2001 and accommodate around 40,000 visitors a year (see Appendix X).

The Museum of Natural History of Fribourg, with the Director of the institution, Mr. Peter Wandeler, active since 2014. The director is also a member of the Committee for the Swiss Museums Association. The museum aims to give a better understanding of nature, more particularly the natural heritage of Fribourg. Not only it is a museum but it serves as a regional centre of competence for flora, fauna and nature protection. The institution is opened since 1824 and welcomes each year 65,000 visitors approximately (see Appendix XI).

The Anonymous Museum, with the Director of the organisation, Mr. Roberto Andrey. The latter museum wanted to remain anonymous, hence the name. Roberto Andrey is therefore an alias name which will be used throughout the paper (see Appendix XII).

Moreover, in terms of the analysis of the interviews, specific data was extracted from the interview transcripts, categorised and organised into different themes (see Appendix XIII). Subsequently, a descriptive and explanatory analysis was conducted based on discourse analysis. For each of the themes, general observations were detected as well as recurring points of agreements or disagreements and trends. Also, important individual answers were highlighted and ultimately, direct quotations were made. Moreover, the presentation of the results as well as data analysis are based on an inductive approach, whose principle is to go from particular to general (Loubier, 2021).

Ultimately, this way of collecting data will provide with the strategy opted by various museums regarding the use of technologies within their institutions. Furthermore, benefits as well as challenges and issues will be explored, thus enabling a better comprehension related to a management and strategic perspective of these cultural organisations.

Comparative analysis

As a second methodological means, a benchmark study has been elaborated by the author (see Appendix XIV). A total of 60 museums have been identified and analysed in order to highlight the technological instruments of each institution.

On the total of 60 museums studied, 40 of them are in Switzerland, on which 20 are based in the French part of the country, 19 are located in the German part and one is in the Italian-speaking region. The other 20 entities are located abroad. For the ones in Switzerland, the purpose was to have organisations located in different areas, whether rural or city-centered but more importantly, located within different cantons of the country. The goal was also to have a diversity in the museums selected, characterised by the typology of the museum as well as its size. To define the typology of selected museums, data from the Swiss Federal Statistical Office (FSO) was employed, where a categorisation of eight types of museums is established (FSO, 2021, p. 6). The categories are the followings: natural history museums, art museums, archaeological museums, technical museums, history museums, ethnology and ethnography museums, regional and local museums, and a category called *others*, usually referring to a specific theme. As for the size of the museums, it was defined by the number of annual visitors. In order to facilitate their size appellations, the further abbreviations will be used, as shown in table 3. As explained in the *background information and context* chapter, there is already an existing division for museums attendance in Switzerland but the benchmark table has been categorised slightly differently for more representativeness. Data collection were made through annual reports but also by contacting museums.

Table 3: Museums' appellation in relation to their size

Museums' sizes	Number of annual visitors	Abbreviations
Small museums	< 20,000	**S**
Medium museums	Between 20,000 and 50,000	**M**
Big museums	Between 50,000 and 500,000	**B**
Extra-large museums	> 500,000	**L**

Source: author's data

As for cultural entities abroad, 13 museums were either a border country or located in Europe in order to see the offerings of neighbouring nations. The last seven museums are to be found on different regions of around the globe. Four are in the United States, one is in Canada, one is in China and the last one is in Australia. Famous international museums have been selected as well as less known, thus enabling a diverse representation of international museums. All the above criteria were used to select the institutions that would provide a sufficiently diverse sample.

In addition, several criteria have been defined for the analysis, all of them linked to the use of technological means inside museums' exhibitions or online. In order to have a table as representative and as reliable as possible, not only the latest generation technologies have been analysed but also the more usual ones. Therefore, the categories identified are the followings: audio guides (either in the form of a device or directly in an App), multimedia areas (presence of animated screens with audio and video), interactive terminals (possible interactions with the user and the terminal), tablet computers, online collections, 360° virtual tour on website, AR, mobile App, VR, AI, holograms and social media presence. A last category named *other* refers to diverse tools that are not part of the already mentioned categories. Besides, a table with more details about museums' technological use can be found in the appendices (see Appendix XV).

To collect data, respective internet website of each institution has mainly been used. Each section of each website have been carefully examined to collect information. Moreover, the platform of *TripAdvisor* has been used to review any pictures or comments that would provide indications about the use of digital tools within the museum in question. To determine whether each museum used an App or not, the *App Store* was employed. As for the presence of each museum on social media, each social media platform was investigated if there was any. Additional documents such as annual reports, press releases or presentations were employed to collect data. In some cases, data collection was obtained directly by contacting the museum of interest.

Moreover, discussing the grading scale of the comparative analysis, a total score of 26 points can be attributed. Data not present or data for which no information was provided received the grade of zero. Data that was slightly present received the grade of one, and the information that was highly present received the grade of two. For mobile App, AR, VR, AI and holograms, the grade of one has been attributed when only used once for a temporary exhibition for instance and the grade of two has been credited when used several times or permanently. In regards of the social media category, museums that have up to two social media received the grade of one and the ones that possess more than two social media and who post regularly, obtained the grade of two.

As for the analysis of collected data, the software *Sphinx iQ2* has been used. For each of the sections using the benchmark analysis, indications about a specific technological tool in relation to the size of the museum as well the typology of museum has been put into relation.

The ultimate goal of the comparative analysis is to assess what digital tools are in place within those cultural entities, but it will not indicate to what extent those tools are well managed or used as only their presence has been measured.

Chapter 5 – Results and analysis of the study

This chapter is divided into two parts. The first one implies the outcomes of the qualitative research, based on the nine museums interviewed. The second part refers to the results of the comparative analysis of the 60 museums located in Switzerland and abroad.

Qualitative research

5.1 Overview of technological tools within museums, benefits and motives

Amongst the nine museums interrogated, seven of them use technological tools within their exhibitions. Only two museums, namely under the name of Laténium Museum and the Museum of Natural History of Fribourg are considered low-tech museums as they hardly propose any technological devices to their visitors within their exhibitions.

Firstly, the use of technology within interviewed museums is multiple and varied. As part of usual offerings, there are audio guides as well as screens or diverse projections. In terms of more recent technological instruments, they are represented by geo-tracking Apps, AR often linked to an App or VR with the use of headsets. The majority of tools are used for special events, workshops or as part of temporary exhibitions. Only one museum, the Museum of Communication, make use of holograms under the form of a Gatebox, which is part of the current temporary exhibition called *SUPER, the second Creation*. The latter institution also offers very innovative technology characterised by robots. There are two types of them. The first one, Nao, which benefits from a speech recognition device, and was placed there to entertain the visitors and propose Tai Chi lessons for instance, among other of its skills and capabilities. The second one, Rooby, is like a Segway with a tablet computer and whose role is to offer guided tours to the visitors. Furthermore, the Fondation Opale make use of immersive tools that are represented by mapping video installations, as part of their current temporary exhibition named *Breath of Life*.

Then, there are numerous positive outcomes of the implementation of technology inside museums. The main positive aspect brought by museums refers to the possibility of transmitting a message in an accessible and more understandable manner. In other words, technology enables to ease and clarify the way the information is communicated. Additionally, the majority of museums also stated that technological devices are interesting as it makes it possible to show a quantity of information in a limited space and to conveniently change the content to be displayed. Therefore, there is some flexibility in the way the exhibitions can be managed thanks to technology. Another positive factor that raised concerns was the

interactivity and novelty that technology can provide due to its power to offer visitors with an immersive experience.

Finally, amongst the seven museums that are technology-oriented, there are five of them whose initiative to launch technological instruments came directly from the museum in question. Reasons for implementing tools were multiple. By having the opportunity to put a bigger amount of data within technological tools rather than offline, museums acknowledged that they could expand their offerings as well as their content in some way and many more. **Jöelle Bertoncini Moret, from the Olympic Museum, explained: « en tant que musée, c'est aussi de se positioner comme un musée étant à la page » (as a museum, it is essential to position itself as a museum that is up to date) (J. Bertoncini Moret, Digital Project Manager, personal communication, 7 February 2022).** Also, another motive was a desire to include the public and to propose them to live something new and an unforgettable experience. A rationale to launch technology was also to make the visitor's journey interesting and, through playful tools, deliver a real message. **Christian Rohner, from the Museum of Communication mentioned: « c'est de plus en plus démocratisé le digital et les technologies, les gens sont relativement à l'aise avec ça et on essaie d'aller dans ce sens aussi en tant que musée » (digital technology is becoming more and more democratised, people are relatively comfortable with it and we are trying to move in this direction as a museum) (C. Rohner, Head of Exhibitions and Digital Museum, PC, 7 February 2022).** Besides, only the Lagerhaus Museum defends the idea and motive of attracting younger generations with the use of technological innovations.

The idea of implementing tools within the other two museums came from external organisations. Regarding the Basel Historical Museum, it was the University of Basel that approached the entity to launch a VR project. As for the Fondation Opale, it was the willingness of a community of artists to implement technology within the entity. Active in the domain of aboriginal contemporary art, the artists that exposed their works at the Fondation Opale wanted their works to be recreated or reproduced through technological tools but at the same time they wanted to be to the closest representation of reality by using technology.

5.2 Utility and importance of latest generations technological tools

The majority of respondents considered new technological tools as useful for several reasons. Technology offers plenty of possibilities of presenting exhibitions, there is a bigger access to objects or histories through it and this is a great way to enrich content as well as to deepen the offer. As it is the case for the Lagerhaus Museum, Philipp Gross explained that technology was advantageous as it allows to have a clearer explanation, especially in their field that is native and brut art, which is a complex domain. Thanks to AR, they were able to propose deeper explanation and make their artworks more comprehensive for the public.

Furthermore, the Olympic Museum as well as the Alimentarium Museum brought the playful and entertaining utility of technological means. **However, Nicolas Godinot from the Alimentarium Museum said: « mais on ne peut pas s'arrêter là car notre mission n'est pas d'être des entertainers » (but we can't stop there because our mission is not to be entertainers) (N. Godinot, Head of Content & Curator of Natural Sciences, PC, 3 February 2022).** Therefore, allowing an innovative experience is essential for him, but museums must carefully consider their approach and the place of technology within museums, while focusing not only on an entertainment approach but also an educative one. The curator also mentioned that the utility stands in the fact that people can better retain what they have seen or heard and permits to stimulate thinking, foster curiosity, exchange, understanding, and knowledge acquisition for visitors. The Fondation Opale supports this statement by explaining that people can better imagine and feel the elements transmitted through the exhibitions by being immersed with technological instruments. On the contrary, for the Anonymous Museum, the utility of technology was qualified as not useful at all. For its director, Roberto Andrey, this is the content that matters and not the contribution of technology.

The Museum of Natural History of Fribourg and the Laténium Museum, which are low-tech museums, generally see utility in using technological tools within museums. For Peter Wandeler, director of the Museum of Natural History of Fribourg, stated not being against a possible implementation of technological instruments someday. Also, the director explained that the potential lies in the fact that technology is useful to support a global message rather than being the mainspring of an exhibition. For him, if the tool can help to better explain something or better tell a story, it is relevant. **Virginie Galbarini, from the Laténium Museum stated: « il faut que ce soit un tout, que ce soit judicieux dans la thématique » (it must be a whole, it must be judicious in the thematic) (V. Galbarini, Communication/Marketing and Public Relations Manager, PC, 15 February 2022).** She said that currently the museum does not see the potential technology can bring to the Laténium Museum and explained that it would require qualified workforce such as a specialist in that particular domain. In addition, she

mentioned that maintenance is essential as when a device is temporarily broken, it creates deception and frustration for the visitor. Therefore, those essential elements are to be considered.

Regarding the importance of technology, three out of nine respondents declared it as highly important, namely the Basel Historical Museum, the Alimentarium Museum and the Museum of Communication. The Olympic Museum said that technology has its place, as long as it is well thought. **For the Fondation Opale, Vanessa Pannatier explained: « on veut vivre avec notre temps ça c'est sûr… donc, oui on trouve important de suivre l'évolution et d'intégrer la technologie » (we want to keep up with our modern time, that's for sure... so, yes, we think it's important to follow the evolution and integrate technology) (V. Pannatier, Head of Communication, PC, 10 February 2022).**

The Lagerhaus Museum and the Anonymous Museum do not confer great importance to technology. The first institution mentioned their public is mostly represented by adults or aged people and they explained that it was not on top of their list even though they are quite active with AR technology. The second entity again emphasised the fact that what matters the most above all is the content before implementing any technology.

The Olympic Museum as well as the Museum of Natural History of Fribourg both declared on one hand the importance of technology but they are questioning a possible return to more traditional museums without too much technology. Silvia Mosca, digital project manager at the Olympic Museum explained that perhaps the innovation could stand in the fact to reduce the amount of technology within museums. Peter Wandeler, director of the Museum of Natural History of Fribourg shared this opinion by stating certain visitors are fed up with constantly being surrounded by digital and they are perhaps looking for a reversal of this trend to ultimately opt for simpler experiences.

Furthermore, before any technology can be used, it requires deep and wise reflection. Many respondents mentioned the importance of considering the theme of the exhibitions as a priority before thinking of a technological mean that could support it. Technology should not take the lead on the interaction field nor the message that is transmitted, yet it might still be an added value to the exhibitions and to the visitors. **Christian Rohner, from the Museum of Communication suggested: « trop souvent la technologie est utilisée pour être utilisée… c'est un add-on, sous forme d'essai et peu d'énergie est investi dedans » (very often technology is only used to be used... it is an add-on, in the form of a trial and little energy is invested in it) (C. Rohner, Head of Exhibitions and Digital Museum, PC, 7 February 2022).**

Finally, four museums interviewed mentioned the term *gadget* when referring to technological tools that are not well managed or ineffective. They suggested that the technology chosen for an exhibition must be relevant as well as having an educative purpose at the same time not to fall in the latter category, as explained **Virginie Galbarini at the Laténium Museum: « il faut que ça apporte réellement un contenu et que ce soit pas juste un gadget, c'est toujours ça le bon équilibre à trouver » (it must bring content and not only be used as a gadget, that's always the right balance). (V. Galbarini, Communication/Marketing and Public Relations Manager, PC, 15 February 2022).**

5.3 *Magic recipe* to make technologies effective

For the majority of respondents, it was challenging to provide a concrete answer to determine the *magic recipe* to what makes technologies effective within museums. Nevertheless, a few leads have been obtained and argued with.

Three of the museums that were interviewed, namely the Basel Historical Museum, the Olympic Museum and the Anonymous Museum shared similar opinions with regards to a possible *magic recipe*. For them, what truly counts is the content proposed, meaning the first element to consider when launching an exhibition is the story to be vehiculated, a story that must catch the visitor's attention and not the way and how the story is presented. **Anne Chevalley from the Olympic Museum explained « est-ce que la technologie sert vraiment ce contenu ou au contraire elle le dilue et on perd le contenu qu'on voulait délivrer » (does technology truly serve the content, or does it dilute it and as a result we lose the content we wanted to deliver) (A. Chevalley, Chief Curator, PC, 9 February 2022).** Therefore, what must be considered a top priority is the content of an exhibition, and only when this parameter is known, the potential possibility of implementing technological tools can be planned to ultimately obtain effective results.

Another element that has been shared by many museums is the fact that a technological tool must be an added value for the visitor to be effective. The goal when implementing a tool should be to attract and retain the visitor within the museum and allow him to live a global and original experience. The visitor should have the feeling of being immersed in the exhibition and ultimately actor of its visit.

For Silvia Mosca from the Olympic Museum, the key to make technologies effective is to be in a participatory process with the visitors meaning to understand what their expectations are and to what extent technology can or cannot respond to their needs. **Silvia Mosca stated: « On peut avoir toutes les idées du monde mais il faut avoir l'avis du visiteur, il faut faire**

avec eux, il faut leur poser la question. Et ça, ça sera efficace. Ils peuvent nous donner des informations auxquelles nous n'avons peut-être jamais pensé. » (You can have all the ideas in the world, but the visitor's opinion is essential, you must work with them, you must ask them in order to obtain information which we would have probably never thought about in the first place. And that will be effective) (S. Mosca, Digital Project Manager, PC, 7 February 2022).

5.3.1 Most interesting technological instruments to consider

Amongst latest generation technologies, five of the respondents suggested that the most appropriate tools referred to AR. Several reasons explained this choice. For cultural entities, this instrument is a great mean to expose additional content to the exhibitions while still being connected to the reality of the field. The Fondation Opale mentioned that the tangible content is still existing and is central to the exhibition, and then AR could support and add value to this content.

Three of the entities interviewed opted for the use of VR as most appropriate tools. Reasons for this choice are diverse. The Museum of Communication explained that VR offers plenty of new possibilities such as reliving past events or virtually visit a place that would not be accessible otherwise. Hence, recreating universes in the virtual allow brand new experiences for the visitor. The Alimentarium Museum saw potential in VR not directly within the museum, but online. More precisely, VR is an interesting tool to use in the metaverse and it offers the opportunity for people as they can interact with the museum in a different manner. Finally, for the Basel Historical Museum, VR is an appealing experience to propose for novice users.

5.4 Difficulties and challenges encountered of implementation

Four of the museums interviewed put forward the necessity of having a powerful and qualified workforce to deal with technology, which is fundamental according to them. Various competencies are required in the domain such as internal or outsourced developers, technicians that are responsible for installation and maintenance, employees working in the cultural mediation or simply collaborators that are well informed about how to use and supervise visitors about the possible tools. Solid expertise in the domain is therefore essential to be successful and to avoid any problems. Christian Rohner from the Museum of Communication stated another challenge linked to human resources. He employed the term *change management* to refer to an accompaniment of employees that are working within the same museum for many years. For him, these people need to be driven towards technological

developments, they should be directed to change but that requires consideration and takes time.

Another huge difficulty encountered referred to employees understanding how technologies work and carefully think what tools are the most suitable for visitors and how they can be implemented successfully. Such process is time consuming but taking the time to plan ahead of time is indispensable and should be granted particular thoughts according to the majority of museums interviewed. **Silvia Mosca from the Olympic Museum added: « C'est vraiment de profiler ce contenu en pensant encore une fois aux visiteurs ... C'est des défis très pratiques, pragmatiques, encore une fois proche de l'utilisateur. Et le défi qui regroupe tout ça, c'est de savoir se décentrer de sa fonction de producteur pour aller un tout petit peu du côté de l'utilisateur. » (it is really about profiling this content and again thinking about the visitors ... These are very practical, pragmatic challenges, once again close to the user. And the challenge that brings all this together is to know how to decentralise one's function as a producer to go to the user's side) (S. Mosca, Digital Project Manager, PC, 7 February 2022).**

For two museums interviewed, namely the Alimentarium Museum and the Fondation Opale, another major challenge was to find the right partners to work with, adequate associates that were able to develop effective and suitable tools.

5.5 Influence of technological tools on the visitor experience

The Museum of Communication as well as the Olympic Museum clearly confirmed that the implementation of technological tools enhanced the visitor experience within museums. Only the Anonymous Museum underlined that the visitors' experience has not been improved thanks to technology.

Several reasons have been evoked by respondents which demonstrate the enrichment of the visitor experience thanks to technology. Firstly, it allows an original and interactive experience for the user. Then, it provides flexibility as the person has a certain freedom to choose the content to be watched or heard, therefore allowing a deepness and optimisation on the information transmitted, as stated the Museum of Communication. Finally, another prominent point refers to individuals being deeply involved and immersed with the help of technology, hence resulting in a positive experience for the visitor. More importantly, the Olympic Museum explained that technology gives the opportunity for individuals not only to be active physically but also intellectually, thus enriching the experience lived.

Furthermore, three of the museums interviewed mentioned that in many cases, the presence of technology facilitated the comprehension of the message communicated as visitors were more integrated into a given context.

The Basel Historical Museum, the Alimentarium Museum and the Anonymous Museum declared that what creates a great experience for the visitor is the theme of the exhibition above all, before any technology can be added. Therefore, technology is not the first asset accountable for making the visitor experience interesting but it is the global museum offer that can create a memorable experience for the visitor, according to those three cultural institutions.

Additionally, the majority of museums witnessed that the inflow of visitors was not affected following the implementation of technological instruments. Consequently, the number of visitors has remained steady for most of the organisations. However, the offerings allowed to widen the public's museum as it was the case for the Alimentarium Museum that had families as their main target audience. Since the introduction of technology, they saw their public more diversified with young adults for instance. On the totality of museums interviewed, two of them saw their public younger, at least during the period they proposed technological tools, namely the Basel Historical Museum and the Communication Museum. For four museums, the public remained unchanged.

5.5.1 International visitors

On five museums interviewed, all of them welcome 20% or less international tourists to their museums, except for the Olympic Museum that generally receives 60% of foreign visitors. Four of these five cultural organisations attested that the use of technology inside the exhibitions is not a motive for international people to go to a museum. However, the boost of the digital on the Internet such as on social media have enabled entities to gain in visibility towards foreign visitors and in some cases was a motive to make them come and visit a museum.

Furthermore, the driver to attract the foreign clientele in a Swiss museum do not refers to the presence of technology inside the museum, but rather to iconic monuments that has a link with the Swiss traditions such as the Home of Cailler in Broc whose exhibitions are about Swiss chocolate. **Also, Andreas Mante from the Basel Historical Museum explained: « C'est l'ambiance qui fait foi, je dirais. Comme par exemple, les gens sont attirés chez nous à cause du bâtiment *Haus zum Kirschgarten*. Ce qui les intéresse, c'est de voir la bâtisse. Aussi, le musée de Musique que nous avons, c'est dans une ancienne prison. Et ça, ça attire des gens. Je crois plutôt que c'est l'ambiance qui aura le pouvoir d'attirer des touristes ou non. » (it is the atmosphere that counts, I would say. For example, people are attracted to us because of the *Haus zum Kirschgarten* building. What interests them is to see the building. Also, the Music Museum that we have is in a former prison. And**

that is what attracts people. I think it is the atmosphere that will attract tourists or not) (A. Mante, Head of Communication, PC, 31 January 2022).

5.6 Future vision of Swiss museums

5.6.1 Possible harm of technological tools within museums in the future

All museums are unanimous regarding this point, even for low-tech museums. They all agree that there is no threat nor possible harm in the future as long as technology is well managed and wisely used. Poor management or using tools without careful consideration represents a useless expense, as stated the Alimentarium Museum and the Olympic Museum.

The priority is to always consider the mission and the role of a museum and put in place tools that have an educational purpose. **Anne Chevalley from the Olympic Museum explained: « Je pense que le danger ça serait de perdre son âme un peu dans tout ça et finalement de créer une sorte de parc d'attraction et d'oublier la fonction première d'un musée qui est quand même un lieu de connaissance et de partage » (I think the danger would be to lose one's soul in all this and finally to create a sort of amusement park and forget the primary function of a museum, which is first and foremost a place of knowledge and sharing) (A. Chevalley, Chief Curator, PC, 9 February 2022).** Additionally, many respondents witnessed the utility of technology but suggested to find a good equilibrium between the physical and digital presence within museums.

5.6.2 Future technological projects for museums

On the seven museums interviewed, only two museums have further projects using latest generations technological tools. Some do not know at this stage how their following exhibitions will be presented. For the others, a majority prefer to concentrate on the technology they have already used and keep up with tools they already master before implementing another technology.

5.6.3 General museums challenges and current visitors' expectations

Respondents brought many different answers to the challenges that museums can experience nowadays as well as the current visitors' expectations with regard to those cultural organisations.

Several museums suggested that part of the challenges for institutions are to remain interesting, competitive, innovative, complementary and agile in the field. Is it essential for establishments to be able to question and to renew themselves as much as possible.

Another challenge evoked by most of the interviewees refers to the understanding of who their visitors are, what their needs are, and how to fulfil their requirements. The Olympic Museum added that it is fundamental to be visitor-oriented and to think about the amount of time the visitor wishes to dedicate to digital during its visit for instance. Three of the respondents, namely the Basel Historical Museum, the Alimentarium Museum and the Museum of Communication mentioned not only the importance to be familiar with its public but also to understand the population that do not visit their museum. The goal is to grasp the reasons behind it, and in some cases find a manner to attract this potential public. Also, the Olympic Museum suggested the need for people to have something immediate and to spend less and less time reading or trying to make an effort to access something. The museum mentioned that it can be an issue if one stays in a fairly classic version of an exhibition and advised museums to adopt digital from the beginning.

On one hand, an additional aspect concerns museums' inclusivity and the importance of being accessible and open to various cultures. On the other hand, organisations should remain sensitive towards the artists that usually come from different backgrounds as stated the Lagerhaus Museum. Being inclusive and accessible for anyone is a major challenge to be met for museums. Possible leads to be inclusive can be to go through owning the *Inclusive Culture* label as it is the case for the Laténium museum or beneficiating of the *FALC* system as explained the Fondation Opale, which represents a simplified language. Moreover, both entities insisted on the importance for visitors to feel welcomed while entering a museum.

With regard to the visitors' expectations in the near future, the public is not only in search of information and learning something new when visiting a cultural institution but they want to be entertained and to feel emotions while learning. Two of the museums questioned, namely the Basel Historical Museum and the Alimentarium Museum shared this same opinion about the subject. **Nicolas Godinot from the Alimentarium Museum explained: « Le côté un peu plaisant, de jeu…font partie de l'apprentissage…les nouvelles technologies vont y contribuer en partie. Utiliser l'Entertainment sert d'aide et de support à la réflexion et à l'acquisition des connaissances » (games are part of learning and new technologies will contribute to this. Using entertainment serves as an aid and support for reflection and knowledge acquisition) (N. Godinot, Head of Content & Curator of Natural Sciences, PC, 3 February 2022).**

Furthermore, the majority of entities interviewed explained that visitors do not only want to be passive when visiting a museum but they feel a real need to be actors in the process. This can be expressed in several ways. One way to be more active for the visitor is reflected through the possibility to give its opinion about content, themes or subjects and have valuable

exchange with stakeholders in the museum. Moreover, visitors are in the quest of being in a participatory process and to discover a multidisciplinary place. Museums can go towards this direction by offering a restaurant where the visitor can enjoy a meal, a conference room where discussions are organised or they can go even further with involving the visitor's ideas as part of a further exhibition. As for Generation Y and Z, the Museum of Communication explained that there are certainly expectations towards the use of digital since these generations are technology-oriented and are rather at ease with it.

Comparative analysis

The two graphs (tables 4 and 5) demonstrate the repartition of the comparative analysis of the 60 museums by size and typology.

Table 4: Size of museums (number of annual visitors)

Taux de réponse : **100,0%**

	Nb	
De 50000 à 500000	**28**	46,7%
500000 et plus	**13**	21,7%
De 20000 à 50000	**11**	18,3%
Moins de 20000	**8**	13,3%
Total	**60**	

Source: author's data (2022)

Table 5: Type of museums

Taux de réponse : **100,0%**

	Nb	
Other+Regional and local Museum	**19**	31,7%
Art Museum	**16**	26,7%
Archaeological+History Museum	**10**	16,7%
Technical Museum	**8**	13,3%
Natural History Museum	**7**	11,7%
Total	**60**	

Source: author's data (2022)

Tables 6 and 7 refer to the number of points attributed about the totality of technological tools used by museums. As a reminder, museums have been divided into different categories when referring to their size: **S** (small, less than 20,000 visitors), **M** (medium, between 20,000 and 50,000 visitors), **B** (big, between 50,000 and 500,000 visitors) and **L** (extra-large, over 500,000 visitors).

Table 6: Totality of technological tools in relation to the size of museums

	Moins de 20000	De 20000 à 50000	De 50000 à 500000	500000 et plus	**Total**
Moins de 3	**12,5%**	**9,1%**	**14,3%**	**0,0%**	**10,0%**
De 3 à 5	**37,5%**	**54,5%**	**10,7%**	**0,0%**	**20,0%**
De 6 à 8	**12,5%**	**36,4%**	**39,3%**	**0,0%**	**26,7%**
De 9 à 11	**37,5%**	**0,0%**	**14,3%**	**61,5%**	**25,0%**
De 12 à 14	**0,0%**	**0,0%**	**3,6%**	**30,8%**	**8,3%**
15 et plus	**0,0%**	**0,0%**	**17,9%**	**7,7%**	**10,0%**
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **<0,01** ; Khi2 = **44,97** ; ddl = **15** (**TS**)

La relation est très significative.
Répartition en 6 classes de même amplitude
Les éléments sur (sous) représentés sont coloriés.

Source: author's data (2022)

To be more precise, table 6 refers to the totality of technological tools present within the 60 museums in relation to their size. As a reminder, museums can be granted a total score of 26 points, which corresponds to the left column of the table. As it can be witnessed, S museums do not go over 11 points, with a representation of 37.5% museums between 9 and 11 points, meaning that S museums have relatively a low use of technological tools. For M museums, over half of the museums (54.5%) barely use tools with a score between three to five points. On the contrary, there is a greater use of technology for L museums with no museums below nine points, and 7.7% of these museums scored above 15 points.

Table 7: Totality of technological tools in relation to the type of museums

	Archaeological+History Museum	Art Museum	Technical Museum	Natural History Museum	Other+Regional and local Museum	Total
Moins de 3	10,0%	6,3%	0,0%	42,9%	5,3%	10,0%
De 3 à 5	10,0%	18,8%	25,0%	28,6%	21,1%	20,0%
De 6 à 8	0,0%	37,5%	37,5%	0,0%	36,8%	26,7%
De 9 à 11	50,0%	25,0%	25,0%	14,3%	15,8%	25,0%
De 12 à 14	0,0%	12,5%	12,5%	14,3%	5,3%	8,3%
15 et plus	30,0%	0,0%	0,0%	0,0%	15,8%	10,0%
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,08** ; Khi2 = **29,26** ; ddl = **20** (**PS**)

La relation est peu significative.
Répartition en 6 classes de même amplitude

Source: author's data (2022)

As illustrated in table 7, archaeological as well as history museums have the strongest presence of technology with 50% of them scoring between nine to 11 points, and 30% of museums account for 15 or more points. Besides, almost half of natural history museums (42.9%) have nearly no technological presence within their institutions.

Table 8: Presence of audio guide in relation to the size of museums

	Moins de 20000	De 20000 à 50000	De 50000 à 500000	500000 et plus	Total
0	50,0%	63,6%	42,9%	7,7%	40,0%
2	50,0%	36,4%	57,1%	92,3%	60,0%
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,03** ; Khi2 = **8,64** ; ddl = **3** (**S**)

La relation est significative.
Répartition en 6 classes de même amplitude
Les éléments sur (sous) représentés sont coloriés.

Source: author's data (2022)

Table 8 refers to the presence of audio guides within museums in relation to their size. As a reminder, the grading scale goes from zero (not present) to two (full presence) and corresponds to the left column of the table. S museums have a parity between the ones who propose an audio guide to their visitors and the ones who do not. As for L museums, 92.3% do offer audio guides, meaning that nearly every museum of this size has such offer.

Table 9: Presence of audio guide in relation to the type of museums

	Archaeological+History Museum	Art Museum	Technical Museum	Natural History Museum	Other+Regional and local Museum	Total
0	10,0%	37,5%	62,5%	71,4%	36,8%	40,0%
2	90,0%	62,5%	37,5%	28,6%	63,2%	60,0%
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,08** ; Khi2 = **8,44** ; ddl = **4** (**PS**)

La relation est peu significative.
Répartition en 6 classes de même amplitude

Source: author's data (2022)

In relation to the presence of audio guides for the typology of museum (table 9), this is the archaeological and history museums that have the best score, with 90% of entities offering audio guides. For the other typology of museums, only few natural history museums offer this tool with only 28.6% of museums. On the contrary, art museums as well as others and regional museums propose audio guides with 62.5% and 63.2% respectively.

Table 10: Presence of interactive terminals in relation to the size of museums

	Moins de 20000	De 20000 à 50000	De 50000 à 500000	500000 et plus	**Total**
0	**87,5%**	**81,8%**	**50,0%**	**76,9%**	**66,7%**
1	**12,5%**	**18,2%**	**21,4%**	**0,0%**	**15,0%**
2	**0,0%**	**0,0%**	**28,6%**	**23,1%**	**18,3%**
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,11** ; Khi2 = **10,34** ; ddl = **6** (**PS**)

La relation est peu significative.

Source: author's data (2022)

Table 10 concerns the presence of interactive terminals in relation to the size of the museums. S and M museums recorded for a similar existence of interactive terminals with 12.5% and 18.2%, respectively. As they scored one, this means those entities do not benefit from many interactive terminals within their exhibitions. Surprisingly, for B museums, half of museums do not benefit from such tools but still 28.6% have a strong presence of interactive terminals. As for L museums, only 23.1% propose several of these tools within their institutions.

Table 11: Presence of interactive terminals in relation to the type of museums

	Archaeological+History Museum	Art Museum	Technical Museum	Natural History Museum	Other+Regional and local Museum	**Total**
0	**80,0%**	**100,0%**	**37,5%**	**85,7%**	**36,8%**	**66,7%**
1	**0,0%**	**0,0%**	**25,0%**	**14,3%**	**31,6%**	**15,0%**
2	**20,0%**	**0,0%**	**37,5%**	**0,0%**	**31,6%**	**18,3%**
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,004** ; Khi2 = **22,44** ; ddl = **8** (**TS**)

La relation est très significative.
Les éléments sur (sous) représentés sont coloriés.

Source: author's data (2022)

Still concerning the existence of interactive terminals, table 11 reveals that art museums do not benefit from such tools. Moreover, natural history museums are in a similar position since 85.7% of entities do not propose it either. However, amongst all these categories, technical museums are the ones beneficiating the most from these tools with 37.5% followed by others and regional museums with 31.6%.

The following section of the analysis refers to the latest generation tools available in museums.

Table 12: Presence of AR in relation to the size of museums

	Moins de 20000	De 20000 à 50000	De 50000 à 500000	500000 et plus	**Total**
0	**62,5%**	**90,9%**	**89,3%**	**38,5%**	**75,0%**
1	**25,0%**	**9,1%**	**7,1%**	**46,2%**	**18,3%**
2	**12,5%**	**0,0%**	**3,6%**	**15,4%**	**6,7%**
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,02** ; Khi2 = **14,75** ; ddl = **6** (**S**)

La relation est significative.
Les éléments sur (sous) représentés sont coloriés.

Source: author's data (2022)

Moreover, discussing the presence of AR in museums, table 12 clearly indicates that M museums do not offer any AR technology within their institutions with a representativeness of 90.9%. B museums are in a similar case with 89.3% of museums not offering AR. As for L museums, almost half of them (46.2%) proposed AR technology at least one time and only 15.4% offered AR several times as part of their exhibitions. S museums follow L museums as they also made use of AR many times with 12.5% of cultural entities.

Table 13: Presence of AR in relation to the type of museums

	Archaeological+History Museum	Art Museum	Technical Museum	Natural History Museum	Other+Regional and local Museum	**Total**
0	**60,0%**	**68,8%**	**75,0%**	**85,7%**	**84,2%**	**75,0%**
1	**20,0%**	**25,0%**	**12,5%**	**14,3%**	**15,8%**	**18,3%**
2	**20,0%**	**6,3%**	**12,5%**	**0,0%**	**0,0%**	**6,7%**
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,62** ; Khi2 = **6,20** ; ddl = **8** (**NS**)

La relation n'est pas significative.

Source: author's data (2022)

The most widespread presence of AR stands within archaeological and history museums with 20%, followed by technical museums with 12.5% (table 13). These types of museums proposed AR several times. On the contrary, natural history museums as well as others and regional museums are the most underrepresented museums that do not benefit from AR within their exhibitions with 85.7% and 84.2% respectively.

Table 14: Presence of mobile App in relation to the size of museums

	Moins de 20000	De 20000 à 50000	De 50000 à 500000	500000 et plus	**Total**
0	**62,5%**	**81,8%**	**67,9%**	**7,7%**	**56,7%**
1	**25,0%**	**9,1%**	**10,7%**	**7,7%**	**11,7%**
2	**12,5%**	**9,1%**	**21,4%**	**84,6%**	**31,7%**
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **<0,01** ; Khi2 = **24,01** ; ddl = **6** (**TS**)

La relation est très significative.
Les éléments sur (sous) représentés sont coloriés.

Source: author's data (2022)

Table 14 indicates the presence of mobile apps in relation to the size of museums. Mobile apps are to be found under different forms. They are either serving as an audio guide or part of part of an AR project. L museums are the most represented. They received the higher score with 84.6% of cultural entities owning at least one app aiming at different purposes such as above cited or owning several apps. Moreover, 25% of S museums also owns an app.

Table 15: Presence of mobile App in relation to the type of museums

	Archaeological+History Museum	Art Museum	Technical Museum	Natural History Museum	Other+Regional and local Museum	**Total**
0	**40,0%**	**50,0%**	**62,5%**	**57,1%**	**68,4%**	**56,7%**
1	**20,0%**	**12,5%**	**12,5%**	**0,0%**	**10,5%**	**11,7%**
2	**40,0%**	**37,5%**	**25,0%**	**42,9%**	**21,1%**	**31,7%**
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,85** ; Khi2 = **4,03** ; ddl = **8** (**NS**)

La relation n'est pas significative.

Source: author's data (2022)

In relation to the presence of mobile apps within the typology of museum, table 15 shows the greatest representation within archaeological and history museums as well as natural history museums with 40% and 42.9% respectively, owning more than one app. 68.4% of others and regional museums do not own an app within their museums.

Table 16: Presence of VR in relation to the size of museums

	Moins de 20000	De 20000 à 50000	De 50000 à 500000	500000 et plus	**Total**
0	**100,0%**	**81,8%**	**75,0%**	**38,5%**	**71,7%**
1	**0,0%**	**18,2%**	**21,4%**	**46,2%**	**23,3%**
2	**0,0%**	**0,0%**	**3,6%**	**15,4%**	**5,0%**
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,06** ; Khi2 = **11,90** ; ddl = **6** (**PS**)

La relation est peu significative.

Source: author's data (2022)

Table 16 displays the existence of VR compared to the size of museums. There is a clear demonstration that S museums have no VR technology. M and B museums have similar presence of VR with 18.2% and 21.4% respectively. This means such cultural entities have used VR technology at least one time as part of their exhibitions. Nevertheless, L museums have the strongest presence of VR technology with almost half of museums (46.2%) offering this tool at least one time. Moreover, 15.4% of entities benefit from VR permanently within their museums or they have proposed this type of tool two times or more.

Table 17: Presence of VR in relation to the type of museums

	Archaeological+History Museum	Art Museum	Technical Museum	Natural History Museum	Other+Regional and local Museum	**Total**
0	**70,0%**	**62,5%**	**75,0%**	**71,4%**	**78,9%**	**71,7%**
1	**20,0%**	**37,5%**	**12,5%**	**14,3%**	**21,1%**	**23,3%**
2	**10,0%**	**0,0%**	**12,5%**	**14,3%**	**0,0%**	**5,0%**
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,56** ; Khi2 = **6,82** ; ddl = **8** (**NS**)

La relation n'est pas significative.

Source: author's data (2022)

The typology of museums that benefit the most from VR technology is represented by art museums with 37.5% of institutions offering VR at least one time within their museum (table 17). Furthermore, 14.3% of natural history museums proposed this technology several times or as a permanent way.

Table 18: Presence of AI in relation to the size of museums

	Moins de 20000	De 20000 à 50000	De 50000 à 500000	500000 et plus	**Total**
0	**87,5%**	**100,0%**	**92,9%**	**69,2%**	**88,3%**
1	**12,5%**	**0,0%**	**7,1%**	**30,8%**	**11,7%**
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,09** ; Khi2 = **6,62** ; ddl = **3** (**PS**)

La relation est peu significative.
Répartition en 6 classes de même amplitude

Source: author's data (2022)

Table 18 indicates the presence of AI in relation to the size of museums. Only M museums have no AI at all within their institution. All other museums propose AI but as they scored one, this means none of them benefit from AI in a permanent way. L museums recorded the highest percentage of AI use with 30.8% of cultural entities. Therefore, amongst identified museums, AI is not very represented.

Table 19: Presence of AI in relation to the type of museums

	Archaeological+History Museum	Art Museum	Technical Museum	Natural History Museum	Other+Regional and local Museum	Total
0	90,0%	87,5%	87,5%	100,0%	84,2%	88,3%
1	10,0%	12,5%	12,5%	0,0%	15,8%	11,7%
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,86** ; Khi2 = **1,28** ; ddl = **4** (**NS**)

La relation n'est pas significative.
Répartition en 6 classes de même amplitude

Source: author's data (2022)

Concerning the existence of AI compared to the typology of museums, the cultural institutions that benefit the most from this technological tool are others and regional museums, even though they account for 15.8% of museums only, which is rather insignificant (table 19).

Table 20: Presence of hologram in relation to the size of museums

	Moins de 20000	De 20000 à 50000	De 50000 à 500000	500000 et plus	Total
0	87,5%	100,0%	82,1%	92,3%	88,3%
1	0,0%	0,0%	14,3%	7,7%	8,3%
2	12,5%	0,0%	3,6%	0,0%	3,3%
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,43** ; Khi2 = **5,92** ; ddl = **6** (**NS**)

La relation n'est pas significative.

Source: author's data (2022)

Table 20 shows the presence of holograms in relation to the size of museums. Similar to AI, this technology is not very significative within museums. Only 12.5% of S museums offered holograms more than one time or permanently and 3.6% for B museums.

Table 21: Presence of hologram in relation to the type of museums

	Archaeological+History Museum	Art Museum	Technical Museum	Natural History Museum	Other+Regional and local Museum	Total
0	80,0%	93,8%	87,5%	100,0%	84,2%	88,3%
1	20,0%	6,3%	12,5%	0,0%	5,3%	8,3%
2	0,0%	0,0%	0,0%	0,0%	10,5%	3,3%
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	

p = **0,51** ; Khi2 = **7,27** ; ddl = **8** (**NS**)

La relation n'est pas significative.

Source: author's data (2022)

As for the existence of holograms compared to the type of museums, it can be found in others and regional museums with 10.5% of entities (table 21).

Chapter 6 – Interpretation and discussion of the results

In this chapter, the earlier results will be interpreted but also put in relation with the findings of the literature review. The structure of this section refers to the first three research objectives that can be found in chapter two of this paper. The last objective will be considered in the recommendations chapter as it concerns guidance and best practices intended towards museums' professionals.

Understand Swiss museums' motivation or rejection to integrate technology

The majority of museums explained that they were favourable to the implementation of technology and find it truly useful for delivering content and to make it more understandable. Indeed, it allows many possibilities for organisations to present artefacts or to transmit knowledge and therefore deepen the offerings. This pairs with the literature review where for example AR and VR is said to be effective for a better understanding of the content proposed due to the level of immersion. It therefore gives the opportunity to visitors to better understand the content of exhibitions (Camps-Ortueta et al., 2021).

Furthermore, people attach nowadays a great importance to experiences meaning they wish to be involved into a process and not just being passive but actors. They are in search of emotions. The last element was put forward by respondents as part of their motivations to introduce technology within their institutions. Therefore, technological innovations enable visitors with greater interaction and allow them to be part of an experience since they are not just looking at exhibitions passively, as stated Pop & Borza (2016) in the literature review chapter. Moreover, based on the findings of Jarrier et al. (2019), many cultural institutions are granting a huge importance to implement digital innovations within their exhibitions with the purpose of enhancing the visitor experience. In line with their ideas, there is a necessity to stimulate many features such as the five senses, pleasure, imagination or cooperation.

More importantly, many respondents claimed that the motivation should not come from the technology itself but one must have a solid and fundamental idea of the theme, story, and purpose of the exhibition. This is where priority should come first. Only when this parameter is known, then a technological instrument can be considered to support the content. Therefore, technology should not be integrated without careful thinking, and other dimensions must be studied such as the purpose of implementing technological innovations and how it will add value for the visitor.

Amongst the museums interviewed, technological tools are widely used within temporary exhibitions, except for the Museum of Communication whose proposing robots as a permanent

approach. In the context of latest generation technologies, the latter museum is the only one using holograms and none of the nine institutions ever made use of AI. This can be explained due to the complexity of integrating such tools as well as their relatively high costs. However, most museums interviewed made use of AR or VR as part of their exhibitions, which seems to be more accessible as it requires less expertise and in some cases, part of the processes can be done internally. A rationale for museums to make use of technological innovations as part of their temporary exhibitions and not in the context of permanent ones can be explained due to the fact that permanent exhibitions usually have a lifespan of around ten years meaning the content has to be defined for such period of time. Therefore, since technologies evolve rapidly, it makes it easier to plan latest generation technological tools as part of temporary exhibitions as their content is being modified more regularly and it is less risky of becoming obsolete. This matches with the statements of Weiwei et al. (2021) who explained that visitors' needs change rapidly as well as technology does.

To continue with, the Laténium Museum as well as the Museum of Natural History of Fribourg are two low-tech museums, as explained earlier. Even though they are not against the presence of technologies within museums, the Laténium Museum explained that archaeology is a complex discipline and it quickly evolves thanks to new discoveries. Therefore, there is a fear of misrepresenting the content through the use of technology as it would oblige the visitors to see it in a certain manner, which can be biased or unrepresentative. In addition, it is not part of the vision of the institution since they prefer to focus on offline cultural mediation rather than on using latest trend technologies. Furthermore, they do not see any added value for their entity as well as their typology of museum. Nevertheless, they really care about delivering a message to each type of visitors they welcome and find it important to show the excavations as they are, in a tangible manner and not with the use of technological instruments. This overlaps with the statements of Pop & Borza (2016) who suggested that some museums prefer low-tech settings at they are as engaging as the use of technological innovations. Besides, if the latter museum had a specialist in digital technologies, they would maybe have considered having such tools. Therefore, it shows the importance of having qualified employees dedicated to this purpose.

Just like the Laténium Museum, the Museum of Natural History of Fribourg is not against technology within museums' walls and find it appropriate if it can tell a story in a more comprehensive way. The organisation has already considered using AR but they explained it needs careful reflection and once again it must be adapted to the content. Also, the latter museum usually lends itinerant exhibitions to other institutions and this may be even more complicated to have technological devices since damage can be caused, according to the museum.

Motives of rejections to implement technological tools are multiple. Indeed, cost issues can occur, or the budget allocated to the exhibitions may be limited for introducing technological innovations. Another factor relies upon the desire of visitors to have the possibility to experience, share and to give their opinion with museums. Such statement has been emphasised by Mairesse et al. (2017). Indeed, the authors declared that visitors express a real need to learn, share knowledge and debate when visiting museums. This can hardly be done with technological instruments but more with physical museums' professionals. Therefore, mediators are in some cases considered more relevant since they allow a real exchange between the museum and the visitor.

Above all, the role of museums should not be forgotten and the object should always be centered to the exhibition. Such element must be prioritised over any technological innovation. Only then technology can be added and can serve as a support to enrich the experience. Furthermore, there is a general frustration of many people having to be confront to technology in their daily lives. Consequently, some museums are questioning a reversal of the trend to reduce the amount of technology offered, which could be even more relevant for visitors. Finally, technologies evolve rapidly as stated earlier and this component should be considered before implementation.

Implications concerning new technologies within Swiss museums

There were many challenges that were encountered by museums before and during the implementation of technology. Indeed, several points were brought. Surprisingly, the amount of money to be invested was not one of the main aspects that were put forward by respondents. Only the Basel Historical Museum referred to the important expenses that can occur when introducing technology. Such results contradict the claims of Courvoisier (2020) that explained financial aspects are part of major challenges of implementation. In the case of Swiss museums, this can be explained due to the fact that they receive financial help from the state or municipalities, as explained in the *background information and context* chapter, although budget dedicated for such purposes might surely be limited. Furthermore, all respondents agree that qualified workforce should be hired to handle technology efficiently, especially when technological projects are led internally. Indeed, skilled labour force is vital for institutions. Hence, improvements involving employees' training as well as hire specialists in the domain needs careful consideration.

Concerning the visitor experience, many of the interviewees explained that this is not really the technology that encourage the public to come and see museums of their interest but rather the theme or the content that is to be presented. Moreover, this is more present especially in

the case for the international clientele. Indeed, when visiting cultural institutions such as museums, foreign visitors prefer to see very typical aspects of the Swiss culture such as visiting the House of Cailler in Broc or the House of Gruyère in Pringy, both synonymous of national heritage. Moreover, international visitors may be reluctant to visit some museums due to the strong Swiss franc, which ultimately leads to an unaffordable price for this public. However, online offerings may be a pull factor for international visitors and serve as an initial contact to further inspire this public to come and visit a museum. Still concerning the visitors, latest generation technologies enable the public to be more immersed into an exhibition and have the power to provide an edutainment experience, meaning that on one hand it has an educative purpose and on the other hand it permits the visitor to be entertained. Hence, technology results in positive outcomes in relationship with the visitor experience.

Also, results from the analysis demonstrated that today's museums should offer a global experience for the visitor and make museums lively places. This means visitors not only spend an hour in within museums' exhibitions and then leave but the goal is to retain the visitor longer within facilities to enrich its experience. This is reflected in visitors visiting exhibitions and experiencing technology, going to a restaurant enjoying a coffee or a meal, go to the shop to buy a souvenir, then go to a conference room for a discussion or a show and so on. Two of the respondents, namely the Museum of Communication as well as the Fondation Opale see the general tendency for museums to becoming more and more a hybrid place, where the visitor participates in many different activities within the museum and where offerings is pluralistic. Part of hybridisation also refers to a combination of online as well as offline content or a mix between analogue and digital within exhibitions. This overlaps with the statements of Simone et al. (2021) where they presented the typology of museum called *augmented museum* corresponding to a fusion between onsite and online, thus enabling a more hybrid museum experience.

Furthermore, results from the analysis revealed that there is no threat of using technological innovations within the future, as long as it is well managed and adequate in the context of museums' exhibitions. This can be explained due to the fact that people are constantly connected nowadays and rather at ease with technology. Therefore, digital instruments have their place within museums even though a good equilibrium must be settled according to the visitors' needs and preferences.

Level of use of technology within Swiss and foreign museums

Overall, the results of the comparative analysis of the 60 museums demonstrated that B and L museums tend to offer a greater amount of technology within their institutions compared to S and M museums, particularly when it comes to latest generation technologies (AR, mobile app, VR, AI and holograms). In addition, archaeological and history museums followed by others and regional museums are the typology of entities using technology the most, according to the benchmark analysis. Nevertheless, natural history museums are rather low-tech museums.

Furthermore, foreign museums mainly benefit from a stronger presence of technology compared to Swiss museums. Indeed, no foreign museums scored under seven and the British Museum in London as well as the Virtual Archaeological Museum in Ercolano received the higher score with regard to their use of technology.

The following sections refer to each technological tools individually, which were examined in the *results and analysis of the study* chapter.

Concerning the presence of audio guides within museums, they are mostly present within L museums with almost every museum offering such tool. As for S and B museums, half of these museums do propose audio guides. Moreover, they are the most represented within archaeological and history museums, art museums and others and regional museums.

As for the presence of interactive terminals within museums' exhibitions, they are barely present within S and M museums but find more territory within B and L museums. Typology of museums not proposing interactive terminals at all are art museums, which is rather understandable since they mainly expose artworks as core content of their exhibitions. On the contrary, interactive terminals are mostly represented within technical museums as well as others and regional ones.

From a general perspective, the use of AR is rather low within analysed museums. Only a minority of S, B and L museums have been introducing these tools several times or permanently within their exhibitions. Nevertheless, almost half of L museums have already made use of AR technology once. Concerning the type of museums using AR, they are the most represented by archaeological and history museums. In contrast, AR is barely used within natural history museums as well as others and regional entities.

Furthermore, for the use of mobile App, L museums clearly benefit from one or several Apps as part of their offerings. Surprisingly, more than one third of S museums owns at least one App. Archaeological and history museums are the typology of museums who are the most

represented when it comes to propose a mobile App. Besides, only a minority of others and regional museums propose an App.

Concerning the use of VR within analysed museums, there are not any S museums who have already used this technology. As for M museums, less than one fifth have already implemented VR once. On the contrary, there is a bigger use of VR for B and L museums. To be more precise, almost half of these museums have used this technology once and 15% of them proposed VR many times or permanently within their exhibitions. Furthermore, VR finds its place mostly within art museums.

As for AI, no museums analysed offer such tools permanently. Additionally, M museums do not offer AI at all. However, almost 40% of L museums made use of AI once. AI seems to have find its place the most within others and regional museums, even though the percentage of these entities is rather insignificant.

Regarding the presence of holograms within cultural organisations, it is barely represented generally speaking. The size of museums where this technology is the most used is by B museums. Typology of museums that are the most represented are others and regional museums even though they account for 10% of museums, which is again rather insignificant.

Besides the existence of technology within museums' exhibitions, the comparative analysis showed that cultural entities also benefit from a strong online presence. The 60 museums analysed all make use of social media to communicate with their public. Most museums are active on more than two social media, generally on *Facebook*, *Instagram* or *Twitter*. Some of the institutions employ other platforms such as *TikTok*, *LinkedIn* or *YouTube*. Surely, the COVID-19 crisis has accentuated the use of social media for cultural institutions, in particular during the lockdown causing temporary closures of museums. The latter statement has been emphasised by a study led by the ICOM in Simone et al. (2021) in which it was confirmed that the lockdown boosted the use of technologies. Additionally, 25 of the 60 museums expose their collection online and only 13 out of 60 entities offer their visitors a virtual tour on their website.

Chapter 7 – Recommendations

Following the results of the analysis, some recommendations as well as best practices are given regarding the use and implementation of new technological tools towards museums' actors. This chapter responds to the research question *How can Swiss museums take advantage of technology, especially latest generation technological tools to enrich the visitor experience?* as well as the last research objective which is *Formulate recommendations about the best practices for the museums' managers*. The recommendations are intended towards museums' professionals but can be adapted, to some extent, to other types of institutions who wish to implement technological instruments someday.

Prioritise the theme or content before the implementation of any technology

To begin with, the first recommendation denotes the consideration of the latest generation technological tools to be integrated. Before any implementation of technology, the theme as well as the content must be considered a top priority before wishing to implement any technological support. It is only when this factor is known that professionals can start to think about a technological innovation that can support the content of an exhibition. Indeed, rush headlong will not be helpful and can cause failure in terms of desired results. There is no point of introducing technology just for fun or because one thinks it can bring additional value to the exhibitions and increase the attractiveness of a museum without thinking about it rigorously. One must not think that technology is a universal solution but it must be a real added value to the visit while aiming at an educative purpose. Once appropriate technological support is found, it needs reflection regarding multiple aspects. Museums should reflect on how technology will add value to the content offered as well as the manner to proceed to be successful and to achieve expected outcomes. Moreover, cultural organisations should consider the fact that technologies evolve at a tremendous speed. Therefore, it is highly recommended for museums to have a long-term vision when considering any technological tools. *As a concrete action, once museums know exactly how their exhibition will be set, they could look for adequate technological tools to be used and that will truly support their content.*

Consider the visitor experience and find a good equilibrium with technology

Subsequently, the second recommendation refers to put a special focus on the visitor experience while integrating technology. Indeed, one must think about the target market as well as their regular clientele to define what tools would be the most appropriate and the ones who would not. In some cases, it could be worth considering another public that is not regular or not part of the usual clientele and try to attract and encourage such visitors to come and visit a museum, partly thanks to technology or to special temporary exhibitions. Furthermore,

the customer journey should be considered as a whole and then the goal is to assess how much place to grant to technology to create a complete experience. A good equilibrium must be found between the analogue offerings as well as the digital one in the customer journey. In line with the above, museums should go towards the direction of being a hybrid place. Indeed, not only does the visitor enters the museums' wall to see exhibitions, accompanied by a guide or not, but that person also makes use of other facilities. Nowadays, it is becoming more and more common for museums to open restaurants, coffee shops, seminars' rooms and so on. Some museums even go further and propose events such as yoga lessons or gatherings with artists or renowned celebrities. Therefore, it gives the opportunity to visitors to be actors of their visit and to be fully immersed and involved into a real experience. More importantly, the atmosphere of the museum must be welcoming to attract and retain visitors. *Concrete steps for museums are to draw customer journey maps which include all the phases the visitor does before, during and after the visit. This will help museums to grasp where to put the focus and to better understand the visitor's needs. A few examples of customer journey maps can be found in the appendices (see Appendix XVI). Moreover, another lead consists of directly asking the preferences to the visitor through surveys, for instance. Additionally, the use of storytelling can be of a powerful tool to enrich the visitor experience. Storytelling has numerous properties such as captivating the visitors' attention, arouse emotions or help in understanding and better retain information.*

Surround with the right people and partners

Likewise, the third recommendation has to do with the necessity for museums to be well surrounded, either internally or externally. Indeed, museums must consider having a qualified workforce that can handle technological instruments efficiently as well as propose and explain the functioning to the visitors once technology is launched. Moreover, prior the implementation of technology, cultural entities may need expertise from internal developers, digital specialists, content creators, cultural mediators or curators to create the content to be put in place. Skilled labour as well as diversified one is the key to be successful and to propose relevant technological offers. In addition, in the case of external partners involved in the process, the selection of associates must be wisely chosen and need comparison between partners to select the most adequate ones. Indeed, outsourcing tasks enable on one hand a solid expertise and on the other hand a fresh as well as a different vision. *Possible steps for museums are to well structure and define the various positions within the company and try to make sure to recruit employees with necessary skills. As for finding the right partners, museums can ask other cultural entities that outsourced their project and assess whether these entities were satisfied or not with partners their worked with.*

Joining forces with other museums

Finally, the fourth recommendation depicts the cooperation between various museums to join their strengths in order to achieve common results. Indeed, museums can take advantage of other cultural entities to share technological resources. In other words, it means that institutions can work and bond together to set up technological tools that can further be adapted to many museums. This will enable to reduce expenses by sharing costs and gain in the diversity of offerings. Not only will it be beneficial for museums in terms of cost reduction but also this will enable to reinforce the relationship between entities. *Concrete leads for museums are to come up with a common server where they can share useful and valuable information with other museums. Also, this will help museums to better share information with regard to a planning concerning the use of a common technology.*

Chapter 8 – Limitations of the study and future research

Following this study, some limitations aroused and will be presented down below. Additionally, one can be questioning about other essential elements that are worth considering towards the use of technological tools within museums. Hence, future research can ben deepen regarding this subject and are presented in this section.

Even though the qualitative approach directed by semi-structured interviews was beneficial due to the richness of information that was provided, it still has several limitations. Indeed, with over 1,000 museums on national soil, it was hardly impossible to interview all of them due to time constraints. Consequently, the number of museums interviewed (nine entities) represent only a small percentage over the totality of institutions, resulting in a fairly limited generalisation of the results. Therefore, the intervention of additional respondents would have been even more valuable.

As previously stated in the paper, a comparative analysis of 60 museums has been elaborated, thus also including some limitations. Since 40 out of 60 entities are located in Switzerland, this corresponds to less than 4% of the total number of institutions. For more representativity, this would have been interesting to collect data from an additional number of museums in Switzerland and abroad, while still taking into account crucial parameters such as the typology or the size of the museum.

This study has a special focus on the museums' point of view, meaning the judgment from museums' professionals about their vision of technology inside cultural institutions. For further research, it could be worthy having the opinion of the visitors since they are the most concerned about digital innovations within museums, as users. Therefore, investigating visitors' desires and needs towards technology would be more than valuable to assess whether this would coincide with the vision museums have. Moreover, this could provide additional inputs for cultural entities and could help them to best meet visitors' expectations.

As a second element, investigating into other existing technology available on the market to be implemented within cultural organisations such as museums could be valuable. Exploring, deepening and evaluating other innovative technology that are not already used by museums hence should be part of further studies. This will help in identify to what extent they can be used as part of museums' exhibitions as well as witnessing any potential of application to the field. Ultimately, this will be useful in categorising new ways of transmitting information with the use of technology.

Conclusion

Following the results of this research paper, it has been demonstrated that technological tools seem to have their place within cultural institutions that are museums. Even for low-tech museums, respondents mentioned that they were not against the presence of technology within museums as long as it is effectively used and managed. More importantly, museums interviewed saw potential of their implementation to deepen their offerings and to propose variety and novelty in the content offered.

Moreover, in relation to the research question *How can Swiss museums take advantage of technology, especially latest generation technological tools to enrich the visitor experience*?, several leads have been discussed throughout the entire paper. Indeed, museums understood the fact that individuals are nowadays looking for a way of living authentic and unforgettable experiences. Therefore, they try to adapt to the visitors' needs in that sense even though technology should remain an added value for the visitors and not being prioritised over the theme or content proposed. Technologies are not a universal solution, but they can help in a positive experience for the visitor.

Also, it has been demonstrated that several parameters are essential for implementing technology within exhibitions. Indeed, qualified workforce is required as well as being surrounded with the right partners to work with. In addition, museums interviewed are aware that technological instruments must have an educative purpose and highlight the notion of not just being used to entertain visitors. Furthermore, the goal is to be cautious and to find a good equilibrium between the amount of physical as well as technological offerings for a complete visitor's experience.

Consequently, most Swiss museums examined in the comparative analysis have made use of technologies within their exhibitions, although the presence of latest generation technologies is not the most predominant over usual technological innovations. In comparison to the foreign museums studied, Swiss museums are offering less technological instruments. Only a few Swiss museums truly stand out.

To conclude this research paper, the digital world we live in will continue to evolve and to remain of a huge importance in the future. Cultural institutions should follow this trend and make use of technology to remain competitive in the cultural field.

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Author's declaration

I hereby declare that I have carried out this final research project on my own without any help other than the references listed in the list of references and that I have only used the sources mentioned. I will not provide a copy of this paper to a third party without the permission of the department head and of my advisor, including the partner company with which I collaborated on this project, with the exception of those who provided me with information needed to write this paper and whose names follow:

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