Master Programme in European Studies of Society, Science, and Technology (ESST)

INNOVATION IN MUSEUMS

THROUGH THE USE OF ICTs

Camila Costa Barbosa

Oslo, 20/03/2013

16935 words

Camila Costa Barbosa

camilacb8@gmail.com

University of Oslo

Autonomous University of Madrid

European Studies of Society, Science, and Technology (ESST)

Supervisor: Fúlvio Castellacci

Word count: 16935

Abstract

In the last decades, museums have transformed their role from restricted high-class mausoleums to popular attractions along with other leisure activities for both local and touristic routes. Hence, they have to relate with the socio-economic environment in similar ways as for-profit organizations, concerning the sustainability of their operations, and to innovate to achieve excellence in their mission of serving the society with socio-cultural and educational purposes.

While museums have many ways to innovate, the dissemination of information and communication technologies (ICTs) in this field has recently received some attention for their influence and the possibilities those tools offer to enhance innovative strategies. ICTs are found in most museums operations, both inside and outside its walls, being used by the work team, users/visitors, the market, and the environment in general. Those tools can help from internal procedures, to exhibition design, and customer relationship management. Despite recent researches, however, our understanding of the different functions played by ICTs for the innovative activities and economic performance of museum organizations is still limited.

The aim of this thesis is to investigate further how museums make use of ICTs in order to execute and achieve success in their innovative projects and goals. Based on the existing literature, the thesis presents a new typology of ICTs' use in museums dividing technologies according to their characteristics, objective, and place of use. This typology is later confronted with empirical results to investigate the impression visitors have about the relevance of ICTs in promoting innovation.

Keywords: museums, creative industries, innovation, ICT, audience.

TABLE OF CONTENTS

TABLE OF ILLUSTRATIONS

1. Introduction

Museums were considered, for very long, as mausoleums in which artefacts were protected from deterioration and, as well, from the access by the society in general (Witcomb, 2003). Most museums nowadays, however, do not appear to be likewise anymore. Independently of the type of collection or institutional support they carry, museums are becoming increasingly available and a greater number of people have access and interest for this kind of institution. Many museums are now important destinations along with other local or touristic routes, acting as a social meeting point for the different groups of visitors, as well as serving as significant research centres. Museums have become thus a significant agent in the local and global economy. For those reasons, these institutions have to seek new and improved ways to operate and communicate with visitors and the environment whilst working towards their main mission: producing cultural value for the society. Museums and other cultural heritage institutions are one important part of the 'creative industries' and innovation in the creative industries provide major stimulating outputs towards economic evolution (Koellinger, 2008). Many experts agree that the creative industries are vital producers of innovative inputs to many markets (not only in its own field, but also into other sectors) (Müller et al., 2008).

Innovation is a very complex process found in form of products, services or processes, that affects technological, organizational, managerial, market, and user behaviour dimensions (Archibugi and Iammarino, 2002; Miles and Green, 2008). It refers, in most cases, to the ability of an organization to adapt to changes of the environment at the same time as producing itself changes that affects the environment, in a simultaneous endless loop (Peacock, 2008). In most part of organizations within the creative industries, innovative inputs come from the results of the interaction with consumers (and non-consumers) (Mulgan et al, 2007). Innovation is essentially a social response to the changes in user behaviour, however in

form of products/services (and processes - created to allow the development of these products or services) designed based on the opinion and needs of the users. The active participation of users in today's industries has revolutionized the way products and knowledge are produced, diffused, and consumed (Bahkshi and Throsby, 2010). This revolution generally relates to the technological revolution that happens in the information and communication technology industry.

The new and social technologies have radically changed the way society functions from daily aspects to radical changes. The ICTs and other great inventions like the steam engine machine and electricity are compared with each other due to their ability of performing multiple functions through their practical and facilitating tools (Hempell et al, 2004). In the case of museums, the new technologies can improve and change institution's operative and conceptual aspects. ICTs can serve as tools to enhance the way institutions use their internal operative systems, create revenue-generating activities, exhibit artefacts, communicate with its publics and the market, diffuse knowledge, conserve, and research.

1.1 Research goals

In this study, the analysis of innovation in museums occurs in parallel with the study of innovation in the creative industries once the latter have additional available material and outgoing debates, differing from the specific case of museums. By studying technology and innovation in the creative industries, this work can withdraw a better understanding of the relationship of these two main topics: innovation and technology within museums.

There are several studies made about economics, innovation, and technology; although, there are not that many studies oriented to the cultural heritage field, especially concerning museums. Still, these institutions are important and influential agents in many

sectors of today's society. The effects appear in a wide range of domains such as incentives on local economy, their participation in the evolution of new and social technologies, and in the social and cultural service provided through their products. Therefore, it is essential to investigate the cultural heritage field, as many academics and experts currently attempt to do, as to understand further the position of these cultural heritage institutions in consumers' lives. It helps to create a democratic and sustainable evolution of culture, society, economy, technology, and within the field itself in the ever-changing environment. Moreover, there are not that many studies taking in consideration, specifically, the characteristics of these technologies for museums' users and institutions (but only its consequences in the market, economy, and growth). To achieve this wider perception about museums, technology, innovation, and the environment surrounding it; I propose the following research question:

RQ: How do museums innovate using information and communication technologies?

In this study, the types of technological innovation suggested by Vicente et al. (2012) (organizational/managerial and visitor experience), will be explained to a greater degree. The study divisions found in the works of Bahkshi and Throsby (2010) and Camarero and Garrido (2011) will be equally considered, in order to define the investigation's own distinct conceptual distribution of topics. The former, concentrate the study surrounding similar categories as suggested by Vicente et al. (2012): audience and business model/management (in addition to value creation and art form, which will not be included in this analysis because this investigation will be about museums in general and not specifically about museums of art). The latter, considers the market (behaviour and conceptual issues towards collaboration

and funding projects) and service dimensions (quality and value towards managerial and organizational orientations).

This investigation will attempt to consider all those predominant conceptual outputs provided by the literature review, but it will set them in a cause and effect (variables)analysis of the interaction between users and technologies (see figure 1, below). Consequently, after the briefly presentation of the introductory theoretical framework, the work will follow three main subdivisions, according to the type of innovation as a result of the interaction with the ICTs in museums. The divisions will willingly help to give a better understanding of the greater picture of the environment surrounding museums, setting the users and technologies in focus, instead of solely concentrating the variables dependants on institution's agency.
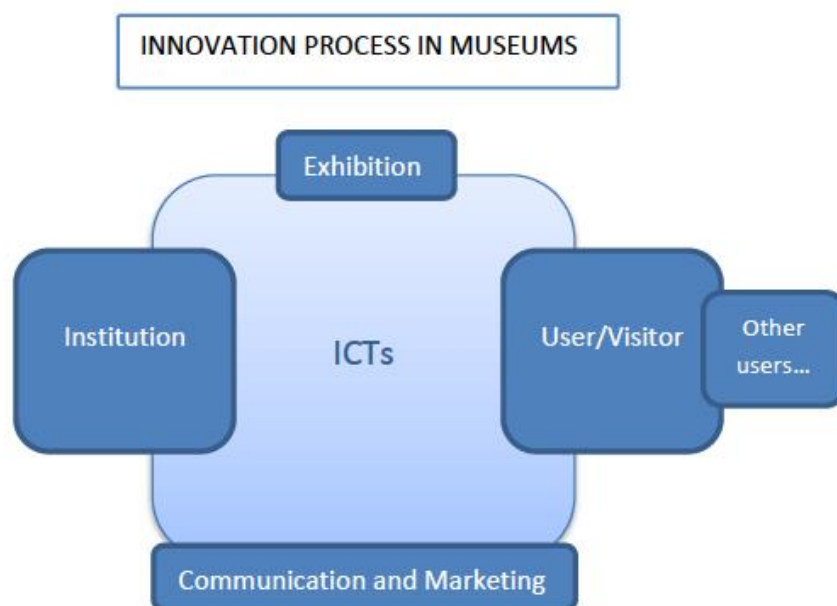

Figure 1: The figure above illustrates the investigative model chosen for this research in which the institution and the users/visitors connect through technologies before, during, and

after the visit, regarding communication goals and the management of the possible relationships with each other (and others).

1.2. Structure of the thesis

This study is composed of four main sections: (1) literature review, (2) typology of ICTs in museums, (3) methodology, and (4) results. This structure attempts to provide a clear way to the understanding of the investigation methods from the presentation of definitions and current context surrounding the main topics, description of specific tools and strategies, and the empirical part, to the extent of the verification of the validity of the suggested typology is possible.

I will start by presenting a brief description about the current context surrounding museums and other cultural heritage fields, and the creative industry sector in which museums are enclosed (chapter 2). Further, in the first section, I will describe the types of innovative activities and innovation characteristics of both the cultural heritage field and in general terms (chapter 3). In the second section, I will describe the use and influence of technology in our lives and in museums, plus give examples of the foremost technologies currently in use in museums (chapter 4). These first chapters will serve as reference for the clarification of the elements that later will go under investigation and analysis on the third and fourth sections. The third section will describe the methodology in use through mixed research methods as interviews, survey, and non-participative observation (chapter 5). The fourth section will analyse the diversified material and cross it with the theoretical review presented beforehand to explore research's results (chapter 6). Lastly, the analysis of the results will lead the work to the presentation of its final remarks (chapter 7).

Summary of sections and chapter:

Section 1 – Literature Review: chapters 2 and 3.

Section 2 – Typology of ICTs in museums: chapter 4.

Section 3 – Methodology: chapter 5.

Section 4 – Results: chapter 6.

I believe it is important to emphasize that the terminology used in this investigation may vary across other studies and academics, as well as among users and producers. In this thesis, for example, I will use the terms 'real' and 'physical' when referring to museums inside buildings' walls, and terms 'virtual', 'digital', and 'online' will serve to illustrate their Internet versions or other kinds of tools based of information and communication technologies. In addition, the delimitation of topics treated in this study follows an attempt to provide a brief and overall overview of the field of museums. There are, despite, many other relevant and strongly related topics that would need consideration when producing such study (like intellectual property issues, policies, value creation, knowledge management, and information society). These topics will not be analysed in their totality (if at all) in this thesis, nonetheless, due to practical and conceptual grounds.

2. Cultural heritage institutions and the Creative Industries - Definitions and current context

2.1. Cultural heritage institutions

Museums are one kind in the wide range of cultural heritage institutions. Other institutions included in this sector are libraries, art galleries, churches, and parks, schools, and the print media. Museums usually concentrate their efforts and arrange their collections around pre-defined subjects of interest like, for example, art, archaeology, architecture, science, history, technology, and photography. They can also vary conforming to size, age, institutional style, and type of funding. Museum's field is, for these reasons, heterogeneous according to its organizational and cultural aspects. Withal, museums commonly demonstrate a dogmatic position when defining the curatorial goals of exhibitions in agreement with their own orientations instead of reflecting society's interests (Macdonald, 1998). Nowadays, however, museums are transforming their role as conservative mausoleums to a more socially engaged posture, including and representing both high and popular cultures (Witcomb, 2003). A more contemporary definition, as delineated here by the International Council of Museums, addresses museums as "a non-profit making, permanent institution in the service of society and of its development, and open for the public, which acquires, conserves, researches, communicates and exhibits, for purposes of study, education and enjoyment, material evidence of people and their environment" (http://icom.museum/the-vision/museum-definition/).

Granting that museums primarily are not-for-profit institutions, with essentially social aims as their main objectives (such as education and preservation), Camarero and Garrido (2011) calls attention for the fact that museums also depends on the creation of revenue.

These institutions are part of the competitive field of recreation and leisure activities, being included in both touristic and local routes and, furthermore, affecting local economy (Frey and Meyer, 2006). This is because museums have to compete for the investments and spare time of the public just as other cultural and recreational activities (Anderson, 1999). Today it is possible to observe how museums have thus changed. Museums try to adapt to new contexts aroused from greater social changes. Museums are, nowadays, as laboratories of our social records (Telos, 2012). Conform this approach; the response of museums to social shifts puts them in a new position of mediators of culture, instead of an authoritarian producer (opposite to the idea of museum as mausoleum). One of the latest works of Vicente et al. (2012) define the current position of museums as agents of "preservation and valorisation of cultural heritage support for artistic creation, facilitating access to and involvement in culture, protecting pluralism, freedom of expression and cultural diversity" (p. 653).

The urge of museums and cultural institutions to keep themselves updated with current and constant changes of society forces them to engage (at least partially) in commercial strategies as any other for-profit enterprises, although their non-profit and social goals still being the main purpose of institutions (Bahkshi and Throsby, 2010). Consequently, museums are now more engaged in innovative activities in order to operate in a more sustainable, attractive and interactive way with its public and the society in general. Here is where tools like the new information and communication technologies (ICT) play a main part as the leading innovative means of this current (and future) role of museums and other cultural heritage institutions (San Martin, 2012). The new technological developments in the museum field meet not only technical challenges but new paradigms too. It proposes the reanalysis of institution's mission and vision, internal structure and practices, and stronger relationship management (with other actors as its visitors/users, market, and the environment in general) (Novak et al., 2001).

2.2. Creative industries

By the end of 1990's was already clear the economic influence (at both micro and macro dimensions) of activities associated to culture, creativity, and knowledge. As an attempt to aggregate all the related activities into similar market groups, this field had (sub-) definitions as 'cultural sector' and 'cultural industry'. In the end, the definition of the concept as 'creative industries' was in favour of the inclusion of the diverse strategic and characteristic aspects and issues of each market (Cunnigham et al., 2004; Garnham, 2005; Potts et al., 2008 and Potts, 2009b). The European Union suggests, as guidance, that the 'cultural sector' produces cultural products and services to be experienced 'in situ' such as visual art, dance, photography, libraries, and archives (20+20, 2010). The 'cultural industries', however, comprehend the producers, reproducers, diffusers, and exporters in mass of cultural products as the print media, television, and cinema. Subsequently, the 'creative industries' are the connection between these two definitions where culture serves as the creative impulse and the starting point to the production of creative and cultural products/services and, ergo, innovation. Albeit, once the boundaries and definitions are yet not precisely established and unanimous, the accounts of each field conclude by crossing with each other. The currently cross-sectional definition of creative industries is to encompass both cultural sector and cultural industry in one and only wider industry. This compilation into creative industries offers a better understanding of the "non-market economy of cultural public goods and private imagination that seeks new ways of seeing and representing the world" (Potts et al., 2008, p. 3).

Museums, as shown in the figure 2 (below), are part of the creative industries. In this study, I will use the creative industries as a reference for the study of innovation in museums once there are only few works specifically concerning innovation precisely in museums. On

the other hand, innovation and economic evolution related to the creative industries is receiving gradually more attention of critics and academics.
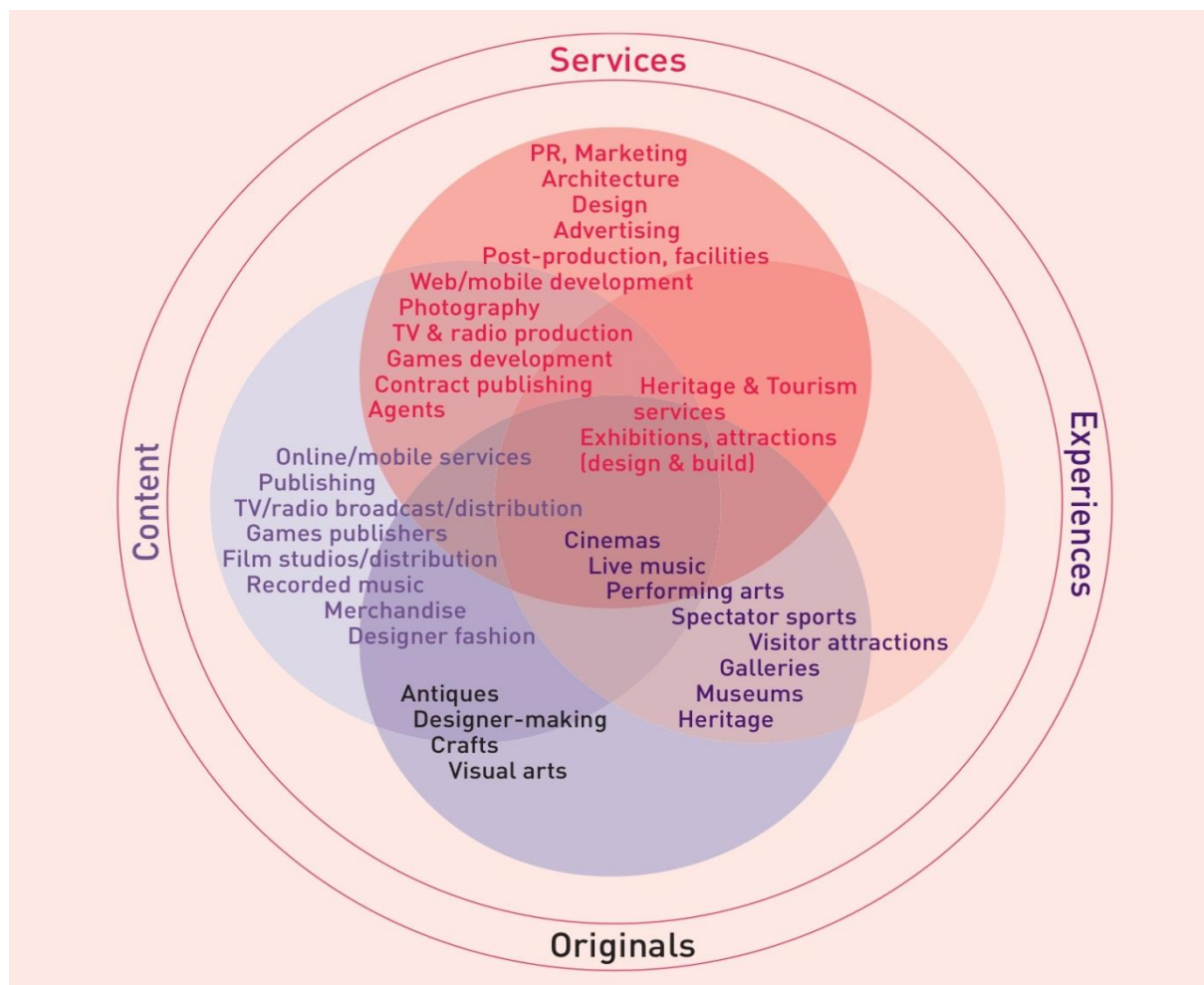

Figure 2: The figure above shows the distribution of products and services within the creative industries (NESTA Report, 2006, p. 55).

The way cultural goods are originated, produced, and distributed is being transformed due to changes in society, through the "the rise of human creativity as the key factor in our economy and society" (Florida, 2004, p. 4). Müller et al. (2008) explains that immaterial outputs (like content) are taken into consideration to a higher level in the creative industries

(instead of the physical product, conversely to other industries as, for example, the manufacturing sector).

In the creative industries, the real value of a product or service is in the content, the cultural meaning, and in the experiences provided by the interaction with it (Miles and Green, 2008). The industry present many elements based primarily on the value of intangible aspects such as experience, service, and information. The latter, can be absorbed repeatedly, in countless (new) forms, and thus opening possibilities for constant innovation and for coexistent production and consumption. Hence, innovation in the creative industries goes beyond the physical and aesthetical attributes, but it also affects the environment, customer relationships, market, distribution, and organizations' internal operations. Besides the facts based on indexes of economy, innovation, and technology within their own fields; creative industries growth is believed to be primarily thanks to the inclusion and consideration of ideas created from and to social spheres of society, which end up promoting development, economic evolution and growth into other fields too (Potts, 2009b).

In the next descriptive chapters, I will investigate further the basic definitions of the study area, the current position and practices of museums towards innovation, and the use of technology as the main tools to innovate.

3. Literature

Both for-profit and not-for-profit, local, national and global enterprises, are facing the challenges of the constant changing society we now live in. The ability to handle and adapt to the new paradigms and demands, while working towards its mission, is vital for their survival (DigiCult Report, European Commission, 2002, as cited in Peacock, 2008). Organizations have to be capable to deal with change whilst innovating and rethinking their concepts and activities, at both micro and macro perspectives (Lam, 2004). The creation of new products and services becomes increasingly a response to social needs of the ever changing environment (Bahkshi and Throsby, 2010; Camarero and Garrido, 2011; Mulgan et al., 2007). This adaptation path regularly leads to innovation, which is not a single event, but rather a complex process that encompasses many dimensions of the organizations and the environment (Tidd et al., 2009).

According to Miles and Green (2008), there two factors that can both affect and be affected by innovation: technological development and organizational change. Technological development emerges from innovations that are either responsible for the creation or adoption of new and enhanced technologies or other technology-induced products and services. Nonetheless, organizational change results from the creation or adoption of new working methods, operative structures, and activities, both internally and towards influential agents such as consumers and business partners. For Kline and Rosenberg (1986), the foremost forces towards innovation are the market, and the impacts of technological and scientific advancements. By focusing in the market, instead of in organizational forces, the authors emphasize the commercial frontier of innovations, which concentrates in fulfilling market and technological demands in order to profit and sustain their operations and future innovative projects. Despite, the changes and transformations happen not only in the market level but

also with the usage of knowledge and new ideas towards economic development that can reflect in changes in organizational, managerial, and institutional levels (Archibugi and Iammarino, 2002). Some of the drivers which commonly induce the development and implementation of innovations are the new information and communication technologies (ICT), new distribution systems (channels and delivery mechanisms), alterations in the driving regulatory environment (policies, globalization, IP issues), and the influence of consumers (which have become more selective, segmented, and active) (Miles and Green, 2008). Accordingly, innovation is not a single process and can encompasses a great range of activities. Those activities vary significantly in consonance to the type of innovation, the industry in which it arises, and other particular characteristics of the organizations (Oslo Manual, 2005).

3.1. Innovation in services

The service industries, opposite to the manufacturing industries, have its commercial activities mainly based on intangible products (Miles, 2004). Although it is harder to analyse systematically intangibles than manufactured products, services have proven their contribution to growth and economic development in many sectors in the last decades.

The service industry is diversified however most activities are essentially based on the management and customization of information and knowledge (Cunningham, 2002). Therefore, it can be easy to produce, store, and distribute; but difficult to protect it intellectually in the same matters done with manufactured products. Moreover, it is more oriented towards social and cultural aspects of the environment rather than the technical specifications of the artefacts itself. Following this reasoning, services become more important than the goods once they serve as mediators between the firms and the users, being

it through tangible products/tools or not (Vargo and Lush, 2004, as cited in Camarero and Garrido, 2011). Additionally, the interactivity between the firms and the users is another characteristic often enhanced by the occurrence of innovation in services, especially technological innovation, where the advancements intensely observe the needs and requirements of its users. Naturally, this interaction promotes the customization of the services to satisfy the market and to improve knowledge exchange among the main agents (users, suppliers, institutional environment) in diverse phases of innovation (e.g. creation, distribution, consumption). Some key groups of activities in the services are the creative industries such as broadcasting, cinema, and cultural heritage institutions. In these markets, major transformations are happening due to the advances it the ICT field, where ICT works as an important instrument to manage information from its production until its distribution.

Likewise, as reported by Camarero and Garrido (2011), service orientation in the case of museums is about the quality (what and how services are provided to consumers) and custodial aspects (the service delivered to the society) toward the definition of the role and value of the institutions (and its services) to society. Service innovation in cultural heritage institutions should then provide service excellence to the public while observing museums' social mission. Conclusively, Ian Miles (2004, pp. 451) highlights some considerations about innovation in services, as featured below:

> Innovation studies will have to take on board the issue of organizational and market
> innovation, interorganizational and client-facing innovation, and even aesthetic and cultural
> innovation… This suggests that our models of innovations should put less emphasis on
> artifacts and technological innovation, and more on seeing innovation as involving changes
> in market relationships that can be effected at least partly through artefact and service
> innovations, with organizational and technological dimensions.

3.2. Innovation in the creative industries

The creative industries are major providers of ideas and creative inputs to the development of new products, services, processes, and new technologies necessary to the production, diffusion, and adoption of those. They normally refer to activities surrounding the production and management of information and knowledge towards economic goals. The creative outcomes of the creative industries promote innovative results also in other firms inside and outside its industry (Müller et al., 2008; Von Hippel, 1988). It happens because creative industry's enterprises also regularly connect to the external environment to innovate (suppliers, partners, competitors, R&D centres, and users/customers, for example). In this manner, they foster innovation not only inside but also promoting supplementary types of direct or indirect innovations in other organizations and even other fields. Figure 3 (below) shows the relationship and the overlapping areas of the creative fields, the cultural industries as a part of the creative industries, and the greater economic sphere:
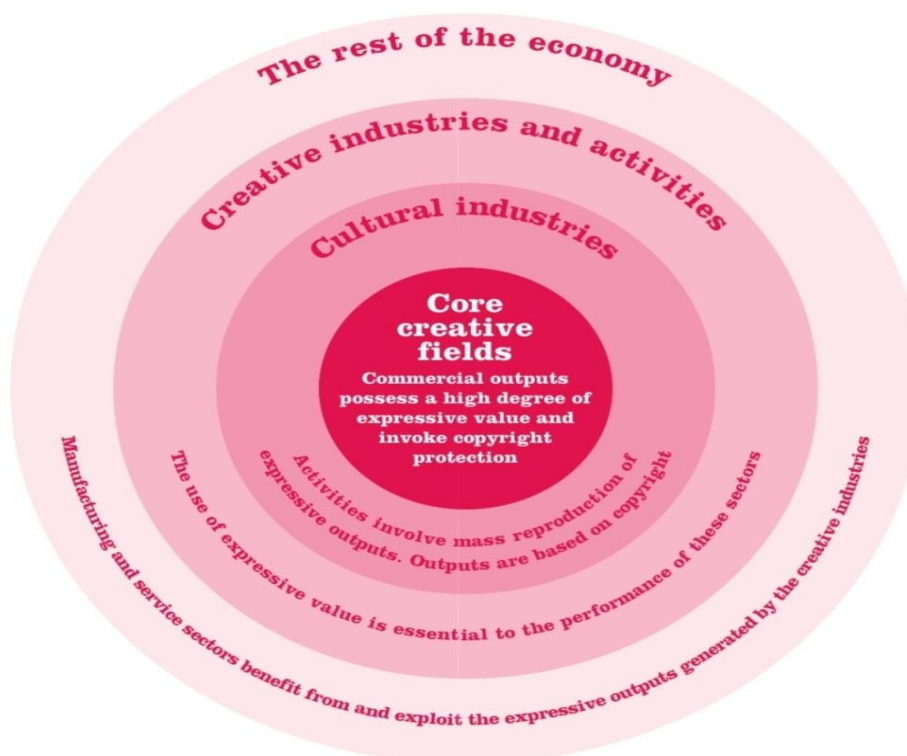

Figure 3: The Work Foundation Report, 2007, p. 5

Although innovative activities normally related to the maximization of profits, it is not always necessarily in this manner (Koellinger, 2008). Museums and other non-profit cultural organizations have social objectives, instead of high profit, as their main goals (Bahkshi and Throsby, 2010). Cultural institutions have, however, to innovate to be able to compete with other leisure and cultural organizations for the spare time and funds of the public in order to operate sustainably (Andreasen and Kotler, 2002). Sustainability is important to grant museums with the possibility to perform more independently, improving design and access to their exhibitions and its content, and thus captivating alternative private funding resources (provided that the sources of funds are not exclusively based on public funds) (Camarero and Garrido, 2011). In addition, the authors point out two types of products that benefit museums' public: core products and supplementary services. Core products (which can also be services) in museums can be illustrated by temporary exhibitions and special programs for oriented groups of visitors. Supplementary services in museum are the services that enrich and facilitate the experience around the exhibition and the visit such as information touch points, customer service, and payment. Lovelock (1996) suggests, besides, that supplementary services can also help cultural institutions to increase their value and their differentiation in the market.

Caves (2000) list the seven economic properties of creative industries, which are:

- A-list (most valuated) /B-list (secondary): ranking of differentiated skills and prominence of the talents, which interfere in the perceived quality and value of projects and products/services in the market.

- Art for arts sake: creative workers care about their product.

- Infinite variety: differentiated/horizontal differentiation products.

- Nobody knows: demand/reception in the market is uncertain.

- Motley crew: some products require diverse skills.

- Time flies: time is of the essence.

- Ars longa: durable products and durable rents.

Nowadays, in the digital era, innovation strongly depicts technological development. In the creative industries, this observation is also true because the facility to create, produce, reproduce, store, diffuse, and share digital content through social technologies and the Web 2.0 (Bahkshi and Throsby, 2010). The new ICTs are a low cost solution to help institutions to organize their activities within and beyond organizational limits (Nelson and Nelson, 2002). Potts (2009a) arguments that the use of these new technologies fills gaps in many process of innovation by promoting easier paths towards the creation, adoption, dissemination, and integration of innovations.

Internally in organizations, innovation through ICT assists firms to perform more effectively by collecting and using knowledge from the public, market, and technology towards organizational innovations (Deshpande et al., 1993; Mulgan and Albury, 2003). Likewise, Muller et al. (2008) analyse this impact of the industry into the organizational and managerial aspects as a result of the necessary changes to prepare the institutions to the implementation of new technologies and to promote internal environment for creativity and innovation in organizations, from leadership to R&D programs

The creative industries grow fast and help to develop other industries. This fact, as treated earlier in this study, is not only because of its impact on economic indexes but also reflects in a social economic evolution, where 'social' ideas are a part of innovation and economic systems and theories (Potts, 2009b). Innovation in the creative sector frequently originates from changes resulted from the feedback of the experiences of individuals (Miles and Green, 2008). Cultural heritage institutions often innovate by following the new

requirements of the current public, which is increasingly more fragmented and detailed, in order to maintain their existing group of visitors, as well as communicating with new potential visitors/users. Ultimately, the creative industries embrace the majority of the symbolic creations exchanged in our modern society, being a moderator element between industrialization and media (Bustamante, 2003).

Vicente et al. (2012) summarize along with the innovative activities commonly found in museums in the last decades (in different levels, supposing the characteristics and structure of each institution) into three lines of innovation: organizational innovation, technological innovation in management, and technological innovation in visitor experience. Organizational innovation is caused by and responsible for changes in the structure of the enterprises and its processes, requiring constant follow up to keep up with the dynamic environment. Technological innovation in management encompasses the technological developments made in museums' processes that facilitate the management of its data and property, such as database software and digitization of their patrimony. Finally, technological innovation employed to enhance visitor experience is available "in situ" (e.g. displays and devices) and online (e.g. webpage and mobile applications) to increase content and the experience values acquired from the contact with the cultural service. In spite of some firms having stronger capabilities and experiences in one type of innovation, it is likely that organizations need to be able to manage diverse types of innovation simultaneously (see table below) (Abernathy and Clark, 1985).

Domain of innovative activity	Range of impact of innovation		
I. *Technology/Production*			
Design/embodiment of technology	improves/perfects established design	↔	offers new design/radical departure from past embodiment
Production systems/organization	strengthens existing structure	↔	makes existing structure obsolete demands new system, procedures, organization.
Skills (labor, managerial, technical)	extends viability of existing skills	↔	destroys value of existing expertise
Materials/supplier relations	reinforces application of current materials/ suppliers	↔	extensive material substitution; opening new relations with new vendors
Capital equipment	Extends existing capital	↔	extensive replacement of existing capital with new types of equipment
Knowledge and experience base	builds on an rein-forces applicability of existing knowledge	↔	establishes links to whole new scientific discipline/destroys value of existing knowledge base
II. *Market/Customer*			
Relationship with customer base	strengthens ties with established customers	↔	attracts extensive new customer group/creates new market
Customer applications	improves service in established application	↔	creates new set of applications/ new set of customer needs
Channels of distribution and service	builds on and enhances the effectiveness of established distribution network/service organi-zation	↔	requires new channels of distri-bution/new service, after market support
Customer knowledge	uses and extends customer knowledge and experience in established product	↔	intensive new knowledge demand of customer; destroys value of customer experience
Modes of customer communication	reinforce existing modes/methods of communication	↔	totally new modes of communication required (e.g. field sales engineers)

Table 1: The table above shows examples of innovative competences that can happen simultaneously (Abernathy and Clark, 1985, p.5).

3.3. Technological innovation

Technological innovation is one of the most powerful forces towards growth, productivity, and industrial development (Abernathy and Clark, 1985). It is motivated by many factors such as curiosity, competition, commercial and financial goals, and by the urge to find more appropriated solutions that require less time and efforts (Walker and Chaplin, 1997). Technology has gone over one of its primary functionality as tools to reach, and be integrated,

in social, cultural, and economic aspects of our lives (like meanings and relations) (Boczkwski and Lievrouw, 2007).

According to Camarero and Garrido (2011, p. 43) technological innovation is "the adoption of new technologies employed to products, services, or the production process for such products and services". Technologically oriented innovations are one of the two main types of innovations: product and process innovations (O'Callagham, 2005; Tidd and Bessant, 2009). The Oslo Manual (2005), an innovation guideline from the Organization for Economic Co-operation and Development (OECD), reports that technological product and process innovations is associated to diverse activities in scientific, technological, organizational, financial, and commercial dimensions. This material exemplifies technological product innovation as the creation of (technologically) new products/services along with the technological improvement of existing ones. Otherwise, technological process innovation refers to both new and substantially enhanced methods of production and distribution. These alterations in processes may affect and generate key or alternative changes (internal and environmental, for example) to enable these technological innovations (Hempell et al., 2004). Whether through products/services or processes, innovation in technology is essentially becoming a result of the acquisition, transfer, and utilization of information (Abernathy and Clark, 1985).

The information and communication technologies (ICTs) are the vital technologies of the last decades, present in almost all sectors of today's economy (Pilat, 2004). The rapid growth and dissemination of ICTs gave reasons for its comparison with other great inventions like the steam engine machine and electricity, offering opportunities within and outside the ICT industry (Hempell et al., 2004). In the past, technological development was viewed as an external force that has innovation as its results in organizations, although, technology is rather as a tool for change, based on the trends and demands of society (Peacock, 2008). ICTs has

changed the way in which people access information and communicate, allowing multidirectional stimulus through the massive use of technologies like the Internet and other digital technologies (San Martin, 2012; Srinivasan et al., 2009). The technological developments found in the 'creative industries' are mainly through the Internet and other ICTs (Miles and Green, 2008). They facilitate the communication process with their public and improve their experience by providing from information, online presence, displays and screens, up to better services such as new forms of ticket sales (Bahkshi and Throsby, 2010; Camarero and Garrido, 2011). ICTs make possible the production and distribution of cultural goods at lower costs, as well as renew current forms of financing and commercialization, and, furthermore, the forms of offer and consumption (Garnham, 2005; 20+20, 2010). The use and influence of new technologies towards competitiveness and growth are thus evident (Koellinger, 2008).

Besides technological advances from and within ICT sector (through the development of both new and complementary innovations), ICTs also affect the way enterprises restructure and re-engineer their organizational and business processes. Hence, ICTs help to not only support communication with its publics, but have also influence in the institution and in the market. To enable all these changes and all these diverse forms of relationship with the users and customers, the new technologies tend to be less 'massive'. They tend to observe and take into consideration the different consumer's groups and interests, aiming to act more globally at the same time as locally, to identify market trends beforehand.

Interactivity, convergence, customization, collaboration, and networks are some of the crucial concepts in the analysis of the influence of ICTs upon technological innovation in general and, especially, in the case of the creative industries (Cunningham, 2002, p. 6). Bahkshi and Throsby (2010) define some of those concepts as part of the three dimensions of the relationship between ICT and museums' publics, which they define as interactivity,

connectivity, and convergence. Interactivity allows a two-way communication and serves as an interaction channel between the visitors and institution's own system (or platform), with the possibility to be adjustable and stimulated by users. Connectivity permits direct communication between institutions and the public, where both parts produce and share opinions and experiences (e.g. social media networks). Lastly, convergence provides access to many of the institution's products whenever, wherever, and from whatever device, and for that reason it connects public, institution, and third parties. The fusion of these three dimensions offers and enables new opportunities to cultural heritage institutions to communicate with current and potential groups of visitors while innovating technologically (Peacock, 2008). They promote deeper engagement of the public before, during, and after the visit; using the museum as mediator and permitting the public and institution to co-create complete innovative experiences, instead of focusing almost entirely on the innovative product or service itself (Sigala, 2005).

3.4. Organizational innovation

In accordance with the type of the innovation, certain adaptations in organizational environments and managerial skills are required in order to permit and foment itself innovative activities (Abernathy and Clark, 1985). Although most of process innovations are non-technical, they can also generate technology-induced changes. Organizations have both technology-induced product (goods and services) and process innovations due to the adoption of certain technologies and in connection to firm and market structures (Koellinger, 2008).

Constant changes and external pressures of the environment (market, users, and technology) affect institutions in many ways, internally and externally. The latter involves the opportunities and challenges of the market and other external financial influences. Internally,

modifications are essential for institutions to sustain their operations and develop new ways to relate to the environment. Organizational structures and philosophies, administrative practices, strategic planning, human resources, internal communication, and business models are examples of the dimensions where adaptation must be continuous (Miles and Green, 2008). They must be regularly readapted for to assure the performance level, to permit and to motivate innovation while working in accordance with museums' mission, field, and technological advancement level (Bahkshi and Throsby, 2010; Hempel et al., 2004; Vicente et al., 2012).

Change at the organizational level customarily corresponds to non-technical innovations, referring mainly to shifts in institutions' structure and managerial aspects (Hempell et al., 2004). These modifications must seek transparency and cooperation (avoiding internal competition) among workers and other cultural institutions to better understand and plan the current and future cultural landscape (Kotler, 2012). The pursuit for multidisciplinary composition and diversity must reach out into other scopes such as skills, business models, administrative operations, collaborations; besides the line of products and services (Peacock, 2008). Though many experts and scholars observe innovation and economic account in the creative industries, it needs further deep and systematic investigation. Creative industries, as stated by Miles and Green (2008), actually induce very much of the called 'hidden innovation', in addition to technological innovations. Hidden innovation refers to innovations that are not fully documented yet through traditional methods, representing mostly innovations in organizational and business spectrums. The hidden characteristics of innovations that happen inside the organizations, through creative inputs and ad-hoc experience, are usually hard to manage and thus represent challenge in measuring and mapping it.

Simultaneously to the non-technical innovations, there is a wide range of technology-related organizational changes within the museum sector, particularly the ones employed to the use of ICTs. These new technologies can help improve performance by promoting organizational restructuring in many ways, for example, with tools for the creation and management of new strategies, business models, internal structures, and investment opportunities (Pilat, 2004). In times of digital revolution, the characteristics of creative industries' products/services and contents is transformed; creating, as follows, an inevitable concomitant influence of technological and organizational innovations into each other. Examples of the transformation caused by digital assets inside museums are the digitization of artefacts, the virtualization of products, security, e-commerce, networking (with the public and the market), aside from new landscapes for intellectual property's policies (Peacock, 2008). Administering technology-related changes require strategic management to adapt correctly in all spheres of organizational (internal structures), behavioural (market intelligence), and cultural (customer value) perspectives while implementing ICTs (O'Callaghan, 2005). The posture toward technology projects will then determine how and under what forms ICTs developments will be explored.

McKersie and Walton (1991) for example, attempt to define three lines of relationship between organizations and technology. The first type of relationship refers to enterprises which already embrace the fundamental requirements (technical and organizational) to be able to extract technology inputs from users into the market (instead of pushing managers' decisions), and then enabling new technologies. Consecutively, the second type describes organizations that foster and create internal conditions and technologies, respectively and simultaneously, granting each other mutual technical and social adaptation. Lastly, the third form of interaction suggests the implementation of technologies as the first accomplishment, followed then by alterations in organization's assets as a response to this new addition into the

internal structure. Once again the role of ICTs can help design organizational innovations from strategic and market drivers (costs, quality, and service) to social aspects (database, online presence, and communication platforms) (Peacock, 2008; O'Callaghan, 2005). Organizational innovation and the management of ICTs, in accordance with enterprises' mission and values, can therefore lead to rethink and reinvent their essential structure towards a more innovative posture.

The social and not-for-profit philosophies of cultural heritage institutions should not be a hinder toward a more market-oriented business philosophy, even though this was not a common practice in this field until a couple decades ago (Camarero and Garrido, 2011). Peacock (2008) addresses the once valid idea of institutions as machines, working as a response to industrial production, in contrast to the new reality of the digital era and the greater participation of users. He wisely points out some compulsory aspects to take into account by museums such as the reinterpretation of the museums position and their interaction with their environment, widening and transforming traditional dispositions to the extent in which museums understand, permit, and pursue access to the environment through new and dynamic exchanges with users, producers, competition, and supporters. Additionally, the author calls attention for the importance of allowing and promoting the understanding of change (which is unpreventable and constant) as beneficial to facilitate it instead of interpreting it as an unknown threat. He summarizes with the thought that "the way we think about and understand change affects our ability to anticipate, shape and direct it" (Peacock, 2008, p. 333). The familiarization with change will later permit institutions to manage it creatively instead of simply responding to it (for strategy and management of change see also Beer, 1980; Falk and Sheppard, 2006; Kline and Rosenberg, 1986, Kotter et al., 1979).

Management and governance in museums, like in other organizations, focuses in determining strategic practices as to improve performance and consider the changing and

challenging funding environment (Vicente et al., 2012). The analysis of the possibilities, the right choice of tools of information processing, and their advantages and potential, are some of the first steps in planning new projects (Müller et al., 2008). The effectiveness of a technological project is, many times, not dependable on the technical aspects itself, but to the appropriateness of it into institution's communication and organizational purpose and goals (intended public, interaction types, engagement, usability, clarity of messages and discourses) (Pujol-Tost, 2011). In addition, defining costs, risks, possible legal and administrative accountabilities, and potentials of ICT investments, for example, will help to avoid failure of commonly costly projects when planning its strategies (Frey and Meyer, 2006).

3.5. Market and financial orientations

Inside their own field, museums and other cultural heritage institutions can find opportunities to acquire knowledge, financing, and partnerships regarding further development of their innovative strategies. Non-profit organizations likely disregard deeper analysis and opportunities of their markets once they operate towards not-for-profit goals. Nonetheless, similar any other industry, the resources available for museums are mostly not enough to enable them to offer the services they intend. There is a range of possibilities that can help museums to innovate and develop in a more sustainable and long-term basis, instead of focusing only in their short-term needs (Liao et al., 2001). Competitors are important to help museums to innovate, either by taking part in the development of the 'market intelligence' or by creating partnerships, collaborations, and joint programs (Camarero and Garrido, 2011). These new arrangements cooperate to diversify and intensify field's knowledge and value, developing together through, for example, R&D collaborations and database sharing and/or unification (Srinivasan et al., 2009).

Understanding the market is important to define business models, to plan, and to seek investment for both the basic operations and special projects. Museums and other non-profit cultural institutions can have their operations financed by either private funding (through own income, stakeholders patronage, sponsorship, and donations) or public funding (through grants and subsides), or even a mix of public and private funding (Vicente et al., 2012; Frey and Meyer, 2006). The two different types of funding in museums (private and public) can affect institutions' policies, behaviour, and the levels of innovation and autonomy according to the nature of the revenue: own revenue and unearned revenue. On the one hand, own revenue and other privates forms of funding permit more autonomy and freedom to find new ways to operate, ensuring future income, and maintaining and motivating existing sources (institutional, legal, and socials environments) (Lord and Lord, 1998; Vicente et al., 2012). In addition, own resources allow more flexibility to focus efforts in visitors' demands and more liberty to seek other private sources of funds (Camarero and Garrido, 2011). On the other hand, subsidies originated from public sources frequently impose fixed commercial agreements, greater accountability, and pre-determined efficiency levels. Those impositions are normally based on standard market perceptions, leaving little space for museums to dedicate efforts to innovate and differentiate themselves in the market (Frey and Meier, 2006; Kirchner et al., 2007; Rentschler and Wood, 2001).

3.6. Business model

In the adaptation process that institutions go through to copy with changes from environment, they find new ways to communicate and operate. It is necessary, likewise, to find appropriated means to exploit these innovations as a strategy to sustain an innovative attitude in a long-term basis while satisfying both their organizational and socio-cultural demands. They need to

find ways to function sustainably whilst meeting their goals and mission, as well as consenting them to use additional efforts in new projects and to reach new potential public and sources of funding (Bahkshi and Throsby, 2010). One solution found by many museums currently is the implementation of ancillary activities, products, and services like shops, restaurants, special events, architectural designs, and special/temporary exhibitions. These supplementary efforts can increase profit and, thereupon, help the museum with operative costs and permitting more financial flexibility to innovate and attract more visitors and more attention in the media (Frey and Meyer, 2006).

Today, with the advance of the digital products, it becomes increasingly harder for the demand and supply actors to delimitate the reach and use of digital products and, for this reason, to create appropriated business models (Greffe, 2008, as cited in Bahskhi and Throsby, 2010). All the more so, organizations should include in their plans the possibility of new collaborators and the positive opportunities found in the new competitors aroused through new technologies and the digitization in most of the sectors of the modern economy (Miles and Green, 2008). The most preferable, so, is to assume a position where the convergence of the elements of the environment are under constant observation, and where cultural institutions are under continuously adaptation and in search of diversified resources. To illustrate this convergent point of view, the figure 4 (below) shows the relationships of innovation and some different business processes with diverse overlapping areas:
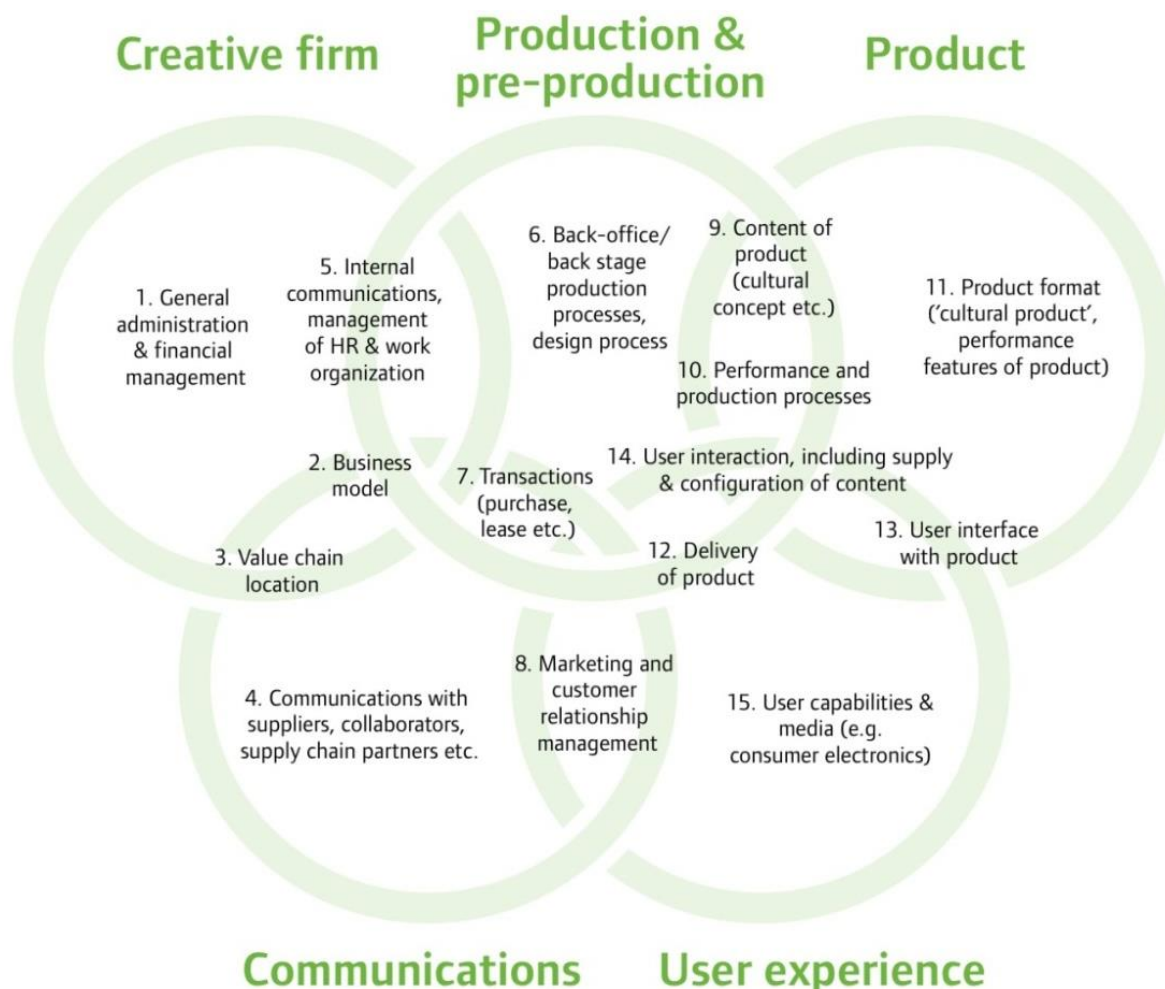
Figure 4: Creative industries' overlapping innovative areas (Miles and Green, 2008, p.67).

3.7. Audience

Since the main inputs for changes in society today come from the consumer's use of technological developments, organizations should avail the possibilities to diversify, reach, and develop new audiences and markets. Museums must attempt to plan and perform strategies analysing the users, and their interactions with technology, as a means to have a more customer-oriented attitude (Rentschler et al., 2002). Flexibility is a major characteristic when considering the audience, while planning and running business models as the market is becoming increasingly fragmented (Miles and Green, 2008). That can be in behalf of the fact

that demand is never static and preferences can last both short and long-term (Vicente et al., 2012).

Audience studies serve as a reference to the study of the different groups of public, visitors, and users of physical and virtual museums. In the last decades, cultural heritage institutions have focused their efforts in more audience-based than product-based strategies. Von Hippel (2005) points out that innovation in general has become 'democratized'; and that is true in the case of museums, where both individuals and institutions develop innovative outputs to demand-customized solutions. This is due to the new forms of demand that are no longer based on 'mass' models but on customized, open, and interactive production, communication, and consumption approaches (Cunningham, 2002).

Museums can seek to understanding the demand and interact with the public targeting to reach individuals and thus achieve diverse organizational and strategic goals. Some strategies to establish relationships with the public is through audience broadening, deepening, and diversifying (Bahkshi and Throsby, 2010; McCarthy and Jinnett, 2001). The broadening of audiences seeks to transform the potential visitors and users, whom currently do not visit/use institutions' products and services, into actual and active audiences. Deepening of audiences refers to efforts made to increase the level of participation of current audiences. Lastly, the diversification of audience attempts to captivate new and diversified groups of audiences who do not visit and would not become visitors if the museum did not do any efforts to connect with them.

The information and communication technologies are useful tools to facilitate the connection between institutions and audiences. Molteni and Ordenini (2003, p.11, as cited in Bahkshi and Throsby, 2010) once stated that 'technologies are prime drivers of change in consumer behaviour' and ICTs triggers interactivity and convergence of many services.

Technological devices stimulate diverse levels of personalization and interaction and can produce, therefore, interesting and exciting experiences (San Martin, 2012). Furthermore, it permits customization and co-production of cultural goods/content by each individual/user (Knell, 2006). Users can produce new contents while generating ideas that induce the creation of a wide array of other innovations, ranging from new products and services to distribution and diffusion of technological innovations (Miles and Green, 2008). These social technologies tolerate both producer-consumer and consumer-consumer interactions, fostering innovative developments and economic progress (Potts, 2009b). This participatory attitude by the user and the availability of digital technologies, which require increasingly less minimum skills to master it, leads to the fast expansion of user-generated contents (UGC) (Bahski and Throsby, 2010). UGC puts the users/visitors in the position of co-creators of content and meanings (Witcomb, 2003). The possibility to co-create and distribute information grants the users the feeling of being a member of a group of creative, democratic, and educative associations (Von Hippel, 2005).

In the following chapter, this thesis will introduce the current technological context surrounding museums' field and will present the ICTs most often found in these institutions today.

4. ICTs in museums: a new typology

4.1. Technology in museums

Technology in museums is being observed since the 1990s and has grown fast thanks to the new possibilities they provide to enhance communication with their audiences and to instigate new business models, helping to widen economic and social values of the cultural heritage field (Bahskhi and Throsby, 2010; Peacock, 2008). That so, museums need to keep them updated and thereupon integrate new technologies into their operations. The technological revolution of the last decades affects the production, management, diffusion, and consumption of culture (Solano, 2012). Technologies can improve the interpretative practices of exhibitions while enhancing visitor experience and promoting social engagement (Peacock, 2008). Museums buy and implement information and communication technologies (ICTs) produced by other firms in diversified forms and for countless purposes. The ICTs can assist museums with, for example, conserving, diffusing, communicating, fostering and funding of cultural activities (Agenda, Telos, 2012; Bahskshi and Throsby, 2010; Peacock, 2008; San Martin, 2012; Vicente et al., 2012). Moreover, the costs, that once were unbearable for many institutions, are reducing because of the evolution of the digital era, permitting higher visual and technical qualities at lower costs and simpler requirements. There is, although, new costs that come with the use of technologies such as the production and management of content, devices, and time and formation of skilled professionals (Petrie and Tallon, 2010). A high-quality digitization of cultural goods, for example, is a key strategy to both preserve the artefacts and, likewise, the starting point to its distribution through digital media (Pascual, 2012).

One of the main characteristics of the use of ICTs are that it has transformed the centralized mass communication methods into personal and customized channels to connect to the environment. The museums and their technologies should then permit and promote access and participation in exploring information digitally, for the achievement of deeper engagement by the users and a deeper understanding of the works (Srinivasan et al., 2009; Anderson, 1999). This way, ICTs should not only serve as complementary tools to the museum exhibition but as an integrated part of its approach. It will help to assure the achievement of a complete or, at least, enhanced understanding of more transparent discourses. Camarero and Garrido (2011) offer a suggestion about the usage of new and social technologies in museums as tools to "help the museum to reach new markets or create new expectations, interests, and experiences for the visitor" (p.43).

The possibilities and the technologies are many. Consequently, the choice of technologies to implement should go along with museums' characteristics and other criteria such as size, organizational structure, mission, and types of funding, audience, and cultural goods collection (San Martin, 2012). These characteristics, when combined with appropriated technologies, will define the level of integration and success of innovation projects. Pujol-Tost (2011) adds up by defining the three current main features of ICTs that reflects in the many specific ICTs found today in museums: computational virtuality, interactivity, and multiplicity of interfaces. Computational virtuality refers to the ICTs ability to deliver and exchange abundant information through limited spaces, and in diversified formats, for the many types of publics, improving communication outcomes. Interactivity concerns both the system response potential to human stimulation and to the possibility of being modified and augmented, facilitating the learning of complex and conceptual information. It allows hands-on interaction with the conceptual thread surrounding exhibition's discourses, setting the technologies as mediators and transforming the galleries into its scenery. Lastly, the

multiplicity of interfaces denotes the great diversity of formats the new technologies offer to connect users and institutions, adding extra value and quality of information to the central object of observation. Conclusively, technologies are changing how cultural heritage institutions produce, present, represent, analyse, and evaluate itself (Bailey, 2010).

4.1.1. Integration and usability

Important aspects like the levels of integration and usability can make the implementation of new technologies successful or not (Pascual, 2012). Technologies can appear to be quite complexes, depending on the level of ICT literacy of the users, and, in some cases, even seem to be competing with the rest of the existing tools, products/services, and current practices (O'Callaghan, 2005). As a result, its appropriated integration presupposes organic and clear interfaces that interlace all the institutions elements, physically and virtually, with the environment and the public. Moreover, the integration should take in consideration both micro-interactions and macro-interactions between visitors and the physical space (Galani, 2003). The former, concerns the interaction between the visitor with a specific piece or technology from the exhibit, on a given moment. The latter, on the other hand, regards the types of activities happening inside institution's halls throughout the whole visit. Additionally, Pujol-Tost (2011) asserts that ICT integration encompasses two spheres of internal and external contexts when representing institution's vision and, at the same time, being suitable, attractive, dynamic, and interactive. The internal conditions refer to the synchrony of the elements that compose the exhibition toward the improvement of the experience of visitors. Despite, the outside conditions bring demands from the society into the institutional level, requiring adaptation of museum's internal values and practices towards public's interests and literacy when implementing new technologies. In addition, the author

suggests four issues that should be analysed and introduced even before the technology itself. First, museums must be aware that they are under constant reconstruction of their discourses, both around the objects and institution's perception by the society. Secondly, cultural institutions need to understand their possibilities and potential to communicate and fulfil their educational mission. The third step refers to the general design of exhibitions, where the physical context and the messages the museum whish to explore need to be clear and in harmony. Finally, the last issue is about the constant analysis of exhibition's objectives and requirements to enable the evaluation and improvement of usage and the choice of technologies.

Furthermore, mobile technologies are all increasingly conveying into one single device, being it owned by the user or provided by the museum during the visit (Dowden and Sayre, 2007, as cited in Sayre and Wetterlund, 2008). The objective is that independently of the device used, the most important is that the user is either familiar or has an intelligible platform that is easy to use (Petrie and Talon, 2010). Those technologies facilitate integration by improving successful usability and allowing connection with museum's objects, discourses, and services and thus help to maintain and potentiate their efforts (Pujol-Tost, 2011). To conclude, the DigiCult Technology Watch Report (2003, p. 9), from the European Commission, points the objective of European cultural heritage institutions when planning and implementing technological advances as

> To build tools and systems to tackle the increasing volume of material needing to be digitised and maintained in accessible forms… By offering personalised, highly interactive, stimulating, hybrid environments and shared spaces to foster the construction of cultural heritage content; and to enable players from different sectors and users to participate actively in creating enriched environments for cultural heritage services by building easy-to-use, intelligent, collaborative and highly interactive tools and systems for non-technical users.

4.2. Specific use of ICTs in museums: a new typology

In this part of this investigation, I will present the technologies most customarily in use in museums as a means to introduce ICT's presence and influence in these institutions' activities. In pursuance of facilitating comprehension of their characteristics, I will divide the technologies addressed here into three main categories, in line with the innovative aspect they mostly correspond to, the theoretical review, and the empirical research material. It is important to highlight that this is a suggestion of typology of the technologies currently in use in museums, but it is true, likewise, that many of those technologies are multifunctional and are present, in different levels, among the other categories. Consequently, the suggestion of categories is:

a) *Informative and expositive technologies that enhance exhibition's design and the presentation of artefacts/content, mainly during the visit* (informative kiosks, audio and smart guides, interactive displays, 3D, holography, virtual and augmented realities, and webpages – more specifically in the case of virtual museums);

b) *Technologies that foster communication and marketing activities, promoting further and deeper engagement by the audience, mainly before and after the visit* (social media networks and webpages), and

c) *Technologies used mainly in organizational and managerial operations in the back-office of cultural institutions, in order to provide and combine the necessary elements for the exhibition and other more apparent technologies* (internal network system and restoration and conservation technologies).

I would like to recall attention for the fact that the mobile technologies will not be treated separately because it is found both in situ and outside museums' physical limits, and it can be employed to the most of practical and innovative purposes, depending on the application, content, and the moment of use. Mobile technologies concede access to museums and its exhibitions, through different levels of accessibility, from wherever and whenever. On top of access to the objects and information around them, they can grant the user the opportunity to customize their visit by making it more personalized and attractive (Solano, 2012). Moreover, museums increasingly use mobile technologies, through the devices provided by the museums or personal devices of visitors, enhancing the experience during the visit. Alternatively, outside the real museum, these technologies create continuity by connecting with the visitors and helping to promote a deeper and stronger personal relationship between them (Sayre and Wetterlund, 2008).

The people who make use of museums' mobile technologies can be their current audiences, new and potential publics or even people that want to see and learn but might not ever come to visit the real museum due to reasons corresponding to, for example, location. Mobiles technologies facilitate the access and can augment the performance of other online museums' communication platforms like virtual museum and social media networks.

4.2.1. Informative and expositive technologies at the exhibition level

Informative technologies

The most common on-site informative technologies found in museums are predominantly compost by services found at the exhibition areas such as plant introduction (PI) stations, personal digital assistants (PDAs, or 'pocket museum'), multimedia kiosks, dock systems, and audio and smart guides. The technologies at the service of the visitors in the hall or in the

exhibition areas provide extra information, from the location plan to complementary information about the exhibition, permanent collection, and the institution. Info stations, kiosks, and docks were the first technological appliances at the service of visitors in museums (Anderson, 1999). Those appliances can offer from simple programmed information to joysticks, touch screens, and virtual reality tools. They are able to give basic information, enlarge understanding and contextualization of a piece, and to control equipment and systems (Kwon et al., 2003).

Diversified types of interactive technologies at KAUST Museum (http://www.kaust.edu.sa/).

Table-screen at carter Museum (http://www.cartermuseum.org) / / Interactive Informative Screen at Rayburn Museum (http://www.cah.utexas.edu/museums/rayburn.php).

PDAs and audio/smart guides are mobile and wireless options to acquire extra information while wandering around the institution. These devices work as interlocutors for visitors in search of extra knowledge on the way and inspire interplay and stimulation (Sayre and Wetterlund, 2008). In addition, these devices offer extra services to visitors, such as audio descriptions for the vision-impaired public, and diversified mediums like videos, photos, sound, and texts.

A PDA model (http://www.museumsandtheweb.com/mw2004/papers/sauer/sauer.html) / An audio guide model from Audio Conexus (http://www.audioconexus.com) / An audio guide illustration from The Lavender Museum (http://www.thelavendermuseum.com).

Tablets can reach other online services offered by the same institution through Internet access (Kwon et al., 2003). Through these digital mobile appliances, the public can acquire complementary information and use the tools to create a customized navigation through the museum, according to their interests. Examples are devices and services that are able to identify, reconstruct and relocate pieces back in their original contexts, along with reproducing diversified multimedia formats, providing the feeling comparable to having the curator/artist himself/herself there, virtually, to explain and comment on his/her work (San Martin, 2012). Some critics suggest that these devices are not social because they induce individual use, but in fact, they can rather encourage conversations by offering extended information and context about the exhibition (Spires, 1989).

Visitors can also use technological tools as the quick response (QR) codes and applications in portable tablets and mobile phones, bringing the museum to the palm of people's hands. QR codes give extra information about the museum or a specific exhibition through bi-dimensional barcode detection of an image (Mediamusea, 2010). These codes give from basic information to direct links to applications and webpages.
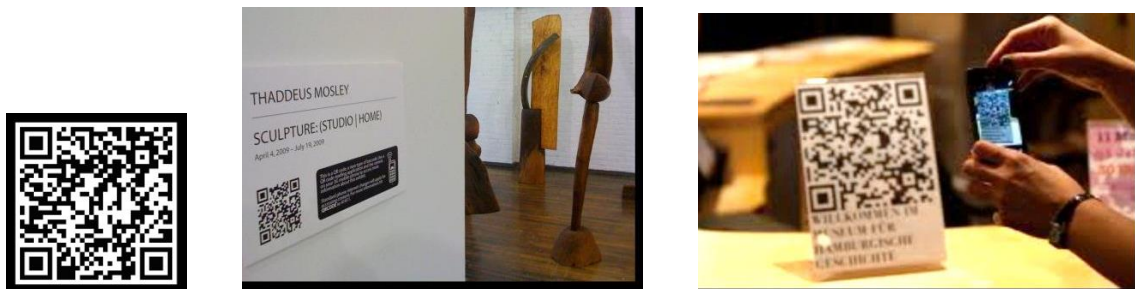
Illustration of use of the codes: graphic example of a QR Code / QR Code at Mattress Factory exhibition (http://www.mattress.org) / QR Code at the Museum Fur Hamburgische Geschichte (http://www.hamburgmuseum.de).

Applications also are tools that establish connection between the institution and the individual visitor, whom can download it directly to his/her personal mobile device and attain from practical information such as location and opening hours up to multimedia files and streaming (Solano, 2012). Besides, one can customize it in accordance to his/her specific interests in a more dynamic and interactive way (Mediamusea, 2010).

IPad application of Dezeen Architecture Publish (http://www.dezeen.com) / Mobile phone application "Xloudia" of Lm3Labs Interactive Technologies (http://2.lm3labs.com). Mobile phone applications of The Museum of Modern Art of New York (http://www.moma.org)

Expositive technologies

Informative technologies are tools that serve as complementary forms to provide additional information. In the case of expositive technologies, however, they mostly refer to a particular piece, or determined part of an exhibition. Some examples of these technologies are interactive screens, 3D, holography, and virtual and augmented realities. They make use of diverse tools as images, illumination, sounds, and even mechanic vibrations to recreate, contextualize, and give the observer a full experience in addition to the attainment of information. Yet, the separation frequently happens into two types conforming to the experience they provide: immersive or non-immersive (San Martin, 2012). Immersive technology makes the visitors feel similar to being in another time, space, and/or context through digitally or mechanically simulation of aspects of the world surrounding the artefact, where the public can interact using their bodies and movements; an example is the augmented reality technology. Conversely, non-immersive technologies use traditional formats, albeit allowing interaction essentially through visualization, to complement the understanding, use, and informative aspects of, for example, immersive technologies. Examples of the non-immersive technologies are the digital interactive and multitouch displays.

Expositive technologies can improve experiential, communicative, and learning potentials of an exhibition by digitally adding information to real objects and promoting different forms of interaction towards a more 'hands-on' exhibit concept (Michael et al., 2010). The use of expositive technologies brings up the same issue pointed out by Solano (2012) and Anderson (1999) about informative technologies: the deviation of attention from the exhibition and the 'real' experience towards the digital tools as playful mechanisms (Pujol-Tost, 2011). In the case of more complexes technologies, they can take attention away from the observation of the original object itself and put the attention into understanding the instructions for the proper use of the tool. It is therefore vital to integrate well the technologies

with the exhibition as to permit a coherent and organic collaboration between the piece and the expositive methods in use.

3D and holography

Tridimensional (3D) objects are geometric models created based on the real context where it can reproduce width, length, and depth of the chosen object. It is used both to create a model based on a physical object, in order to conserve or allow manipulation while protecting the real object, and to visualize dimensional levels in graphics and images (Kwon et al., 2003).

3D model for object's reconstitution at Archaeological Research Institute (source: http://www.museumsandtheweb.com/mw2003/papers/rowe/rowe.html) / 3D anaglyph of an Indian at Karl May Museum (http://www.karl-may-museum.de/web/start.php) + Simplified 3D anaglyph (color-coded) glasses from Berezin.com.

Holography is the bi-dimensional (2D) projection of light in space, which the human eye can see and understand as 3D projections without the use of special apparatus like 3D glasses (San Martin, 2012). 3D technologies are usually more costly than holography once they require the use of complementary equipment or devices for the visualization of digitally created dimensional objects.

Hologram at The Rugby Art Gallery and Museum (http://www.ragm.org.uk/).

Virtual and augmented realities

Virtual reality (VR) collects real world information to compose synthetic tridimensional contexts in which the public can better understand and experience what sometimes can be hard to interpret merely with the use of conventional presentations, informative displays, or their own imagination (DigiCult, 2003; Hirose, 2006). Augmented reality (AR), in turn, is a combination of virtual reality (synthetic) and original (real) imagery and elements put together to complement each other for a full experience (Mediamusea, 2010; San Martin, 2012). This technology is used commonly to reconstruct contexts and simulate realities of, for example, the past and the future. They can interact with the public through many forms ranging from the simple visualization to the manipulation of wearable devices. Likewise, these technologies also can be accessed from personal equipment like mobile devices or home computer (Mediamusea, 2010; San Martin, 2012).

VR technology at Louvre Museum (http://www.louvre.fr/en) (blogmuseumpicassobcn.org) / VR technology at Hong Kong Science Museum (http://hk.science.museum/eindex.php).
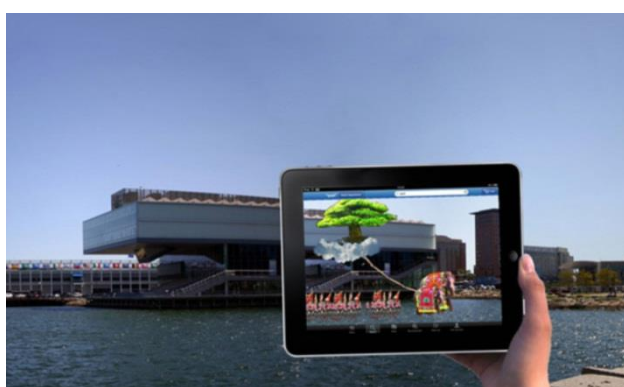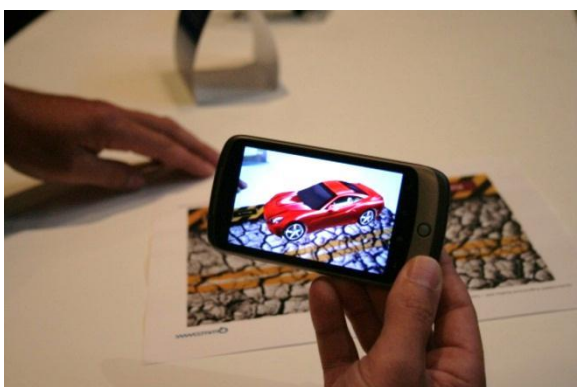
AR technology demo from Qualcomm Wireless Technology and Innovation (http://www.qualcomm.com – source: zdnet.com) / AR for Boston CyberArts Festival (http://bostoncyberarts.org – source: thecreatorsproject.com).

The virtual museum

Andre Malraux in his book "Le Musée Imaginaire" (1947, as cited in Solano, 2012) wrote that museums should become open to the society in general and that it should not be limited by its physical walls, but beyond the place where the object is located. This might have been the beginning of the idea of virtual museum, or museum without walls, as we see today, where people can access museums' webpages and see the objects from anywhere, anytime (Hooper-Greenhill, 2000). Although most museums seem to understand the importance of having an

online presence, many cultural heritage institutions underestimate the potential of their webpages by using it only as a sort of digital visit card, a library, or simply an online version of the real museum (Pascual, 2012; Bahkshi and Throsby, 2010; Srinivasan et al., 2009). This type of webpages that act as digital versions of the real institution presents only the primary information about the museum and the pieces, simply with the objective to inform people that are interested in visiting the real museum, instead of creating an information platform (Kotler and Kotler, 2001). That can be due to the need to create standards that facilitate documentation and sharing of information, but should not be restrictive to the countless perspectives a virtual museum can offer (Blackaby, 1988, as cited in in Srinivasan et al., 2009). Rio Castro (2012) adds by pointing out that virtual museums should not only show the information, but also manage it towards educative, recreational, and commercial objectives.

Virtual museums have (as the real ones) core functions such as exhibition, communication, research, and conservation of the pieces (Kwon et al., 2003). Customization, interactivity, and content are some of key words when speaking of virtual museums, in addition to the informative objectives of a webpage. They have to permit adaptation and accessibility of all types of users without losing its original artistic and social values (Solano, 2012). The online visitor has the opportunity to select, transform, and even generate and exchange content through the webpage without intermediaries (Srinivasan et al., 2009; Rio Castro, 2012). It brings the online visitor from a passive to an active position, where they can both access and generate content, where the discourses around the objects can be magnified by the possibility of adjusting quality and content in the online format (Srinivasan et al., 2009; San Martin, 2012). Moreover, the virtual museum offers the possibility to enhance the experience by connecting with users both before and after the visit to the real museum (Pascual, 2012).

Online museums should offer organic navigation interfaces for each and all kinds of publics and, simultaneously, provide interesting, participative, and almost realistic experiences through new and social technologies, engaging the public and adding value to institutions' image (ICOM, as cited in Kwon et al., 2003; Srinivasan et al., 2009). The more authentic the online experience reveals to be, higher are the chances to bring online visitors into the real museum (Sigala, 2005). Below, the figure 5 shows a suggestion for an art museum ontology combining actors and objects, which is apparently simple but sometimes difficult to apply. However, its implementation would produce a better model for museum's websites to combine objects, discourses, and information.
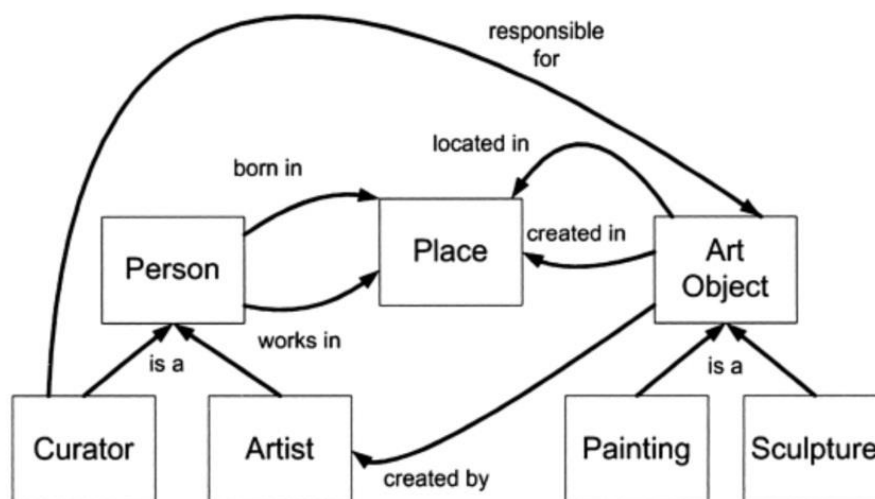
Figure 5: virtual museum's ontology (Bailey, 2010, p.36).

Despite opportunities the public and artists themselves might have to communicate democratically without the need of intermediaries, the appeal and potential of virtual museums brought also the possibility of professional specialization in digital content management, as the 'digital curators' (Mediamusea, 2010; Pascual, 2012). Both real and virtual museums' professionals have similar curatorial objectives when selecting and defining

the most appropriated communication methods to the prospective publics, working in accordance with the varied mediums, publics, and institutional goals. The objective is to use the digital element to add extra value and make more interesting online versions (content selection) or even to create exhibitions available exclusively online. Conclusively, virtual museums should not become simply a digital replica of the physical museum but its extension, collaborating and cooperating to achieve institutions' mission. Therefore, virtual museums, as with the real museums, should rethink its attributes and functionality, repeatedly, as the environment change itself nonstop (Rio Castro, 2012).
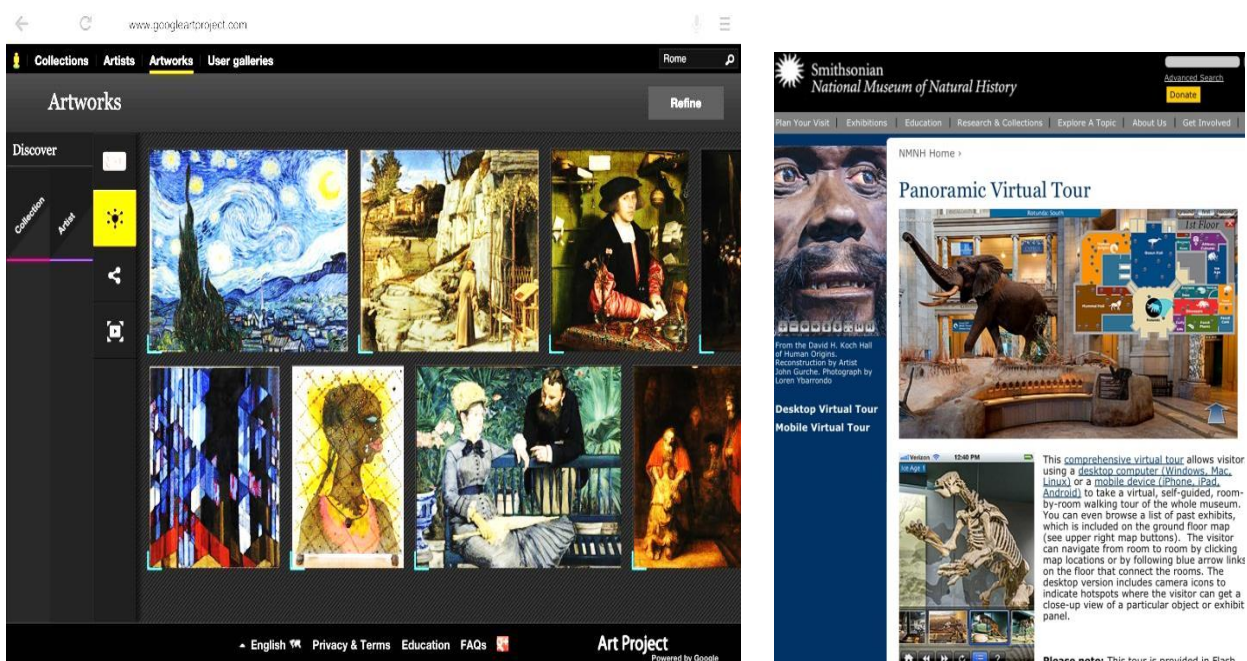
Examples of Virtual Museums: Google Art Project (GAP) (http://www.googleartproject.com/) and the American Smithsonian National Museum of Natural History (http://www.mnh.si.edu/panoramas/).

4.2.2. Communication and marketing technologies

Webpages

Museums webpages, as briefly treated above in the 'Virtual Museum' section, are key references also for the communication and marketing activities (see appendix VI for an example of a thoroughly museum webpage). The first functions of museum's webpages were to inform future visitors about practical information surrounding the museum and its exhibitions. Only in the last decade have museums' webpages added the virtual museum orientation to their websites. Consequently, the current webpages, from the simple and informative websites to interactive and multimedia ones, are also important tools in communicating with the environment. The figure 6 (in the next page) shows an interesting organizational and technical structure for virtual museums. Here, the museum, its users and work team, employ many interfaces and devices conveying the services and communication flow among the diversified categories of users (e.g. visitor/tourist, student/educator, and expert/administrator):
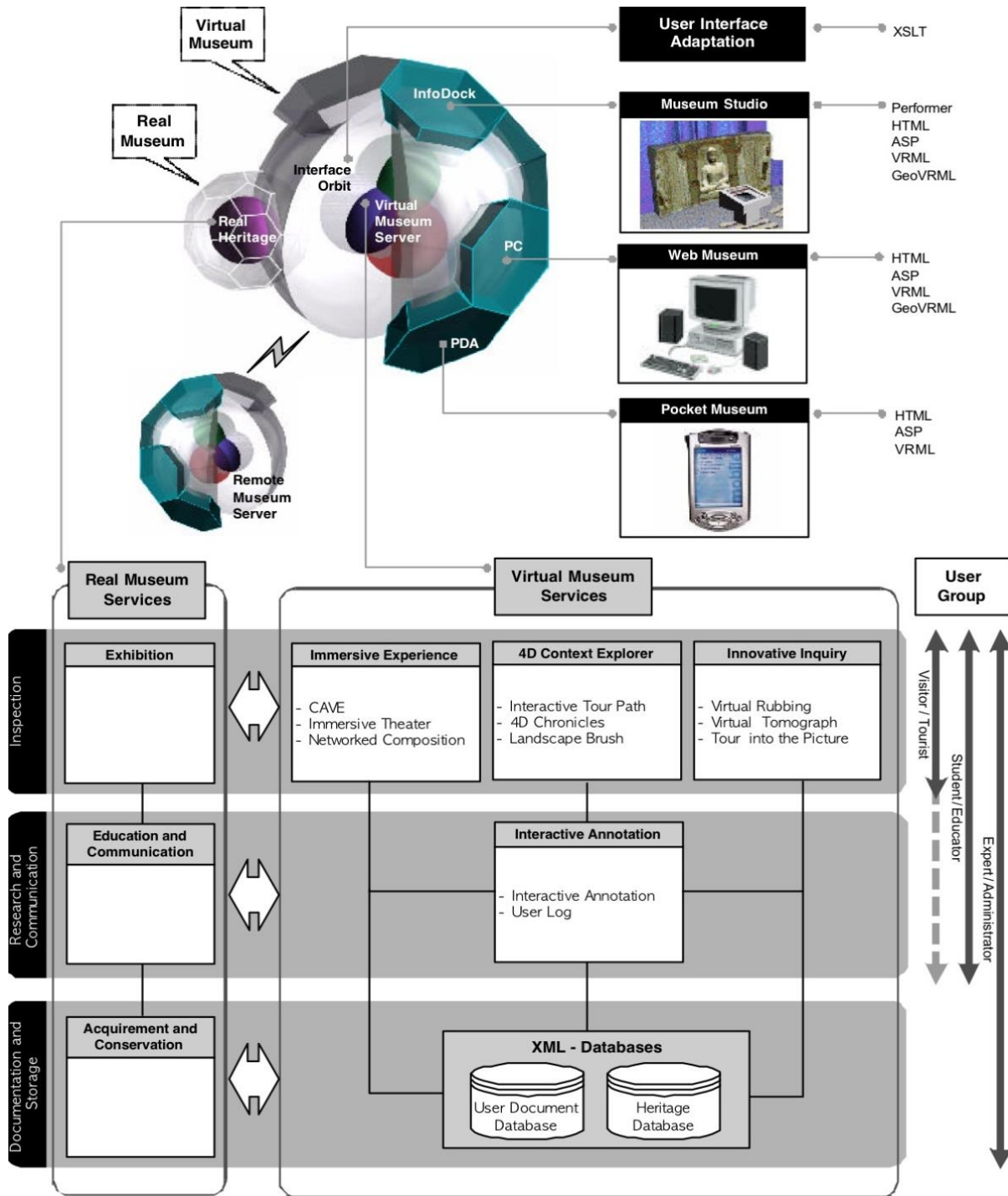
Figure 6: Organizational and technical structures between real and virtual versions of a

museum (Kwon et al., 2003, p. 3).

Social media networks

Social media networks are platforms that combine with many of the technologies treated previously with the intention of promoting full communication with the public and the environment, as well as to reach and create new groups of users and even new market possibilities (Potts et al., 2008). Some examples of social platforms are Facebook, Twitter, LinkedIn, Tumblr, blogs, and other media and news sharing pages. Granting the promising engaging capabilities, the use of social technologies are not yet in its full potential, but generally employed to simply promote and advertise. These networks habitually allow free reorganization and reconnection of varied content with others through elements such as posts, comment spaces, media, videos, and photos (San Martin, 2012). This creates a sort of "'collective intelligence', where meanings are generated and shared in a multidirectional approach, having the exchange of users' opinions as the main element of its composition" (Pascual, 2012, p. 4). The information exchanged by the users are not merely opinions and reviews about the exhibition or piece in question, but it extends to creation of content and affects organizational and managerial aspects, services, and other significant and important activities surrounding cultural institutions (Pascual, 2012.). Some users want to be a part of the creative process and the development of others' ideas, decentralizing knowledge. The higher the number of diversified people involved in the creative process (audience, other cultural institutions, government, professionals, experts, academics), the best is the way of an institution towards a culture of informal and interdisciplinary co-creation and sharing (Celaya, 2012).

Like with the digital curator for virtual museums, the growing importance and influence of social media in institutions' activities opens up space for specialized professionals called 'community managers' that interpret and administer social media activities (Mediamusea, 2010). Once institutions devote time, resources, and efforts in

managing social technologies, they expect to obtain certain return as, for example, to profit from use or online access, or establish collaborations and new sources of funding. Those professionals can truly help an institution to start its virtual presence and make it omnipresent. The level of control by the community managers cannot be so high to connote corporatism or content control, even though, it still has to be indicative (and innovative) enough to be the connection between the interests of museums and their publics (Celaya, 2012).
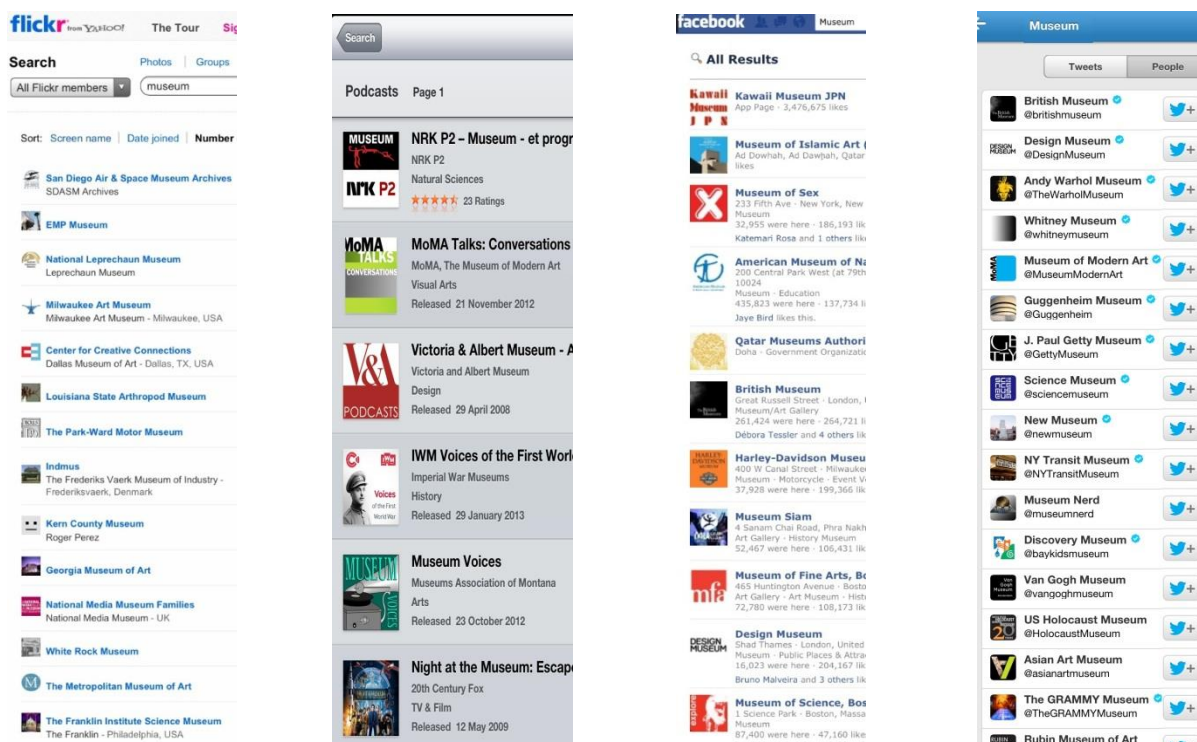
Examples of museums' presence in social media networks (above).
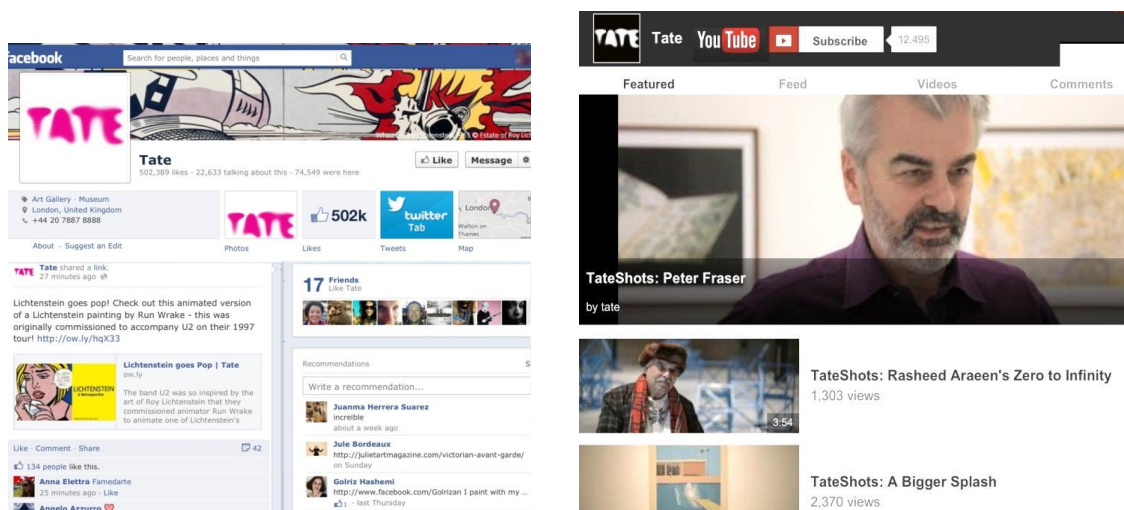
Examples of Tate Museum's pages on Facebook and Youtube (above).

4.2.3. Organizational and managerial technologies

Intranet

Internal network system (intranet), used almost exclusively by museum's staff, helps to maintain an open communication flow, easier sharing of information and knowledge, and also permits better coordination of operations among departments (Anderson, 1999). Hence, it stimulates from higher collaboration and the sense of team by the staff, to wider availability of technical and formal procedures forms, and conversation channels among employees. Intranets are thus important tools for the implementation of an organizational culture and the knowledge management within institutions' walls.

Ruppel and Harrington (2001) assert that intranet platforms help promoting diverse types of organizational culture as ethical culture (consideration toward other people), developmental culture (flexibility and innovation orientations), and hierarchical culture (referring to practical tasks as policies, procedures, and information management). Hereafter, the use of internal network systems can benefit the management of knowledge by the exchange of information independently of distance and time, formally and informally. While the existence of an internal system seems to be an effective tool, the efficiency of the intranet depends on the technical requirements of the platform, the literacy and willingness of users (employees), on top of the security and information adequacy (Lai and Mahapatra, 1988).

Home
Affiliates
Art Services & Prep.
Audiovisual
Conservation
Curatorial
Development
Education
Exhibition
Construction
Exhibition Design
Exhibition Lighting
Exhibition Mgmt
External Affairs
Facilities & Office
Svcs.
Fabrication
Finance
Graphic Design
HR
IT

Processes
IT Policy Handbook
Reservery Procedures
TMS
  TMS Procedures
IT FAQs
Legal
Library & Archives
Licensing
Marketing
Media & Pub.
Relations
Philosophy
Publications & Web
Site
Registrar…
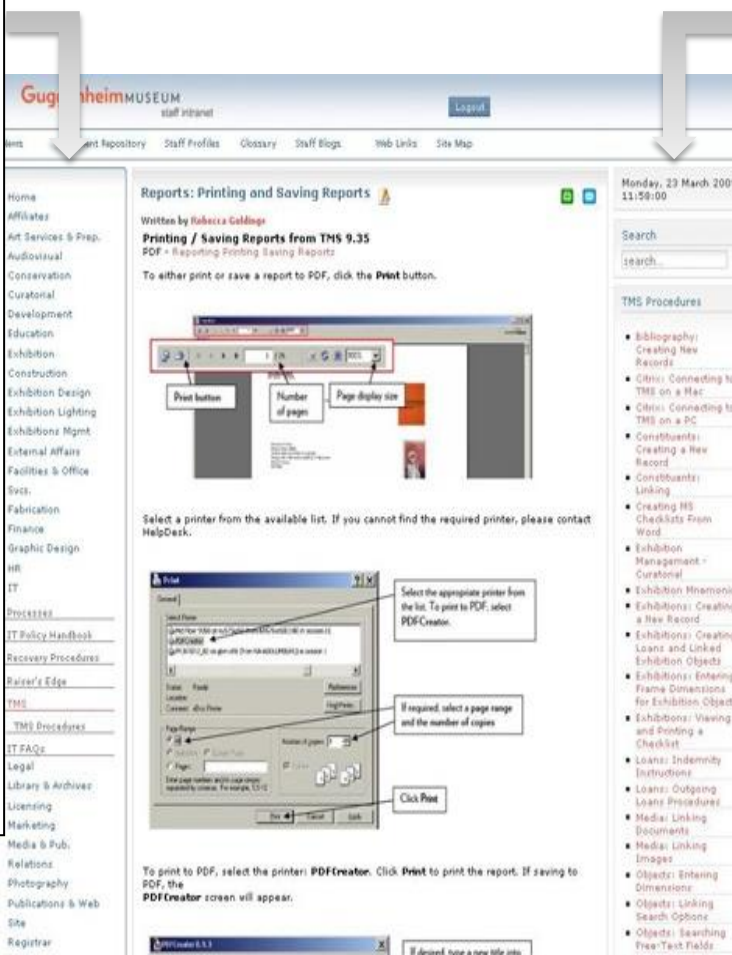
Weekday, Date, Year, Time

Search: _____

TMS Procedures:
* Bibliography: Creating a New Record

* Connecting to TMS

* Constituents: Creating a New Record

* Constituents: linking

* Creating MS Checklists

* Exhibition Management – Curatorial

* Exhibition Mnemonic

* Exhibitions: Creating a New Record

* Exhibitions: Creating Loans and Linked Exhibition Objects.

* Exhibitions: viewing and printing checklist.

* Loans: Outgoing Loans Procedures

* Media: Linking Documents

* Media: Linking Images.

* Objects: entering Dimensions.

* Objects: linking Search Options…

Example of one side of Guggenheim Museum's staff intranet (http://goldilox.wordpress.com/web/srgm1/).

Restoration and conservation technologies

Due to the development of cutting-edge technologies such as digital and laser technologies, cultural heritage institutions are now able to register, manage, and explore permanently the characteristics and composition of artefacts. These technologies are becoming increasingly

important in the preservation and restoration services for cultural heritage goods. Digitization creates a digital representation of objects through diverse processes like 3D scanning, data capturing, geometric modelling, and texture mapping (Li et al., 2010). Through these processes, it is possible to recover and store information surrounding the objects, with high resolution and precision, for diverse uses such as digital versions, research, conservation, and re-composition of historic facts connected to the details of objects and its contexts. Laser technologies are also widely used in the preservation of cultural goods in the cleaning of artworks (without deterioration of piece's original characteristics and material), in the analysis of the piece's original composition (e.g. under layers of a painting), damage assessment, and anti-fraud detection tools (Tornari et al., 2000).

Conservation technologies permit an almost perpetual access to cultural heritage artefacts for use in the future, in places where full access is not possible in order to avoid damages of the original work (e.g. having its digital representation available, instead), in remote access situations, and in case of stolen or broken pieces.

Conservation of Guernica at Museum Reina Sofia / laser modelling at Museum of Liverpool / Digitization at Metropolitan Museum (MET).

5. Methodology

In this study, I use mixed methods of collecting data, due to the nature of the selected topics, to find final relations between all of the ICTs front different groups of user/visitors, and the expected and generated innovative response. The empirical research method used is a combination both qualitative (data not represented in numbers) and quantitative (data represented in numbers) with the purpose of finding answers to the different nature of subjects (Punch, 2005). The mixed sources and methods of collecting data material benefit this investigation by overlapping the strong and weak sides of both approaches. That so, I will test and explore the selected topics aiming to produce data enough to present a general picture of the main elements (innovation types) and their relationships with the variables (ICTs).

The difficulties in finding one single museum that encompasses all the attributes necessary to serve as the case study (and to gain access to it) made me opt for investigating the primary topics of this study (technology, innovation, and museums) in more general perspectives. The process was then employed through a standard protocol to all the different targeted individuals. The respondents and interviewees are residents from both Norway and Spain, due to my connection with the universities located at those two countries. Although employed only in two countries, I have asked the interviewees to respond considering a more international point of view about the topics and the cultural heritage field in general. The groups of respondents and interviewees comprehended ten (10) individuals each, divided into two main groups: experts/professionals and users/visitors. These two groups are, in my opinion, significant representatives of the groups who interact with museums by visiting, co-producing, or studying it (contact with funders and members was unfortunately not possible). The selection of members of the expert and professionals group occurred consistently with the choice of their papers, articles, or other materials published about the theme in question, as

well as their position, availability and wiliness to participate. The group of users consisted of randomly chosen (current and potential) users/visitors, with individuals ranging from art-enthusiastic persons, to students, and individuals with non-art-related professional of personal interests. The randomness in the choice of users/visitors is due to the randomness found in the types of people that visit the great variety or museums.

5.1. Interviews

Interviews are one of the main qualitative approaches in social research. Qualitative empirical research method searches for information (through words) about the world, people, meanings, and events (Punch, 2005). This kind of qualitative data material is attained through interviews, observation, personal notes, and experiences, among many other sources. Interview is a very productive way of collecting qualitative material that will help to understand behavioural, social, and cultural dimensions of our society (Avison and Meyers, 2002). Qualitative method can help the investigator, so, to have access to opinions and to understand the significance of specific issues inside the studied field by 'watching, asking or examining' (Wolcott, 1992 as cited in Punch, 2005, p. 57).

The interviews were employed only to the group of experts and professionals since they were intended to both widen knowledge about the issues and elements, collect their opinion about the suggested topics, and to scan their perspectives and suggestions about the current context. The scanning was helpful to find new and related topics or sources of evidence, not yet designed but of equally great relevance, to take into consideration in the study. The interviews followed an open-ended protocol, as guidance, instead of a structured and strict inquiry, allowing space to the expression of the experiences lived and studied by the interviewees (Yin, 2009). Open questions permit the interviewee to emphasize and further

explore whatever subject they consider important and relevant (Bell, 2010). It is important to be aware of the limitations of the interviewees at the time of the application of the inquiry such as, for example, lack of memory, personal involvement, and bias. The attempt to avoid bias while proposing the questions and receiving the answer (to interpret it properly and neutrally) can sometimes have left space for misunderstandings surrounding the objectives of each question, but it has apparently worked well once the level of instruction and experience of the interviewees are significant about the subjects under analysis.

The protocol was divided into six (6) open-ended questions, distributed into four (4) main subtopics, all related to the case of innovation in museums in our current societal and technological contexts. The subtopics contested were:

- Museums and the current context.

- New technologies in museums.

- Innovation in museums.

- Users' experience in both real and virtual museums.

5.2. Non-participative observation

Once the familiarity of users/visitors with the topics asked can sometimes be unsatisfactory or inexistent, it can induce misunderstanding and misleading when answering the questions. One way to avoid or compensate this kind of disturbances, or to confirm data while collecting evidences, is to employ observational research methods. These methods of direct and naturalistic observation grant the investigator with the possibility to witness the studied subjects naturally, without interference, manipulation, or stimulation by the interviewer (Robson, 2002; Punch, 2005). As written by Robert Yin (2009), these methods are especially recommended when the observation goal is related to the way subjects (technologies) behave

"at work". For that reason, the observational method is in use in this study. This method is performed in, for example, group meetings, sidewalk activities, and field visits. I chose the field visit to perform the observational method, both while running the interviews and inside a museum. While running the interviews, I performed the collecting method unstructured. On the other hand, in the museum, I had a partially structured form with the list of data I was expecting to analyse, mixing words and numbers as data material (description of the artefact, number and nature of interactions, or its denial). Inside the museum, I observed the behaviour of the public without participating or letting them know they were under observation to do not influence the subjects or the environment (Bryman, 2004). This research method gives the investigator detachment and neutrality enough to examine to a greater degree.

The non-participative observation (NPO) occurred in two (2) occasions. I observed one piece, two Sundays, at the same time, during the same period, in the Museum for Contemporary Art of Oslo, Norway. I have decided for this museum because public resources essentially fund it and, at the same time, they have complementary services and commercial operations (store and coffee shop). It seemed to be a coherent option when compared to the other possibilities available locally such as the National Gallery (very traditional and fundamentally publicly funded) and the Norwegian Museum of Science and Technology (very developed technologically, since it is the main objective and mission of this institution, although funded by mixed sources).

The Museum for Contemporary Art of Oslo had an exhibition primarily based on audio and video projections (see appendix III), which seemed appropriated to my investigation, meanwhile, it can have induced the behaviour of the public since the interaction with these technologies is the main form of acquiring knowledge about them. Once most of the pieces offered audio or sound experiences, this particular exhibition did not provide other complementary devices as audio/smart guides. I have chosen an art piece that presents a

combination of image and sound complementing each other in order to communicate the artist's message and provide the whole experience (see picture below).
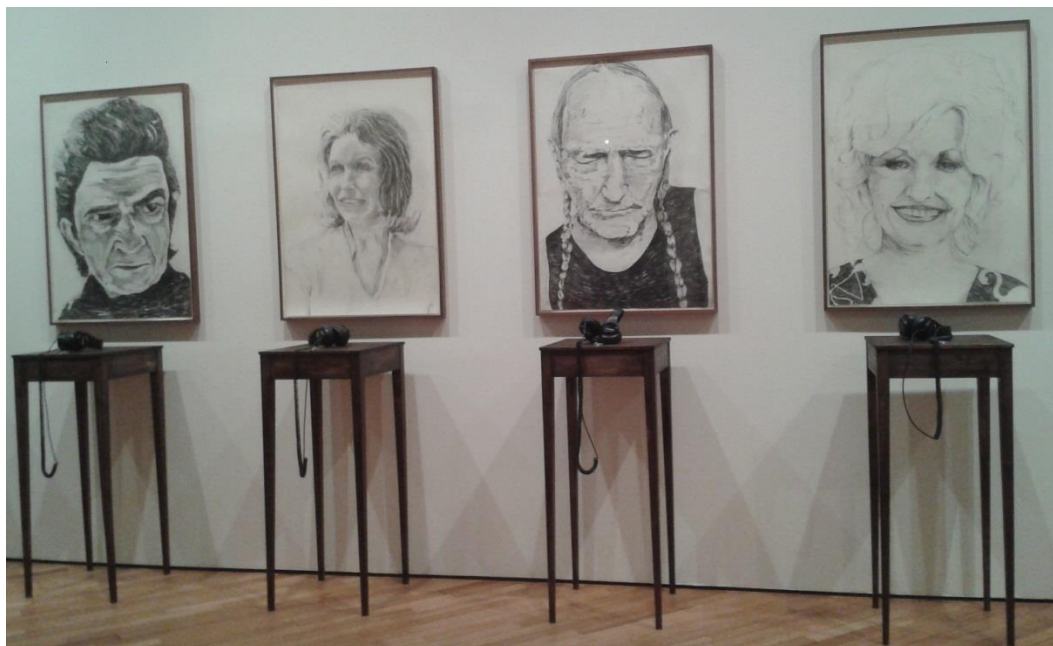
5.3. Surveys

Survey is one of the most used quantitative methods of empirical research. This type of research presents data in form of numbers, which permits measurement and analysis of the multiple variants and possible causal relationships between them (Punch, 2005). Numbers help us to set data in a systematic presentation, by assigning values (numbers) to people, meanings, and events, in order to structure and compare it. Moreover, the conduction of surveys is found often and largely in other similar investigations in the fields of innovation, technology, and museums.

The survey used in this investigation follows the typology in agreement with the innovation scope and the type of ICT found in museums, as reported in the literature review chapter. The innovation scopes used to delimitate the survey's divisions are:

- Innovation at the exhibition (mainly during the visit; embracing both real and virtual exhibitions, but separately),

- Innovation in communication and marketing activities (mainly before and after the visit), and

- Innovation at organizational and managerial levels (internal and market perspectives).

Each of these scopes contains the exact same list of ICTs to be linked with the innovation scope for the respondent to rate the relationship and/or the level of dependence between the technologies and the innovative activities. The rates are in ordinal scale and are set from zero (0) as being "not related/not dependent" up to ten (10) as being "strongly related/dependent". The respondents had the opportunity to answer 'NR' (no response) whenever they did not have information or familiarity enough with the subject to answer it (in these cases, the answers were not included in the final account). Lastly, an extra empty cell admits further and open-ended observations by the respondents.

6. Results

6.1. Analysis

In the previous chapters, I introduced the concepts and characteristics of ICTs and innovation's approaches in order to prepare the thesis to the interpretation of the empirical material, to be able to use the literature to support the methodology, and to search in the empirical material the validation or confrontation of the assumptions made throughout this investigation. The goal of this research is to acquire a greater overview of museums' technological and innovative contexts, at a general rather than specific level, taking in consideration also behavioural and sociocultural issues. In order to help answer the research question and to point out the most influential technological variables towards innovation in museums, this study analyses multiple sources of evidence. The combination of multiple data material grants more validity and confidence to the arguments (if verified) when crossed with all the different sources of information (Yin, 2009).

Quantitative data analyses multiple independent variables to each specific dependent variable (each technology currently in use in museums) to reveal the relevance and effect of each of these independent variables on the technologies (Punch, 2005). The quantitative data shows the values numerically, in scales, in a simple bar chart presentation, aiding the examination and comparison of the variables. The values collected have the 'mean' measured to evaluate better the results that will go under analyse. The mean displays the average value of each question (central tendency) obtained from all responses collected (Punch, 2005).

Qualitative data, on the other hand, represents information not in numbers but in words. In this case, it is important to structure systematic processes of data analysis to be able

to compare and analyse these evidences with both the qualitative and theoretical frameworks. There is not a single and pre-stipulated method to analyse qualitative data, ergo it depends on the characteristics and objectives of the research (Punch, 2005). In this investigation, I will follow the steps of Miles and Hüberman's interactive model of data analysis (1994). This model suggests the data reduction as the first step in organizing qualitative data. Therefore, the answers to the open-ended questions were edited, segmented, and summarized per interviewee as well as per topic (in case of the observation practice, the type and numbers of reactions to the work sorted the results). Since it takes time to transcribe qualitative data, I have transcribed only the most relevant for future analysis. Furthermore, the statements were combined and sorted according to the main concepts and variables found in the theoretical review and from extra notes done while gathering evidences. The second step suggested by the interactive model is the display of data into, for example, visual arrangements; which in this study was through the transformation of data into charts and analytical graphics, highlighting the main meanings. The final step of this model, which is applicable throughout the whole process or exclusively at the end, is the drawing of conclusions and the verification by interpreting and crossing with other data from both qualitative and quantitative gathering. A summary of the answers and the behavioural observations will help to find the similarities across evidences. Still, quotations from the respondents will help to delineate the conceptual frameworks and other findings.

The data analysis will follow a descriptive multilevel analysis of technology-by-innovation. The results of the analysis of each technology in each innovative group will go under comparison, permitting the verification of the findings of one subject into different sources with the aim of reinforce validity and co-relate all the evidences at the same time, around the same dependent variables (e.g. technology X user/visitors X expert/professionals) (Yin, 2009). Yet, interpretations among all the technologies and innovation types will be

combined considering the collected materials, conceptual frameworks, and alternative sources of information in order to explain the data (Punch, 2005).

Conclusively, the starting point for the analysis of each innovation type is illustrated in the figure 7 (below):

Figure 7:
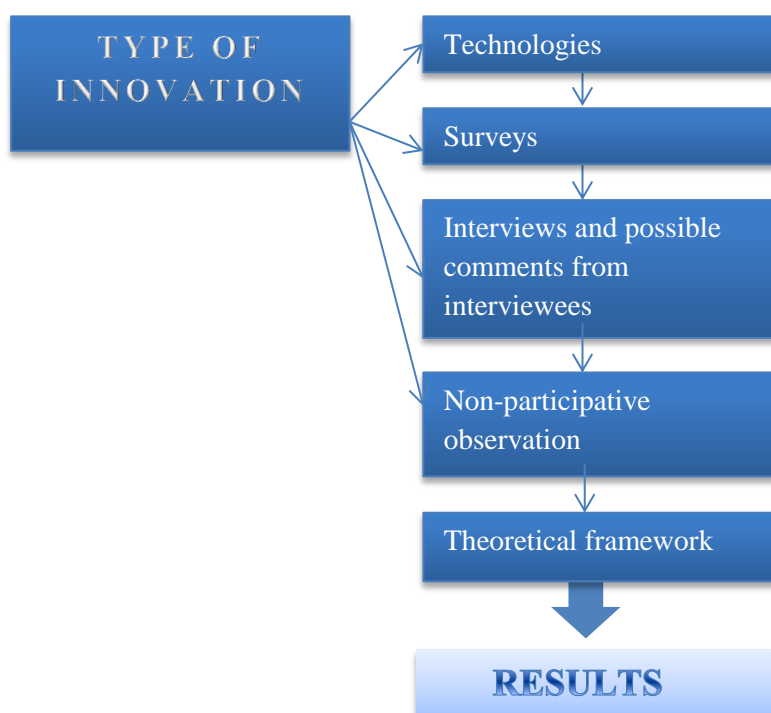
Even though the methods and the evidences obtained in this investigation were made according to systematic processes, the validity of the data must not serve as an example for generalization of the findings since the sample is relatively small, considering the great range of types of people that interact with museums. Moreover, the characteristics of each cultural heritage institution, and their environment, must to be taken into consideration when analysing the respective use and effects of specific technologies.

6.2. Results and discussion

In this topic, I will combine and discuss the results from the diverse research methods used in this investigation with each type of innovation, separately, as presented in previous chapters (innovation A: exhibition and presentation; innovation B: communication and marketing; and innovation C: organizational and managerial). It is important to observe that each answer possibly reflects determined types of museums (consistent with the interests of the interviewees) but the analysis will pursue a consensus. This can suggest, therefore, some deviation in some determined cases, while, in fact, it aims to demonstrate a general comprehension of the museum experience.

While analysing the results, I observed a kind of pattern in the understanding of the suggested technologies by the respondents, which somehow naturally distributed them into different groups, conforming to their characteristics such as internal X external use, new X mature, and technical specifications. Hence, I divided the technologies into four groups and will use these divisions as a starting point for the description of the results (any variances that happen along the way will be indicated):

- *Base* technologies (intranet, digitization and laser),
- *Traditional* technologies (audio/smart guides, audio and video projections),
- *Cutting-edge* technologies (interactive tables and screens, virtual and augmented realities, 3D and holography), and
- *Mobile / Social* technologies (PDAs, mobile phones, tablets, applications, QR codes, webpages, virtual museums, and social media networks).

The first group, called "base technologies", are the technologies used to prepare products/services and back-office operations in order to have the institutions ready to present

the artefacts (intranet, digitization and laser scanning). The second group, the "traditional technologies" group, refers to more mature technologies that one day were new to the museum's scene but is now familiar to most publics since it has been in use for some time (audio guides and audio/video projections). The third group, on the other hand, represent the "cutting-edge technologies", which are technologies that enhance the traditional means and presentation techniques, and are still new for many cultural heritage institutions and their audiences (interactive tables and screens, virtual and augmented realities, 3D, and holography). Lastly, the fourth group is the group of "mobile and social technologies", which mixes both mobile technologies provided by the museums and personal devices, as well as applications, tools and Internet sources used within or beyond museums walls (PDAs, mobile phones, tablets, applications, QR codes, webpages, virtual museums, and social media networks). The last group became a combination of two types of technologies (mobile and social) because, in most of the cases, it became hard to understand the limits of each one and to distinguish their independent roles.

Innovation A: exhibition and presentation of objects, contents, and discourses.

The innovation A refers to the technologies used to enhance and to innovate presentation and design techniques in both virtual and real museums. They essentially interact with visitors during their visit and are responsible for improving the overall experience, in socio-cultural and educational aspects, around the artefact and its discourse, and as a mediator between the institutions and their audiences. Furthermore, in this innovation type, I detected the need to separate between online (virtual) and on site (real) museums since the technology-dependence seemed to vary considerably between those two versions of museums.

INNOVATION A – General results
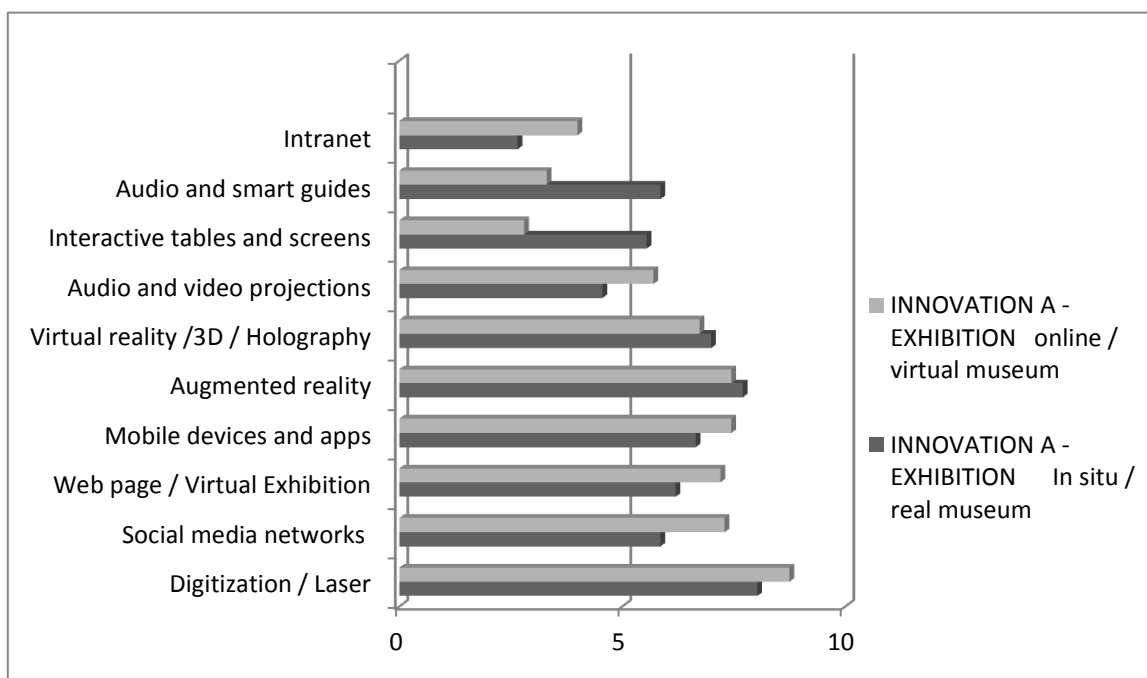
The most valued exhibition and presentation technologies, in general, were the cutting-edge, mobile/social technologies, and base technologies. It is quite understandable that many people are interested in the new technologies and, when given the possibility, they would like to explore those in order to acquire more from their experience (more fun, more learning, and more interaction). The mobile and social technologies are especially important while visiting the virtual museum and may serve as informative (previous and post visit) and complementary (during the visit) tools. In addition to these top rated groups of technologies, one element of the base technologies group, the digitization, has surprisingly been considered very relevant not only for the virtual museum (which has the digitized artefacts as its main product) but also at the real museums. It is challenging to explain the meaning of the high relevance of digitization in the exhibition of real museums, as stated by the respondents, since it had no further observations or comments; but, in my opinion, it may concern the conservation and restoration of objects.

An unexpected variance between users and experts is regarding the cutting-edge and mobile/social technologies. Experts considered the mobile/social technologies much more relevant for the exhibition while users preferred cutting-edge technologies, I assume, as the means for an innovative presentation of artefacts. On one hand, this difference, according to the theory and some comments of the interviewees, possibly reflects the desire of the most of the public for interactivity and play while learning (full experience). Interactivity can promote deeper learning, once it helps to call attention for the object, and to explore further its content, as well as provide socially engaging experiences during the visit (Pujol-Tost, 2011). Specific audiences like students, artists, and experts usually are more interested in maintaining and deepening links with institutions and other users alike, beyond the moment of the visit, targeting the exchange of information and thus creating and distributing knowledge. Ergo, experts might have chosen the mobile and social technologies because of its capabilities for acting as tools for promoting deeper engagement and, in consequence, endorse long-term effects from the museum experience.

INNOVATION A - IN SITU: Users X Experts
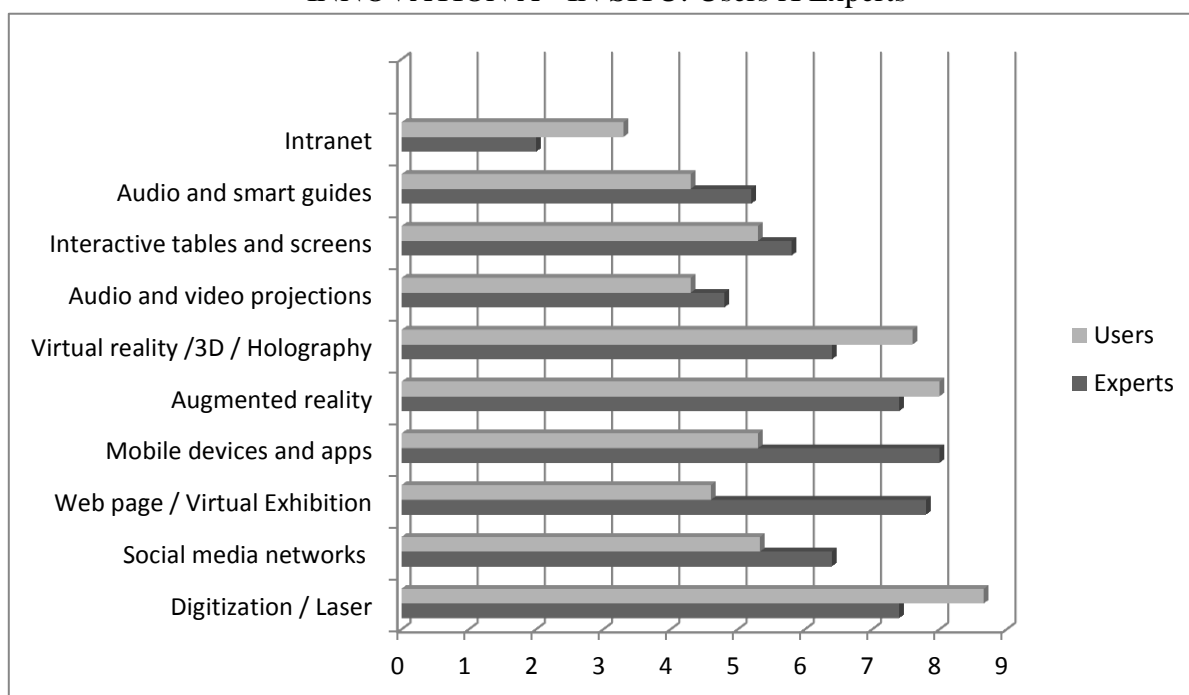
INNOVATION A - ONLINE: Users X Experts
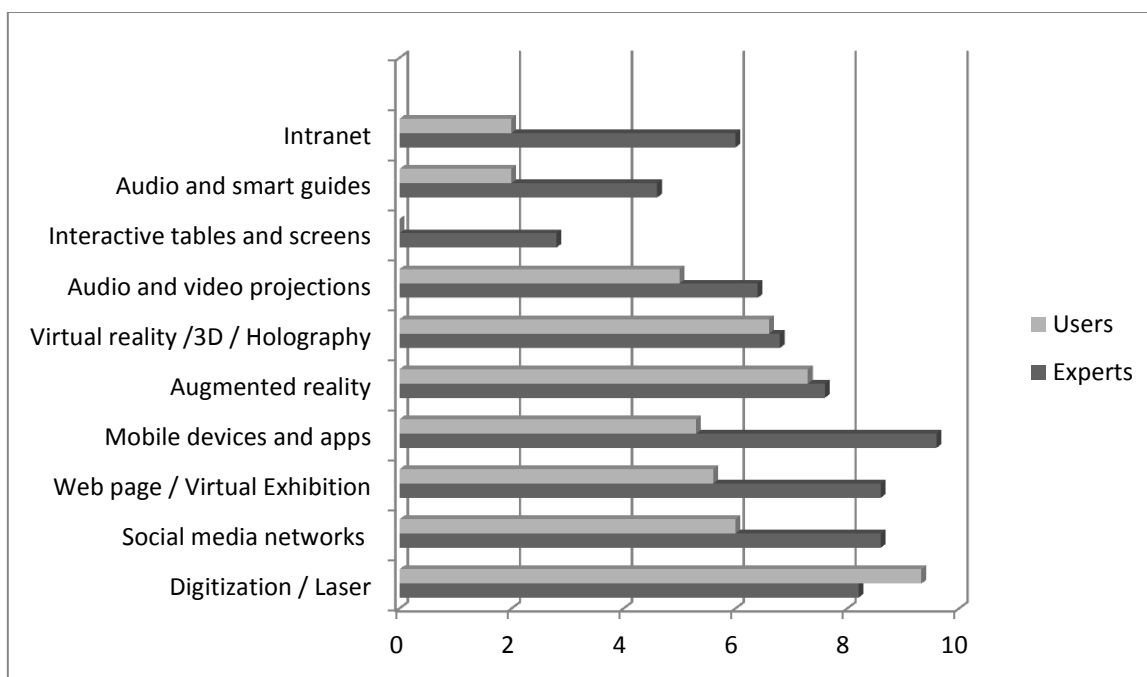
Additionally, in the observational research practice, once neither high tech nor mobile devices were offered, the traditional technologies (audio files, largely) were intensively presented by the museum and the artists and satisfactorily explored by the visitors.

Innovation B: Communication and marketing. Practical information, and widening and deepening of relationships with the audiences.

Innovation B refers to technological tools that serve as facilitators and mediators to communicate with museums' audiences and other agents of the environment. Cultural heritage institutions have their mission, vision, values, and social commitment to transmit. In addition, they have to connect with other actors to understand their audiences and the market to improve continuously their products and services, for socio-cultural and economic reasons. Museums' communication and marketing activities starts from before the visit by offering

information about the institution and its exhibitions, sharing practical instructions, promoting interest, and maintaining the connection with its visitors. Although these tools are in use mostly before and after the visit, they can also be of use while visiting the museum due to the advancements of mobile technologies, which provide access from everywhere, including from within museums. Therefore, technologies inside museums can act as human resources, as said by one of the respondents.

INNOVATION B - General results
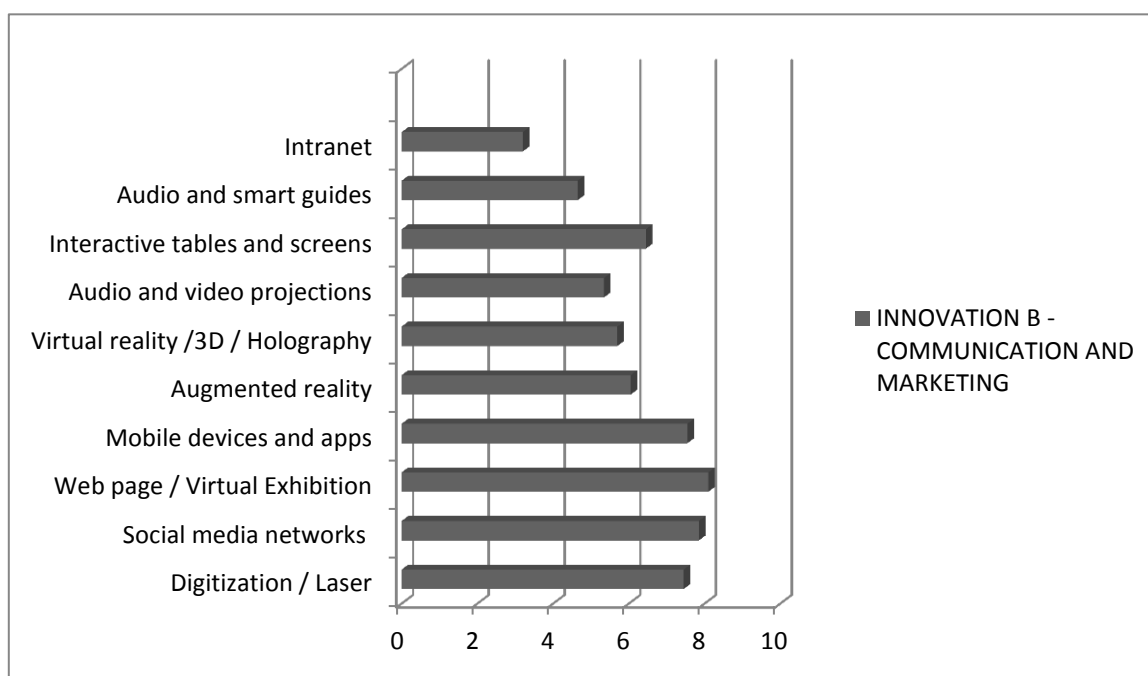
Not surprisingly, the mobile and social technologies achieved the highest general rating in the survey, what confirms the assumption and the division of the technologies included in this group and their respective functions. One interviewee also commented on this specific topic recalling the fact that it is very important for the institution to communicate its mission and vision clearly and intensively once the channels (webpages and social media) are

increasingly similar in appearance and the only way to differentiate is the posture and the quality of the content and discourses they divulge. A secondary technology group, the interactive tables and screens, from the cutting-edge technology group, is also included. That, I suppose, concerns the use of these interactive points as sources of information giving the idea that these tools also communicate content and knowledge.

Among the groups of respondents, there was a considerable difference in the degree in the level of significance of mobile and social technologies. The expert group assigned greater relevance for the use of these technologies than the group of users. I believe it is due to the further knowledge and understanding the experts have on the significance of activities' planning and management in order to achieve socio-cultural and financial goals in the long run. Nevertheless, users do not seem to observe the mobile and social technologies in such a critical way, rather only viewing them as gadgets for instantly obtaining information, relating and connecting to the institution, its exhibition and discourses.

INNOVATION B: Users X Experts
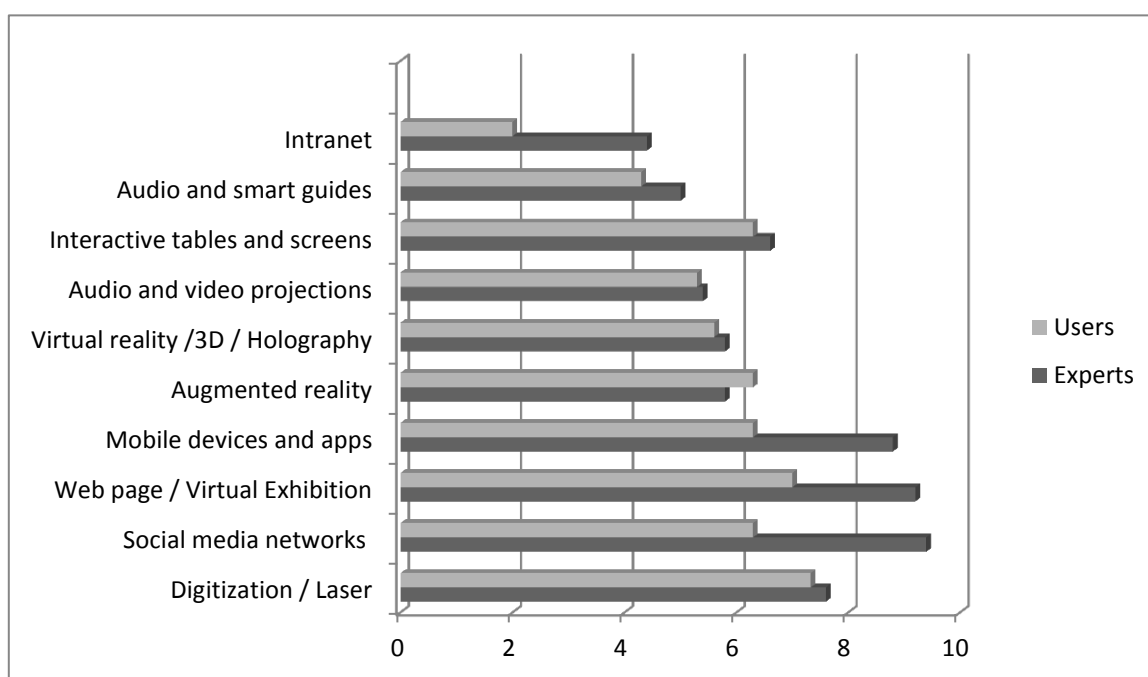
Innovation C: Organizational and managerial. Internal and business practices of the institution.

The innovation C discusses the technologies and innovative activities that alter and innovate the institution internally. These technologies not necessarily need to happen inside the museum walls to affect it internally, but can be found also as a result of all other technologies in use in museums nowadays.

Organizational and managerial innovation is a continuous process where institutions constantly need to rethink and restructure their internal structures and operations in agreement with the characteristics of the changing conditions, reflecting an appropriated posture along with their values into the public and the environment. As a result, the base technologies are the foundation for the production and maintenance of objects and products/services. The intranet system helps the institution with the management of knowledge and general information, fostering organization's culture, sharing of material, unification of procedures and technical forms, and internal communication. Those elements are crucial to strengthen and maintain institution's operations internally, and to prepare it to exhibit their cultural goods, services/products, and thus relate with the environment. Digitization and laser technologies are, likewise, key tools in essential activities that allow museum to exist and function through the analysis of artefacts' characteristics and details (such as preservation and restoration of their patrimony and the reconstruction of facts and contexts surrounding the artefacts). Furthermore, the digitization of cultural goods permits institutions to use their digital versions in diverse ways, for example, through facilitating access to unavailable pieces, protecting objects from deterioration, and availing the many possibilities of use and commercialization of digital artefacts.

INNOVATION C - General results
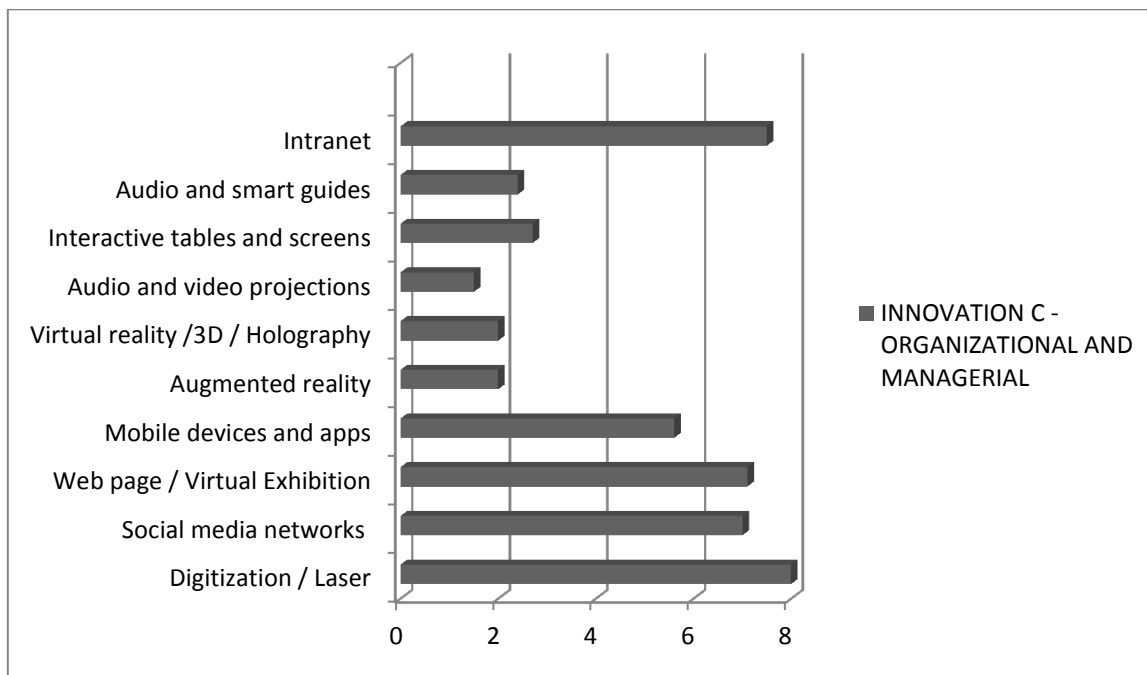
Although not everyone who does not study the field of museums have conscious and deep opinions about the role of these new technologies in the configuration of institutions, the groups of respondents seemed to agree with this hypothesis since they all have consigned great totals to the intranet and digitization technologies. It is challenging to define the level of understanding and importance given to each of the base technologies (since there were no further observations); still, I risk asserting that the great part of the respondents recognized the main characteristics, functions, and values of those technologies for the institutions. Seems to be clear the assistance of this type of technologies, and their results, in the internal performance of museums, in controlling information and knowledge, and to manage their cultural property in order to be able to communicate and negotiate with the market, audiences, and the environment in general. One respondent commented that institutions often have problems to communicate, manage and control information internally and in this case, the existence of intranet and the use of digitalized items are very helpful to promote a more

democratic working condition. The second biggest values were given by both groups of respondents to the mobile and social technologies, although, the rates from experts are higher than the numbers collected from the users. That might refer to the possibility to present and fortify institutional values through those technologies, uncovering and bringing museum's organizational culture to their audiences.

INNOVATION C: Users X Experts
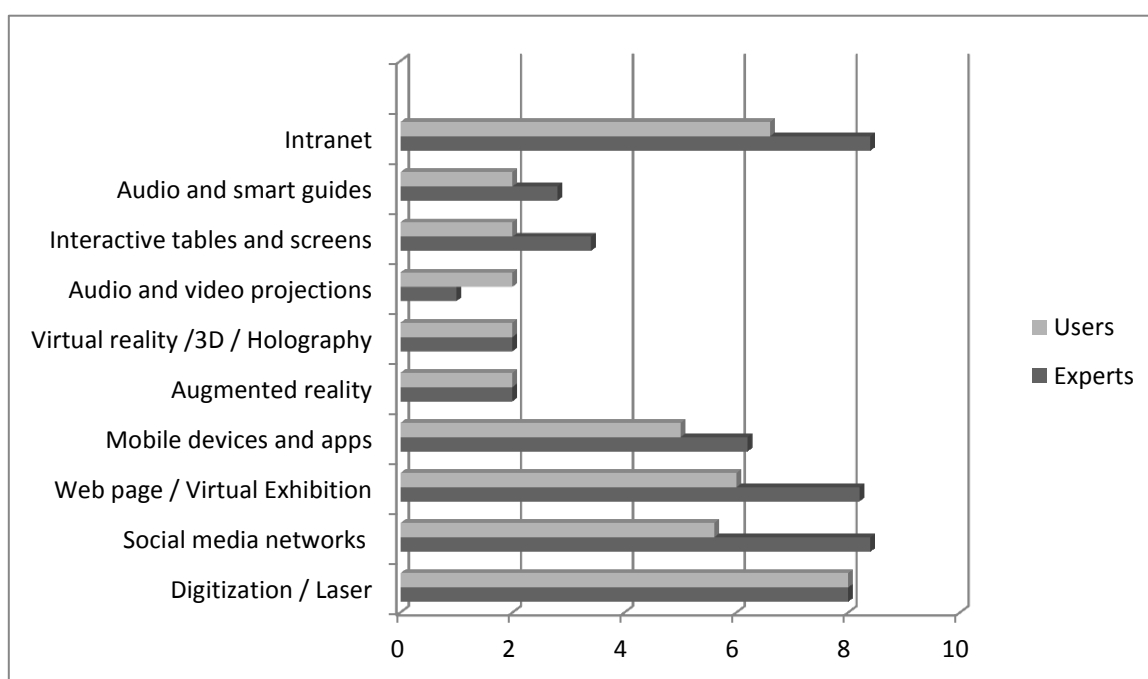
7. Conclusion

In this thesis, I have explored the field of cultural heritage institutions, more specifically the case of museums, in order to identify the use and influence of the ICTs in respect to diverse types of innovation. In the literature review section, I presented the facts regarding the current context and the importance of museums as leisure and recreational agents in the society and the local economy. Next, I studied the innovation types found in services (technological, organizational, business, market-oriented, and audience communication). The examination of innovation occurred through study of the creative industries (sector in which museums belong to) due to the lack of material about innovation precisely in museums. This investigation proposed that innovation in museums often happens through the use of ICTs and, therefore, the subsequent chapter explained the types of technologies, in accordance with their functions with the innovative activities they might induce.

The analysis of these technologies provided a further understanding about the way museums use ICTs to innovate and communicate with its audiences and the market. The purpose and influence of the different types of technologies permitted me to suggest a new typology for those ICTs. Most of the new typological suggestions were confirmed by the survey and the interviews with users and experts, as described in the previous chapter. This new typology helped to answer the research question in a more systematic manner by rearranging the connection between ICTs and innovation. These findings propose the evaluation of the use of ICTs in museums after their impact in the promotion of innovative perception and advancements, instead of after their technical and functional characteristics.

Throughout the investigation, other topics (not technology-based) appeared to be considered of high relevance and correlation when analysing technology and innovation in museums today; and when determining whether the technologies (and its goals) will succeed

or not. The significant topics that deserve, thus, further research are issues surrounding *content strategy* (quality control and management), *user behaviour studies* (needs, interests, future trends, autonomy, and co-production), and *mobile technologies as the future of technological convergence* (allowing anytime and anywhere access from, most likely, personal devices that users are acquainted with, and can customize and continue using after the visit).

Conclusively, these new and social technological tools have proven to help museums to communicate their products/services, mission, values, discourses, contents, and to promote deeper experiences and engagement by current and prospective audiences, both within and beyond museums walls, and both physically and virtually. The study of innovation in museums through ICTs encompasses, hence, a great range of relevant elements that are under constant change, requiring continuous and frequent reanalysis and reconsideration of their effectiveness and appropriateness according to the interests of the institutions and their audiences.

References

Abernathy, W., and Clark, K. (1985, February). Innovation: mapping the winds of creative destruction. *Research Policy*. Vol. 14(1), pp. 3-22.

Anderson, M. (1999). Museums of the Future: the impact of technology on museums practices. *America's Museums*. Vol. 128(3), pp. 129-162. Deadalus.

Retrieved from: http://www.jstor.org/stable/20027570

Andreasen, A., and Kotler, P. (2002). *Strategic Marketing for Nonporfit Organizations* (6th Ed). Upper Saddle River, NJ: Prentice Hall.

Archibugi, D., and Iammarino, S. (2002, March). The Globalization of Technological Innovation: definition and evidence. *Review of International Political Economy*. Vol. 9(1), pp. 98–122.

Avison, D., and Myers, M. (2002). *Qualitative Research in Information Systems: a reader*. London, UK: Sage.

Bahkshi, H., and Throsby, D. (2010, June). Culture of Innovation: an economic analysis of innovation in arts and cultural organizations. *National Endowment for Science, Technology and the Arts (NESTA) Research Report*. UK.

Retrieved from:
http://www.nesta.org.uk/library/documents/Culture_of_Innovation100610.pdf

Bailey, C. (2010). Introduction: making knowledge visual. In Bailey, C. and Hazel, G. (Eds.)(2010) *Revisualizing Visual Culture*. Ashgate: Burlington.

Beer, M. (1980). *Organizational Development and Change: a system view*. Santa Monica: Goodyear Press.

Bell, J. (2010). Doing your Research Project: a guide for first-time researchers in education, health and social science (5th Ed.). Berkshire, England: Open University Press.

Boczkowski, P., and Lievrouw, L. (2007). Bridging STS and Communication Studies: scholarship on media and information technologies. In Amsterdamska, E.; Hackett, M., and Wajcman, J. (Eds.), *The Handbook of Science and Technology Studies* (3rd Ed.). Pp.949-977. Cambridge, Massachusetts: MIT Press.

Bryman, A. (2004). *Social Research Methods*. Oxford: Oxford University Press.

Bustamante, E. (coord.) (2003). Hacia un Nuevo Sistema Mundial de Comunicación. In *Las Indústrias Culturales en la Era Digital*. Barcelona: Gedisa.

Camarero, C., and Garrido, E. (2011, February). Fostering Innovation in Cultural Contexts: market orientation, service orientation, and innovations in museums. *Journal of Service Research*. Vol. 15(1), pp. 39-58. First published on September 23rd, 2011.

Caves, R. (2000). *Creative Industries*. Cambridge, Massachusetts: Harvard University Press.

Celaya, J. (2012, March). Towards Shared Culture: beyond marketing: museums on social network. *Telos Magazine*. Vol. 90, pp. 1-2. Madrid, Spain: Fundación Telefónica.

Retrieved from:
http://sociedadinformacion.fundacion.telefonica.com/seccion=1268&idioma=es_ES&id =2012020111360001&activo=6.do

Cunningham, S. (2002). From Cultural to Creative Industries: theory, industry, and policy implications. *Media International Australia Incorporating Culture and Policy: Quarterly Journal of Media Research and Resources*. Vol. 102, pp. 54-65.

Cunningham, S., and Potts, J. (2008). Four Models of the Creative Industries. *International Journal of Cultural Policy*. Vol. 14(3), pp. 233-247.

Deshpande, R., Farley, J., and Webster, F. (1993). Corporate Culture, Customer Orientation, and Innovativeness. *Journal of Marketing*. Vol. 57(1), pp. 23-37.

DigiCult (2003). Technology Watch Report 1: New Technologies for the Cultural and Scientific Heritage Sector. European Commission, 2003. Printed in Austria.

Retrieved from:
http://www.digicult.info/downloads/html/1049756401/1049756401.html

Falk, J., and Shepard, B. (2006). *Thriving in the Knowledge Age.: new business models for museums and other cultural institutions*. Lanham, MD: Altamira.

Florida, R. (2004). The Rise of the Creative Class. New York: Basic Books.

Frey, B., and Meyer, S. (2006). The Economics of Museums. In Ginsburgh, V. and Throsby, D. Elsevier (Eds.), *Handbook of the Economics of Art and Culture*. Vol. 1, pp. 1017-1047.

Galani, A. (2003). Mixed Reality Museum Visits: using new technologies to support co-visiting for local and remote visitors. In Arvantis, K., and Filippoupoliti, A. (Eds.), *Museological Review Extra*, Special Issue, Vol. 10, pp. 1-15. University of Leicester.

Garnham, N. (2005). From Cultural to Creative Industries: an analysis of the implications of the creative industries approach to arts and media policy making in the United Kingdom. *International Journal of Cultural Policy*. Vol. 11(1), pp. 15-29.

Hempell, T., Van Leeuwen, G., and Van Der Wiel, H. (2004). ICT, Innovation and Business Performances in Services: evidence for Germany and the Netherlands. *The Economic Impact of ICT: Measurement, Evidence, and Implications.* Pp. 131-152. Paris: OECD Publications Service.

Retrieved from: http://browse.oecdbookshop.org/oecd/pdfs/free/9204051e.pdf

Hirose, M. (2006). Virtual Reality Technology and Museum Exhibit. *The International Journal of Virtual Reality*. Vol. 5(2), pp. 31-36.

Hooper-Greenhill, E. (2000). *Museums and the Interpretation of Visual Culture*. London: Routledge.

Kirchner, T., Markowski, E., and Ford, J. (2007, May). Relationships among Levels of Government Support, Marketing Activities, and Financial Health of Nonprofit Performing Arts. *International Journal of Nonprofit and Voluntary Sector Marketing*. Vol. 12, pp. 95-116.

Kline, S., and Rosenberg, N. (1986). An Overview of Innovation. In Landau, R. and Rosenberg, N. (Eds.), *The Positive Sum Strategy: harnessing technology for economic growth* (1986). Washington DC: National Academy Press.

Knell, J. (2006). Whose Art Is It Anyway? England: Arts Council.

Retrieved from: http://john-knell.com/resources/Whose%20art%20is%20it%20anyway%20-%20John%20Knell.pdf

Koellinger, P. (2008, May). The Relationship between Technology, Innovation, and Firm Performance: empirical evidence on e-business in Europe. *ERIM Report Series,* Reference No. ERS-2008-031-ORG.

Retrieved from: http://ssrn.com/abstract=1144294

Kotler, N. (2012). New Ways of Experiencing Culture: the role of museums and marketing implications. In Gail, A. (Ed.), *Reinventing the Museum: the evolving conversation on the paradigm shift* (2nd ed). Pp. 387-394. Lanham, MA: AltaMira.

Kotler, N., and Kotler, P. (2001). *Estrategias y Marketing de Museos*. Barcelona: Ariel.

Kotter, J., Schlesinger, L., and Gathe, V. (1979). *Managing the Human Organization*. Boston: Harvard University Press.

Kwon, Y., Hwang, J., Lee, T., Lee, M., Suhl, J., and Ryu, S. (2003, January). *Toward the Synchronized Experiences between Real and Virtual Museum*. Proceedings of the APAN Conference. Fukuoka, Japan.

Retrieved from: http://www.qgpop.net/2003fukuoka/papers/B5-1.pdf

Lai, V., and Mahapatra, R. (1988). Evaluation of Intranets in a Distributed Environment. Decision Support Systems. Vol. 23 (4), pp. 347-357.

Lam, A. (2004) Organizational Innovation. In Fagerberg, J., Mowery, D. and Nelson, R. (Eds.), *The Oxford Handbook of Innovation*. Pp. 115-147. Oxford University Press.

Li, R., Luo, T., and Zha, H. (2010). 3D Digitization and Its Applications in Cultural heritage. *Proceedings of the third International Conference on Digital Heritage (EuroMed'10.* Pp. 381-388. Berlin: Springer-Verlag Berlin Heidelberg.

Retrieved from: http://dl.acm.org/citation.cfm?id=1939639

Liao, M., Foreman, S., and Sargeant, A. (2001, September). Market versus Societal Orientation in the Nonprofit Context. *International Journal of Nonprofit and Voluntary Sector Marketing*. Vol. 6, pp. 254-268.

Lord, B., and Lord, G.D. (1998). *The Manual of Museum Management* (2nd ed). UK: The Stationary Office.

Lovelock, C. (1996). *Services Marketing* (3rd ed). NJ: Prentice-Hall.

Macdonald, S. (Ed.) (1998). *The Politics of Display: museums, science, culture*. London: Routledge.

McCarthy, K., and Jinnet, K. (2001). A New Framework for Building Participation in the Arts. Santa Monica, CA: RAND Corporation.

McKersie, Robert B., and Richard E. Walton (1991) "Organizational Change." In Scott-Morton, M. (ed.) *The Corporation of the 1990's: Information Technology and Organizational Transformation*. Oxford University Press, pp. 245–277.

MediaMusea (2010). Tendencias 2011.

Retrieved from: http://es.calameo.com/read/0005065666d54c26f281a

Michael, D., Pelekanos, N., Chrysanthou, I., Zaharias, P., Hadjigavriel, L., and Chrysanthou, Y. (2010). Comparative Study of Interactive System in a Museum. In M. Ioannides (Ed.), *Proceedings of the third International Conference on Digital Heritage (EuroMed'10)*. Pp. 250–261. Berlin: Springer-Verlag Berlin Heidelberg.

Miles, I., and Green, L. (2008, July). Hidden Innovation in the Creative Industries. *National Endowment for Science, Technology and the Arts (NESTA) Research Report*. UK.

Retrieved from:
http://www.nesta.org.uk/home1/assets/features/hidden_innovation_in_the_creative_ind ustries

Miles, I. (2004). In Fagerberg, J., Mowery, D., and Nelson, R. (Eds.), *The Oxford Handbook of Innovation*. Pp. 433-458. Oxford University Press.

Miles, M., and Hüberman, M. (1994). *Qualitative Data Analysis: an expanded sourcebook* (2nd ed.). Thousand Oaks, CA: SAGE Publications.

Mulgan, G., and Albury, D. (2003). Innovation in the Public Sector. London: Government's Strategy Unit.

Retrieved from:
http://webarchive.nationalarchives.gov.uk/+/http://www.cabinetoffice.gov.uk/upload/as sets/www.cabinetoffice.gov.uk/strategy/pubinov2.pdf

Mulgan, G., Ali, R. Halket, R., and Sanders, B. (2007). In and Out of Sync: the challenge of growing social innovations. *National Endowment for Science, Technology and the Arts (NESTA) Research Report*. UK.

Retrieved from:
http://www.nesta.org.uk/library/documents/In%20and%20Out%20of%20Sync%20Final %20-%203%20Sept%20-%206pm.pdf

Müller, K., Rammer, C., and Trüby, J. (2008). The Role of Creative Industries in Industrial Revolution. *Centre for European Economic Research. Discussion Paper No. 08-109*.

Nelson, R., and Nelson, K. (2002). Technology, Institutions, and Innovation Systems. *Research Policy*. Vol. 31, pp. 265–272.

NESTA (National Endowment for Science, Technology and the Arts) Report (2006). Creating Growth: How the UK can develop world class creative businesses. London, UK: NESTA.

Retrieved from: http://www.nesta.org.uk/library/documents/Creating-Growth.pdf

Novak, J., Fleischmann, M., Strauss, W., Valle, C., Peranovic, P., and Seibert, C. (2001). From Memória Futura to i2TV: a technological framework and two models for new forms of cultural participation and production in mixed realities. *Proceedings from International Cultural Heritage Informatics Meeting (ichim01)*.

Retrieved from:
http://www.researchgate.net/publication/221356889_From_Memoria_Futura_to_i2TV_A_Technological_Framework_and_Two_Models_for_New_Forms_of_Cultural_Participation_and_Production_in_Mixed_Realities

O'Callaghan, R. (2005). Introductory Essays: technological innovation in organizations and their ecosystems. In Dutton, W. et al. (2005), *Transforming Enterprise: the Economic and Social Implications of Information Technology*. Pp. 1-12. Massachusetts Institute of Technology.

Oslo Manual (2005). The Measurement of Scientific and Technological Activities: proposed guidelines for collecting and interpreting technological innovation data. OECD.

Retrieved from: http://www.oecd-ilibrary.org/science-and-technology/oslo-manual_9789264013100-en

Pascual, M. (2012, March). La Revolución de los Museos y Instituciones Culturales. *Telos Magazine*. Vol. 90. Madrid, Spain: Fundación Telefónica.

Retrieved from:
http://sociedadinformacion.fundacion.telefonica.com/seccion=1268&idioma=es_ES&id=2012013110230001&activo=6.do

Peacock, D. (2008, December). Making Ways for Change: museums, disruptive technologies and organisational change. *Museum Management and Curatorship*. Vol. 23(4), pp. 333-351. London: Routledge.

Petrie, M., and Tallon, L. (2010, March). The Iphone Effect? Comparing Visitors' and Museum Professionals' Evolving Expectations of Mobile Interpretation Tools. In Trant, J., and Bearman, D. (Eds), *Museums and the Web 2010: Proceedings*. Toronto: Archives & Museum Informatics.

Retrieved from: http://www.archimuse.com/mw2010/papers/petrie/petrie.html

Pilat, D. (2004). Introduction. In *The Economic Impact of ICT: measurement, evidence and implications*. Paris: OECD Publications Service.

Potts, J., Cunningham, S., Hartley, J., and Ormerod, P. (2008). Social Network Markets: a new definition of the creative industries. *Journal of Cultural Economics*. Vol. 32(3), pp. 166-185.

Potts, J. (2009a). Do Developing Economies Require Creative Industries? Some Old Theory about New China. *Chinese Journal of Communication*. Vol. 2(1), pp. 92-108.

Potts, J. (2009b). Why Creative Industries Matter to Economic Evolution. *Economics of Innovation and New Technology*. Vol. 18(7-8), pp. 663-673.

Pujol-Tost, L. (2011): Integrating ICT in exhibitions. *Museum Management and Curatorship*. Vol. 26(1), pp. 63-79.

Punch, K. (2005). *Introduction to Social Research: quantitative and qualitative approaches*. London: Sage Publications.

Rentschler, R., and Wood, G. (2001). Cause Related Marketing: can arts afford not to participate? *Services Marketing Quarterly*. Vol. 22(1), pp. 57-69.

Rentschler, R., Radbourne, J., Carr, R., and Rickard, J. (2002). Relationship Marketing, Audience Retention and Performing Arts Organisation Viability. *International Journal of Nonprofit and Voluntary Sector Marketing*. Vol. 7(2), pp. 118-130.

Rio Castro, J. (2012). Art Museums Online: a critical chronology. *Telos Magazine*. Vol. 90. Madrid, Spain: Fundación Telefónica.

Retrieved from:
http://sociedadinformacion.fundacion.telefonica.com/seccion=1268&idioma=es_ES&id =2012013112140001&activo=6.do

Robson, C. (2002). *Real World Research: a resource for social scientists and practitioner-researchers* (2nd ed.). Oxford: Blackwell.

Ruppel, C., and Harrington, S. (2001). Sharing Knowledge Through Intranets: a study of organizational culture and Intranet implementation. *IEEE Transactions on Professional Communication*. Vol., 44, pp. 37-52.

Retrieved from:
http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=911131&url=http%3A%2F%2Fi eeexplore.ieee.org%2Fiel5%2F47%2F19664%2F00911131

San Martin, P. (2012). Entornos Museísticos: Nuevas Tecnologías Expositivas. *Telos Magazine*. Vol. 90. Madrid, Spain: Fundación Telefónica.

Retrieved from:
http://sociedadinformacion.fundacion.telefonica.com/seccion=1268&idioma=es_ES&id =2012013117210001&activo=6.do

Sayre, S., and Wetterlund, K. (2008). The Social Life of Technology for Museum Visitors. *Visual Arts Research*. Vol. 34(2)(67), Museum Education (2008), pp. 85-94. University of Illinois Press.

Retrieved from: http://www.jstor.org/stable/20715478 .

Sigala, M. (2005). New Media and Technologies: trends and management issues for cultural tourism. In Sigala, M, and Leslie, D. (Eds.), *International Cultural Tourism: management, implications, and cases*. Pp. 181-200. Amsterdam: Elsevier.

Solano, J. (2012, March). Universal Access to Culture: museums in the palm of your hand. *Telos Magazine*. Vol. 90. Madrid, Spain: Fundación Telefónica.

Retrieved from:
http://sociedadinformacion.fundacion.telefonica.com/seccion=1268&idioma=es_ES&id=2012020110050001&activo=6.do

Spires, S. (1989). An Audio Tour for Family Visitors. *Journal of Museum Education*. Vol. 14(2), pp. 13-19.

Srinivasan, R., Boast, R., Furner, J., and Becvar, K. M. (2009) Perspective: Digital Museums and Diverse Cultural Knowledges: moving past the traditional catalogue. *The Information Society*. Vol. 25, pp. 265-278. Taylor & Francis Group, LLC.

Telos Magazine (2012, March). La Revolución de los Museos: Agenda. Vol. 90. Madrid, Spain: Fundación Telefónica.

Retrieved from:
http://sociedadinformacion.fundacion.telefonica.com/DYC/TELOS/SOBRETELOS/Nmerosanteriores/Nmero90_90TELOS_PRESENTACION/seccion=1268&idioma=es_ES&id=2012020215420001&activo=6.do

The Work Foundation Report (2007). Staying Ahead: the economic performance of the UK's creative industries. London: Crown.

Retrieved from:
http://www.theworkfoundation.com/assets/docs/publications/176_stayingahead.pdf

Tidd, J., and Bessant, J. (2009). Managing Innovation: integrating technological, market and organizational change (4th ed.). Chichester: Wiley.

Tornari, V., Zafiropoulos, V., Bonarou, A., Vainos, N.A., and Fotakis, C. (2000). Modern Technology in Artwork Conservation: a laser-based approach for process control and evaluation. *Optics and Lases Engineering*. Vol. 34, pp. 309-326.

Vicente, E., Camarero, C., and Garrido, E. (2012). Insights into Innovation in European Museums. *Public Management Review*. Vol. 145, pp. 649-679.

Von Hippel, E. (1988). *Sources of Innovation*. Entrepreneurial Leadership Historical Research Reference in Entrepreneurship.

Von Hippel, E. (2005). *Democratizing Innovation*. Cambridge, Massachusetts: The MIT Press.

Walker, J., and Chaplin, S. (1997). *Visual Culture: An introduction*. Manchester University Press.

Witcomb, A. (2003). *Re-Imagining the Museum: beyond the mausoleum*. London: Routledge.

Yin, R. (2009). *Case Study Research: design and methods* (4th ed.). Thousand Oaks, CA: Sage Publications.

20+20 Nuevas Industrias. Sectores de la Nueva Economía: Industrias de la Creatividad. Fundación EOI (Escuela de Organización Industrial). Madrid, Spain.

Retrieved from: http://www.eoi.es/blogs/20creativa/estudio-industrias-de-la-creatividad-2020-eoi/

Appendix I – Qualitative Research: questionnaire

1) <u>Museums and Current Context</u>: How do you see the position of museums in the current technological and social contexts?

2) <u>New Technologies</u>: What technologies you consider important for a museum to invest? (Expose on them, please).

What in your opinion are de advantages and disadvantages of the use of ICT in Museums?

3) <u>Innovation</u>: In which aspects could museums and cultural institutions innovate? Can you give examples of tools and/or activities to be used in order to innovate?

4) <u>Users' Experience</u>: How do you think the technological advancements can influence people's experience and engagement when interacting with the physical museum and its digital touch points?

5) <u>Personal:</u> What, in your opinion, are the most important and necessary aspects for you when visiting a physical museum and when accessing a virtual museum?

6) <u>Extra</u>: Do you have any other information, comments, material or suggestions that could improve the development of this investigation?

Appendix II – Non-participative Observation Form and Report

Piece: _____

ICT: _____   Innovation: _____

<u>Ways to interact:</u>   <u># of people:</u>   <u>Obs. /reaction:</u>

_____

_____

Total # people:

………………………………………………………………………………………………...

Report: The Museum for Contemporary Art, Oslo, Norway.

Days: 06th and 13th of January 2013.

Period: 12:00-14:00

Average visitors in the museum in these periods: approx. 75-80 visitors (95% adults, 5% children).

1. <u>Description of the artefact</u>:

   The piece is a combination of audio and drawings (portraits). The audio projections are available in front of each drawing, although the audio is not necessarily related to the drawing in front, but to other in the row of drawings.

2. <u>Technology involved</u>: audio files available through noise-isolating headsets.

3. <u>Innovation</u>: exhibition, in situ experience.

4. <u>Ways to Interact</u>:

    The public needed to listen to the files and examining the drawings at the same time in order to try to guess which song is from which musician portrayed.

5. <u>Percentage of interactions</u>:

    Listening to 3 or more files: 58,33%

    Listening to up to 3 files only: 8,33%

    Not interacting at all with the piece: 33,33%

6. <u>Observations</u>: Since the exhibition was mainly based on audio and video projections, I suggest that the behaviour of the visitors was already induced to be more participatory than the normal. The exhibition did not present audio guides or other supplementary technologies. The museum has a co-funded webpage with other governmental museums containing essentially practical information about the museum and exhibitions.

Appendix III – Pictures from the "I Wish This Was a Song" exhibition at the Museum for Contemporary Art, Oslo/ Norway.
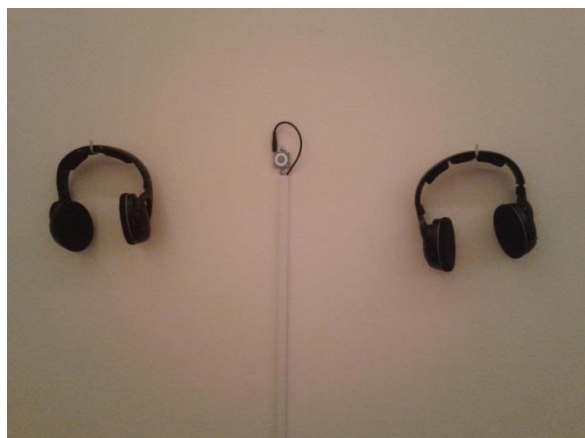
Appendix IV – Quantitative Research: Survey

<u>NAME</u> (optional):

<u>OCCUPATION</u>:

<u>ORGANIZATION/UNIVERSITY</u> (optional):

Q.: What is the relationship between technologies and innovative activities

in museums?

Please answer from 0-10:

0 = "not necessarily related/dependent" and

10 = "strongly related/dependent".

NR (no response): when the respondent does not have enough information to answer the question.

Observations: for any further and volunteer observation related to the individual topic.

		INNOVATION A: **EXHIBITION/ PRESENTATION** Innovations that influence exhibition's format and the experience during the visit. **I**= *in situ* / physical museum **V**= Virtual / online museum **0-10**	OBSERVATIONS (Optional)
T **E** **C** **H** **N** **O** **L** **O** **G** **Y**	**1.** Intranet (Internal Network)	**I**: **V**:	
	2. Audio and Smart Guides	**I**: **V**:	
	3. Multi-touch and Interactive Kiosks	**I**: **V**:	
	4. Audio and Video projections	**I**: **V**:	
	5. Virtual Reality / 3D / Holography	**I**: **V**:	
	6. Augmented Reality	**I**: **V**:	
	7. Mobile devices and apps	**I**: **V**:	
	8. Web Page / Virtual Exhibition	**I**: **V**:	
	9. Social Media Network	**I**: **V**:	
	10. Digitization (digital version / conservation) / Laser (restoration)	**I**: **V**:	
		I: **V**:	

		INNOVATION B – **COMMUNICATION AND MARKETING** Innovations that influence the way to communicate with users/visitors, mainly before and after the visit. **0-10**	OBSERVATIONS (Optional)
T E C H N O L O G Y	**1.** Intranet (Internal Network)		
	2. Audio and Smart Guides		
	3. Multi-touch and Interactive Kiosks		
	4. Audio and Video projections		
	5. Virtual Reality / 3D / Holography		
	6. Augmented Reality		
	7. Mobile devices and apps		
	8. Web Page / Virtual Exhibition		
	9. Social Media Networks		
	10. Digitization (conservation) / Laser (restoration)		

		INNOVATION C – **ORGANIZATIONAL AND MANAGERIAL** Innovations that influence the way organizations manage their activities (internally and related to their market). **0-10**	OBSERVATIONS (Optional)
T E C H N O L O G Y	**1.** Intranet (Internal Network)		
	2. Audio and Smart Guides		
	3. Multi-touch and Interactive Kiosks		
	4. Audio and Video projections		
	5. Virtual Reality / 3D / Holography		
	6. Augmented Reality		
	7. Mobile devices and apps		
	8. Web Page / Virtual Exhibition		
	9. Social Media Networks		
	10. Digitization (conservation) / Laser (restoration)		

Appendix V – Detailed Survey's Results Charts

1. SURVEY EXPERTS (SCHOLARS / PROFESSIONALS)

1.1. EXHIBITIONS (IN SITU AND ONLINE)
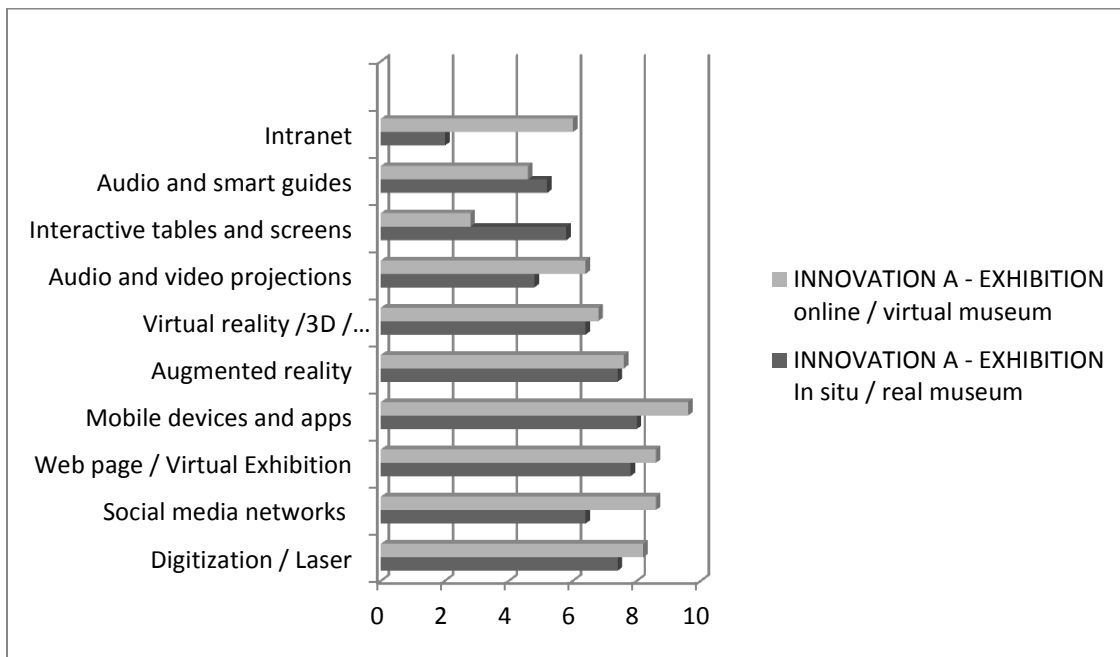
1.2. COMMUNICATION AND MARKETING
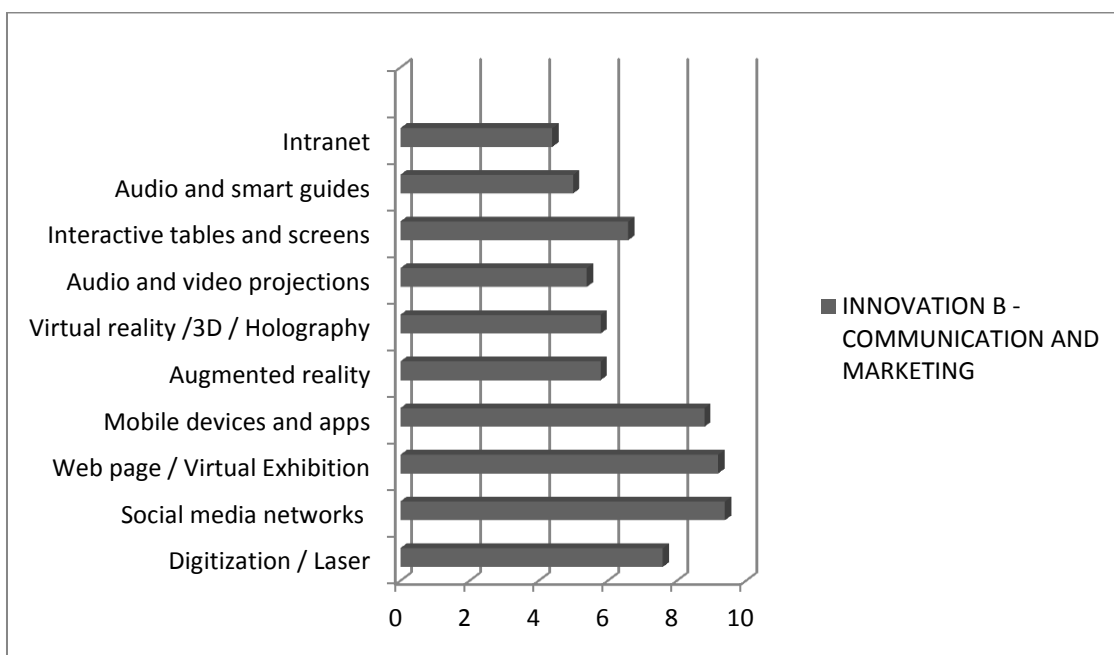
1.3. ORGANIZATIONAL AND MANAGERIAL
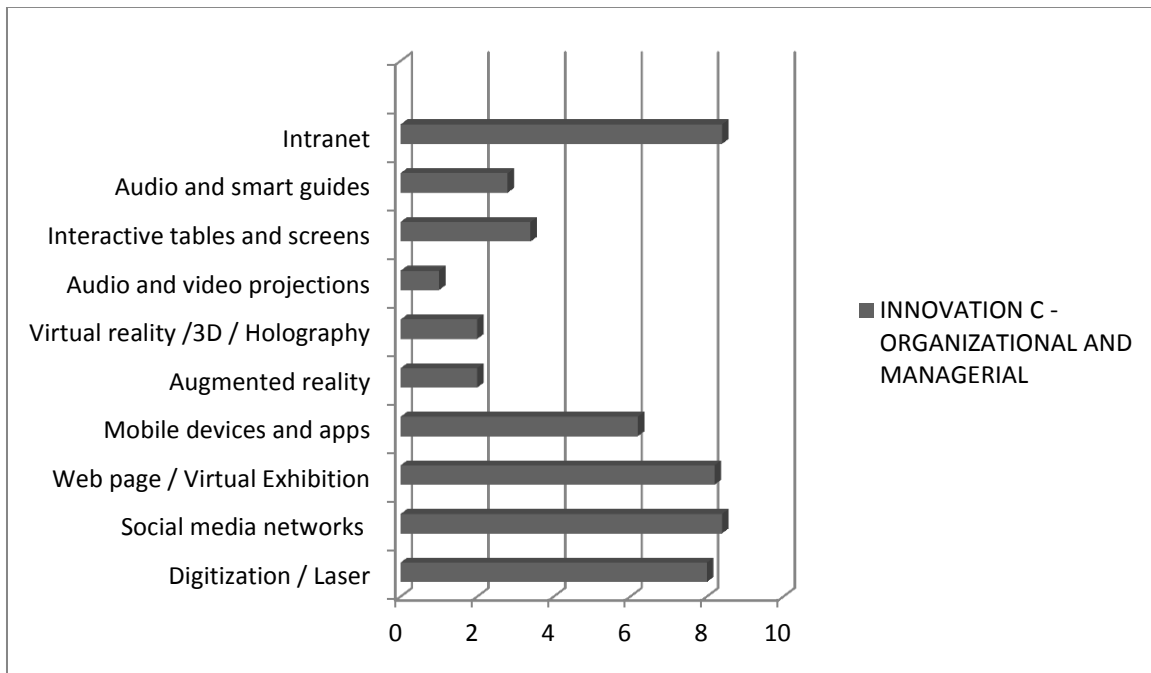
2. **SURVEY USERS / VISITORS**

2.1. EXHIBITIONS (IN SITU AND ONLINE)
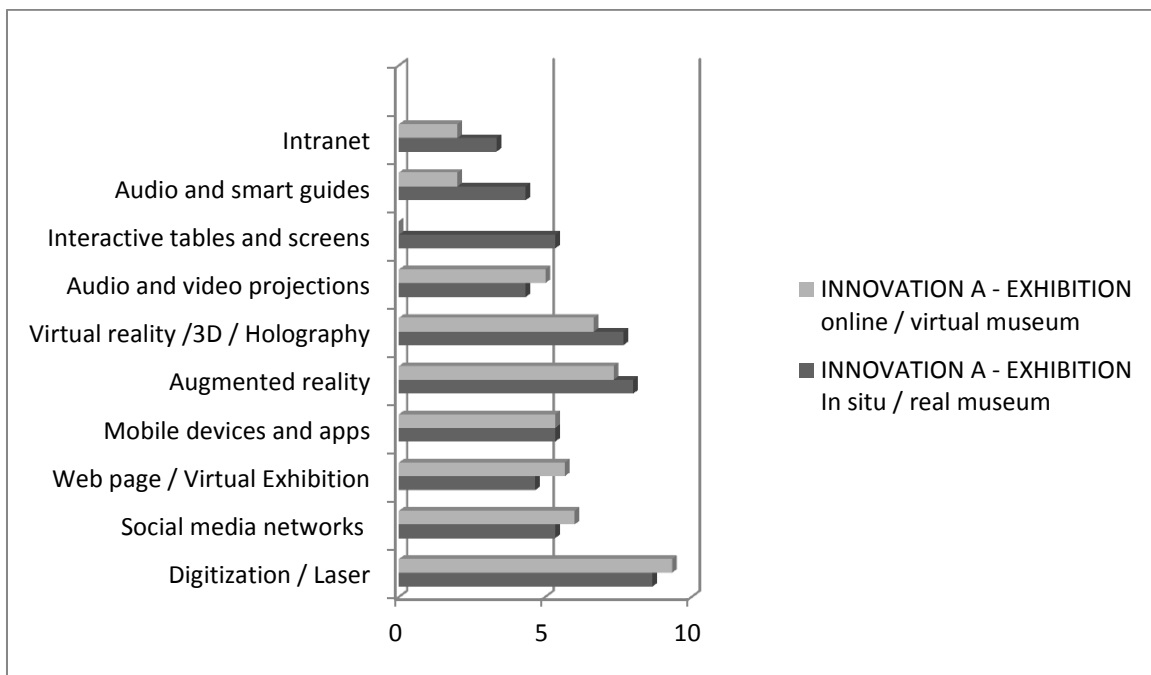
2.2. COMMUNICATION AND MARKETING
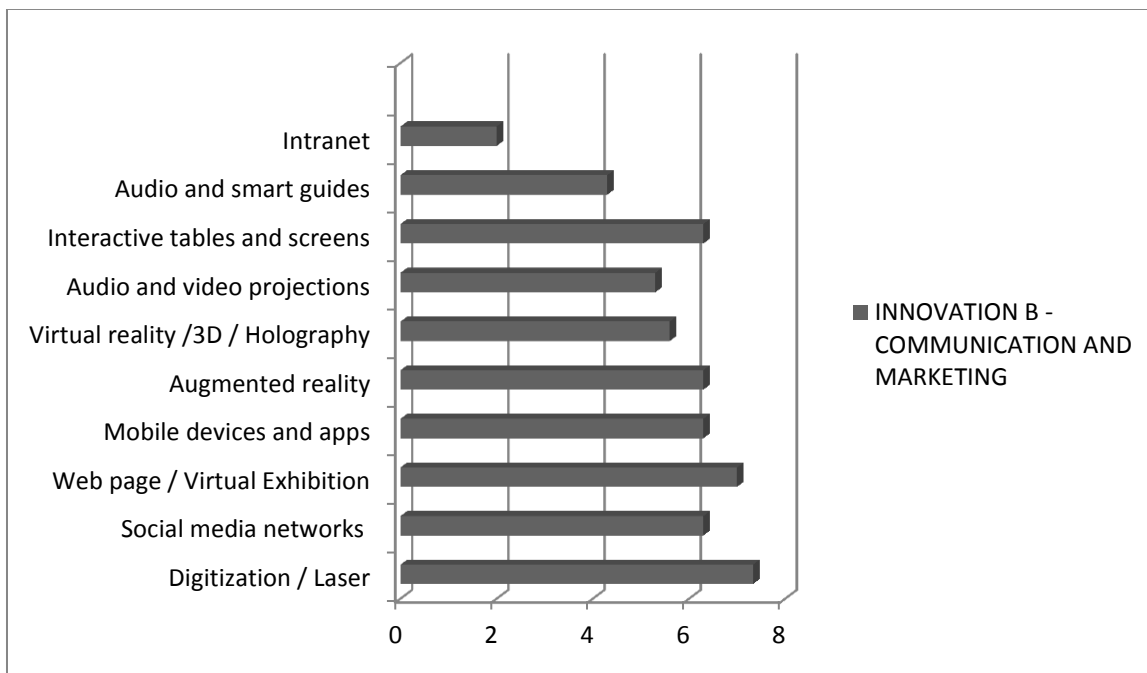
2.3. ORGANIZATIONAL AND MANAGERIAL
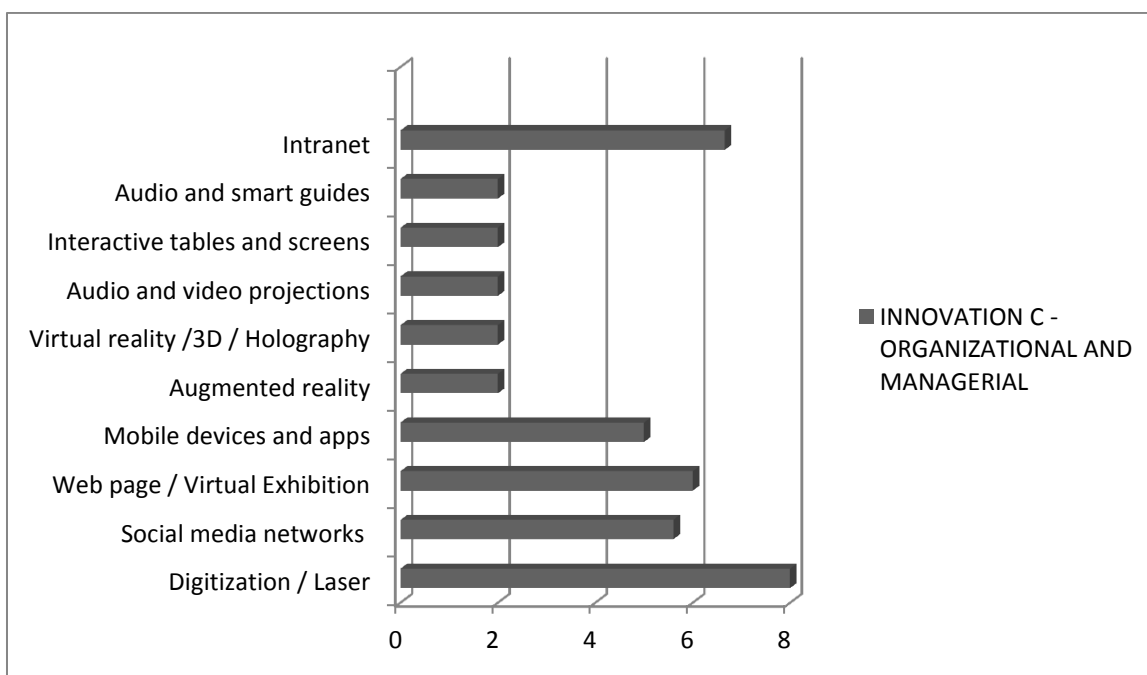
Appendix VI – New York City's Museum of Modern Art (MoMA) webpage tabs (http://www.moma.org/).

Homepage:

Visit:

Explore:

Learn:

Store:

MoMa PS1 (Contemporary art laboratory):
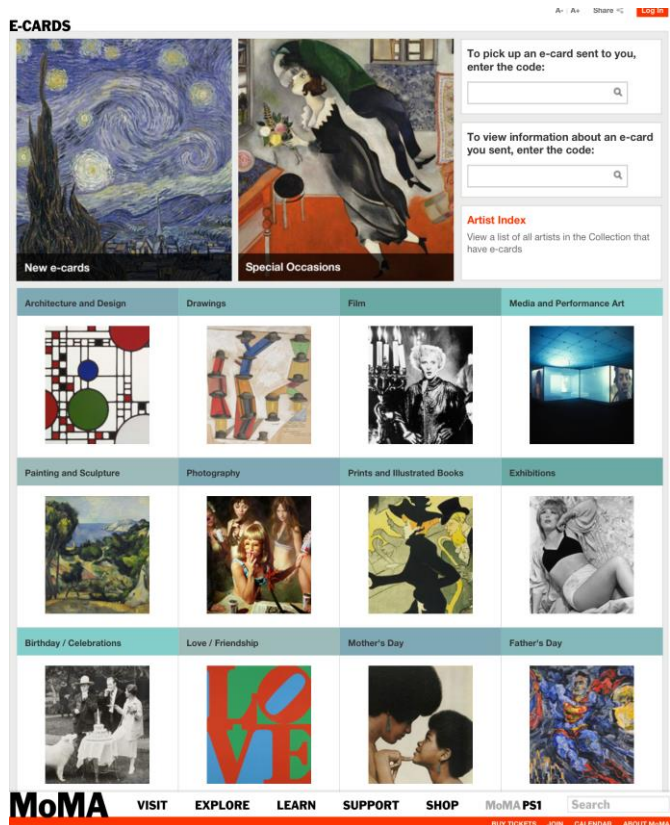

Support:

Digital members lounge:

Multimedia:

Online communities:

E-cards:

Mobile tours: