

INTELLIGENT MUSEUM TICKET: PART OF A NEW ECOSYSTEM.

Final framework proposal for the examination project in "*Museology, Museography and Virtual Environments*" by prof. **Caraceni Simona**, for the international master's degree program in *Digital Humanities and Digital Knowledge* (a.y. 2019/2020) by **Elena Cavalli**¹ and **Marina Christodoulou**².

Abstract: As we are already going through a new era in which the digital world has penetrated the confines of society, it is imperative that all the individual systems of the aforementioned are introduced to the new epoch, in order to synchronize the whole in the new trend. But when culture comes to the fore, the need for personalization is even greater. The museum environment is the first of its kind. The pioneering idea of the intelligent ticket will be combined with several technological aspects, such as IoT, NFC technology etc, in order to gain in the maximum level an innovative and “portable” museum habitat.

Key Words: Intelligent Ticket, Smart Tourism, NFC, IoT, Augmented/Virtual Reality, Gamification, Transmedia.

1. INTRODUCTION

Visiting any museum is a new cultural and cognitive opportunity, not only because of the audience's contact with the exhibits but more importantly because of their introduction to a new door to human civilization³. The spiritual forms that mark every culture and the amalgam of artistic, aesthetic, and experiential reading come to complete human becoming, and to express in the most extensive, and vividly demonstrative way, how the human spirit connects the past, the present, and the future.

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³ ElDamshiry, K. and Khalil, M., 2018. Museum visitors learning identities interrelationship with their experiences. [online] Egypt. Available at: <https://www.researchgate.net/publication/323987626_Museum_Visitors_Learning_Identities_Interrelationships_with_Their_Experiences>

Ever since, but primarily the current period⁴, what we are going through has brought about a strong sense of alteration in all parts of society and especially in places of culture. The complexity of managing a global pandemic crisis lies in unpredictable health-related events, that can destroy many industries in the affected geographical areas⁵. A strong introduction to the digital environment has been observed so that all structures can maintain their social status and distancing⁶ and continue to be productive. This brought about new needs and new thoughts on how to renew and systematize it. The novel approach is the one that leads with rapid steps to the implementation of innovative methods that will be applied for the best possible reinforcement of the system so that it works smoothly in the process of social distancing. This does not mean the fragmentation of quality of life and fragmentation of all social functions. In this new context, the present proposal is wished-for that enhancement, to further and strengthen the effectiveness of the museum environment.

The aim of the study is to propose a pioneering model with full application in the museum environment and to integrate the intelligent⁷ ticket in a smooth but at the same time radical way in the conditions of progress. The goal of this implementations is duple; first it aims the generalization of the audience⁸ of the museum in order to fulfil the purpose of universal knowledge and culture available for everyone no matter the educational and background level. The system itself will profile the user and give tailored data in order to gain the biggest interoperability and to expand the target audience. At the same time, in the background, the museum bionetwork will gain valuable data through the recognition of the specific audience characteristics which will be provided by the synchronized AI application and the approval of the every time user.

⁴ Chakraborty, Indranil, and Prasenjit Maity. 2020. "COVID-19 Outbreak: Migration, Effects on Society, Global Environment and Prevention". *Science of the Total Environment* 728: 138882. doi:10.1016/j.scitotenv.2020.138882.

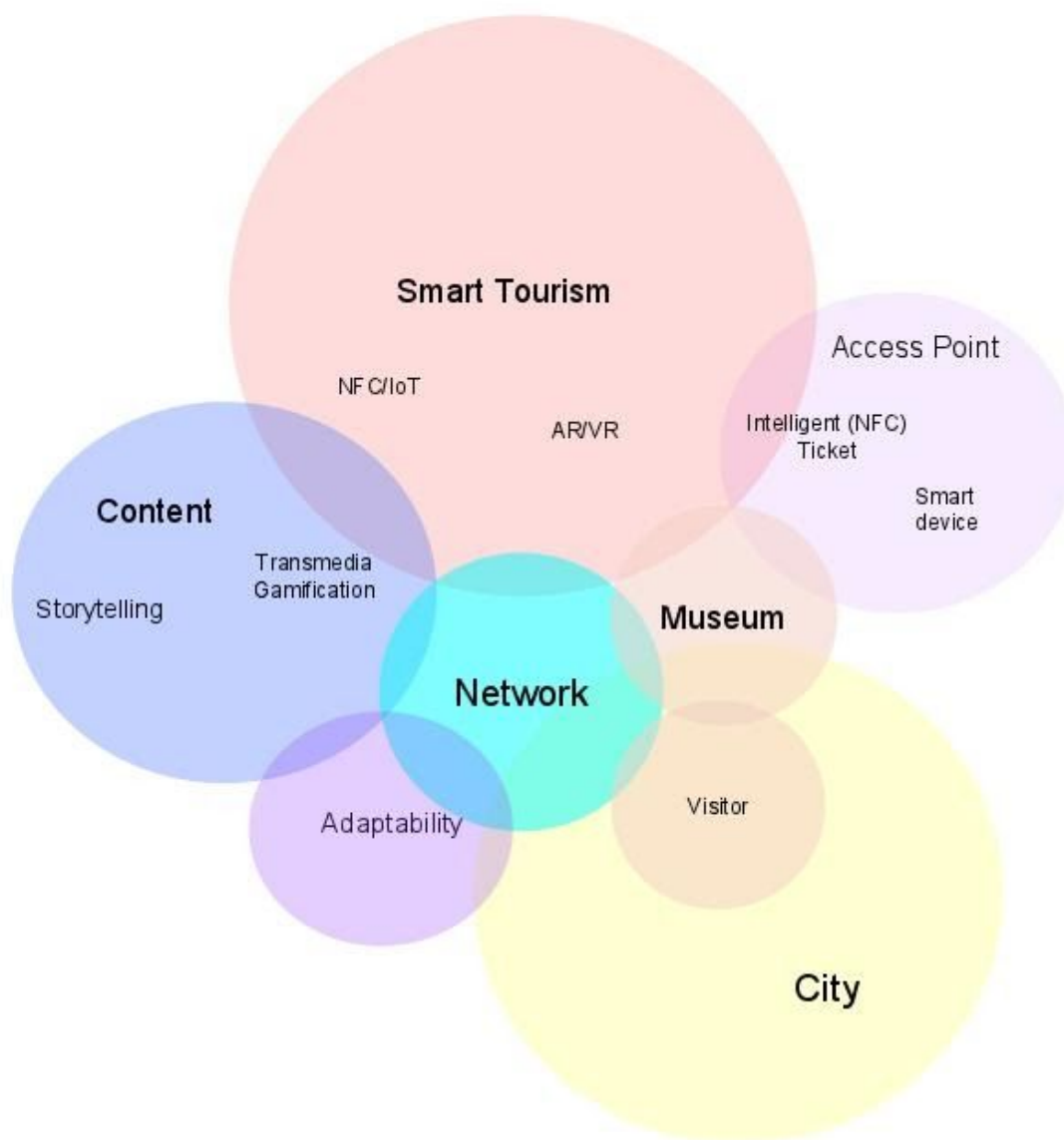
⁵ Mora Cortez, Roberto, and Wesley J. Johnston. 2020. "The Coronavirus Crisis in B2B Settings: Crisis Uniqueness and Managerial Implications Based on Social Exchange Theory". *Industrial Marketing Management* 88: 125-135. doi:10.1016/j.indmarman.2020.05.004.

⁶ McCall, Becky. 2020. "Shut Down and Reboot—Preparing to Minimise Infection in a Post-COVID-19 Era". *The Lancet Digital Health*. doi:10.1016/s2589-7500(20)30103-5.

⁷ Panagiotakopoulos, D. and Dimitrantzou, K., 2020. Intelligent Ticket with Augmented Reality Applications for Archaeological Sites. *Strategic Innovative Marketing and Tourism*, pp.41-49.

⁸ Gilmore, A. and Rentschler, R., 2002. Changes in museum management: a custodial or marketing emphasis. *Journal of management development*, [online] 21(10), pp.745-760. Available at: <<http://dro.deakin.edu.au/eserv/DU%3A30008525/rentschler-changesinmuseum-post-2002.pdf>>

This “smart” touristic ecosystem reinforces skills that count on not only information exchange, but mainly on like IoT (Internet of Things), RFID (Radiofrequency Identification), and NFC (Near Field Communication) technology⁹. The idea will be valid through the usage of a dedicated card with NFC which will be the manner of connection with the main AI application for smart devices which could be either personal acquisitions or will be provided by the museum.



⁹ Gretzel, Ulrike, Marianna Sigala, Zheng Xiang, and Chulmo Koo. 2015. "Smart Tourism: Foundations and Developments". *Electronic Markets* 25 (3): 179-188. doi:10.1007/s12525-015-0196-8.

2. SMART TOURISM

As we can easily learn from the definition of the museum model provided to us by *Reinwardt Academie in Amsterdam*¹⁰, since the late 1980s, the three most important functions of a museum are: preservation, research and communication¹¹. Leaving aside the first two we can well understand that fundamental for the implementation of the last of these functions is the public, the tourist. Exactly in the context of new "*smart cities*" nowadays we have the new growing reality of **smart tourism**¹².

The concept of "smart tourism", although not yet sufficiently defined, is essentially used to describe the growing dependence of both tourist destinations and industries and tourists on the emerging forms of Information and Communication Technology (ICT) that allows it to transfer value propositions.

"Smart" tourism meets new challenges and demands in the world of tourism in general, including the expectation of digital information, equal opportunities, ease of access, sustainability and creative support for the industry¹³. Smart tourism is correlated to smart cities, smartphone applications, smart hotels, smart cards, gamification, AR (Augmented Reality) and tourists' personalized experience¹⁴. The phenomenon is almost founded on technology using Cloud Computing, IoT¹⁵ and sensor-based technology to deliver data¹⁶. In this form of environment museums has also an important role as they consist one of the main touristic spots and touristic interest and it is essential to "absorb" in the most efficient level this new trend.

¹⁰ Desvallées, A. and Mairesse, F., 2010. Key Concepts Of Museology. Kopie: Armand Colin.

¹¹ Caraceni, S., 2015. Designing a taxonomy for virtual museums for the use of AVICOM professionals. PhD. University of Plymouth.

¹² Kontogianni, A. and Alepis, E., 2020. Smart tourism: State of the art and literature review for the last six years. *Array*, 6, p.100020.

¹³ https://pergamos.lib.uoa.gr/uoa/dl/frontend/file/lib/default/data/2865811/theFile/2865814?fbclid=IwAR175j6oLb_taWwaZxAtbrOypBoLyrcoTf4OcWkAOeEAGjil81E5N3Ovsxw

¹⁴ Wang, X., Li, X., Zhen, F. and Zhang, J., 2016. How smart is your tourist attraction?: Measuring tourist preferences of smart tourism attractions via a FCEM-AHP and IPA approach. *Tourism Management*, 54, pp.309-320.

¹⁵ Liu T., Wei B. (2015) Digital Publishing to Create "Smart Tourism". In: Zhang Z., Shen Z., Zhang J., Zhang R. (eds) LISS 2014. Springer, Berlin, Heidelberg.
https://link.springer.com/content/pdf/10.1007%2F978-3-662-43871-8_249.pdf

¹⁶ Gretzel U, Sigala M, Xiang Z, Koo C, (2015a) Smart tourism: foundations and developments. *Electronic Markets*, 25(3), 179-188, , DOI:0047287514538839.

An educational tourist destination such as a museum is expected to present an informative and interactive atmosphere¹⁷. Smart tourism is already a topic of great interest and will be an important and fundamental component of smart cities. The smart revolution that is currently involving all the major cities in the world cannot certainly ignore and forget the tourism industry.

A new and realistic model for smart tourism should be enhanced and promoted as an innovative and revolutionary vision of tourism oriented towards simplifying and improving the tourist experience as well as supported and enriched by new digital technologies¹⁸. The main new challenges of this digital age will be connected to providing complex products and services which can, however, be perceived by tourists as useful, easy to use and time-saving.

3. THE TECHNOLOGIES

The most important core technologies that can realize perfectly smart tourism are ICT¹⁹ (Information and Communication Technologies) and mobile communication. In fact, for that specific purpose, it's possible to take into consideration several useful tools as Internet of Things, artificial intelligence, virtual reality, cloud computing, but most of all augmented reality, and ambient intelligence technologies²⁰ (AmI)²¹. For this document, we will analyze in-depth only three different kinds of technologies that belong to the AmI domain²², and the application of them in some notable project in order to finalize in these we will pertain in the framework.

¹⁷ Amanda, R., Santosa, P. and Rizal, M., 2018. Analysis of Tourists Preferences on Smart Tourism in Yogyakarta (Case: Vredenburg Fort Museum). *Journal of Physics: Conference Series*, 1007, p.012040.

¹⁸ Palumbo, F., n.d. Innovazione e tecnologie digitali per lo sviluppo dello Smart Tourism. PhD in Economia e Finanza nel governo dell'impresa. Università Sapienza di Roma.

¹⁹ Buhalis, D. and O'Connor, P., 2005. Information Communication Technology Revolutionizing Tourism. *Tourism Recreation Research*, 30(3), pp.7-16.

²⁰ Cook, D., Augusto, J. and Jakkula, V., 2009. Ambient intelligence: Technologies, applications, and opportunities. *Pervasive and Mobile Computing*, 5(4), pp.277-298.

²¹ En.wikipedia.org. 2020. *Ambient Intelligence*. [online] Available at: < https://en.wikipedia.org/wiki/Ambient_intelligence >.

²² Yachir, A., Amirat, Y., Chibani, A. and Badache, N., 2016. Event-Aware Framework for Dynamic Services Discovery and Selection in the Context of Ambient Intelligence and Internet of Things. *IEEE Transactions on Automation Science and Engineering*, 13(1), pp.85-102.

3.1 Bluetooth

Bluetooth²³ is a wireless technology created in 1989, which has become a standard protocol over the years used for the exchange of data between mobile and fixed devices at a short distance which is based on short frequency radio waves and which aims at low energy consumption. Managed by the Bluetooth Special Group over the years, this technology has seen the development of increasingly updated versions. The latest and most important, worth mentioning for the purposes of this document are: Bluetooth 4.0, also called Bluetooth Low Energy and Bluetooth 5.0, released in 2016.

Bluetooth Low Energy (BLE)²⁴, which was instituted in 2006, comparable to classic Bluetooth in terms of communication range but which unfortunately presented a fairly low level of security, constituted a turning point for the wireless technology that had as its first objective a considerable reduction in energy consumption and maintenance costs. The achievement of these two main purposes made sure that a whole series of new applications were created in various areas, but above all in the field of beacons²⁵ and entertainment.

Regarding **Bluetooth 5.0**, there are many advantages that it offers compared to its previous versions. The improvements in performance can be identified above all in terms of the range coverage that has significantly increased, the almost doubled speed and the increase in data transmission; finally, regarding the pairing mechanism between devices, major reliability, resistance and stability are certainly among the most noteworthy changes. All these improvements have undoubtedly made Bluetooth 5.0 an excellent tool to be used in the of the Internet of Things field.

3.1 Example - The Museum Palazzo Farnese in Piacenza and the IMApp.

The Civic Museums of Palazzo Farnese in Piacenza are one of the first Italian museums to have a dedicated app in the store, one of the top five museums in Europe to choose this strategy.

²³ En.wikipedia.org. 2020. *Bluetooth*. [online]

Available at: < <https://en.wikipedia.org/wiki/Bluetooth> >

²⁴ En.wikipedia.org. 2020. *Bluetooth Low Energy*. [online]

Available at: < https://en.wikipedia.org/wiki/Bluetooth_Low_Energy >.

²⁵ En.wikipedia.org. 2020. *Bluetooth Low Energy Beacon*. [online]

Available at: < https://en.wikipedia.org/wiki/Bluetooth_low_energy_beacon >.

This museum reality has officially decided to adopt IMApp as an official app and as an interactive multimedia guide. This application, available for the major and most well-known mobile operating systems, aims to make the museum experience as unforgettable and unique as possible. In the official website of the platform we find the following service description:

“Based on the IMApp platform, the App is the first interactive multimedia museum guide in Italy to exploit the potential of iBeacons at its best: it automatically recognizes the artwork to which the visitor is approaching, shows its description on the screen and visualizes a wide range of multimedia contents such as pictures, videos and audio tours. Moreover, the App recreates the experience of GPS navigation in indoor spaces, thanks to an interactive map that shows the location of the artworks on exhibition and guides the user to the selected objects through the shortest path”²⁶.

This project is certainly interesting and noteworthy considering the application of the protocol called iBeacon, developed by Apple in 2013, in the museum and cultural heritage field.

3.2 QR Code

The **Quick Response code**²⁷, usually named as QR Code, is a technology that uses two-dimensional barcodes, that is matrices composed of black modules arranged within a white scheme, usually square in shape, conceived and created for the first time in 1994 specifically for use in the Japanese automotive industry. The QR code can be considered to all intents and purposes a barcode that can only be read by machines, an indicator capable of containing and providing information, usually concerning the objects or environments with which it is associated. Precisely with this regard, the Quick Response code contains location-related data, identification data, capable of providing traceability of the code itself, and of the object to which it is associated, but above all, it constitutes a direct connection point to a specific application or a specific website.

²⁶ IMApp. 2020. Musei Di Palazzo Farnese - Imapp. [online]
Available at: <<https://www.imapp.it/portfolio-item/farnese/>>.

²⁷ En.wikipedia.org. 2020. *QR Code*. [online]
Available at: <https://en.wikipedia.org/wiki/QR_code>.

Over the years, obviously, many versions of the QR code have been developed, however the last standard version released dates back to 2015. Over the years, QR codes have had considerable success, although not in equal measure worldwide. This has certainly been favoured by the fact that they can be used and understood by different operating systems for mobile devices, benefited by the fact that they can provide fast feedback and that they can transmit and store a substantial amount of data, usually, two hundred times more if compared to the previous and traditional barcodes, at a price considered advantageous.

Nowadays, considering their easy usability and their clear and marked recognizability, QR codes are generally increasingly known and used, especially in the field of experiences related to augmented reality and virtual reality, even if in 2014 an important deficiency was demonstrated regarding their security and protection from external attacks.

3.2 Example - WeChat travel experience mini-program for Smart Tourism.

Starting in 2011, the WeChat application launched by the Tencent group has spread incredibly in China and around Asia as the main mobile messaging applications. However, it soon evolved into an all-inclusive application of a whole series of services, including payments and tourism, meanwhile, in the West, we are used to seeing provided by multiple and varied applications. This application, which is already a fundamental component of the daily life, online and offline, of billions of Chinese, massively uses the technology provided by QR codes.

In fact, as a consequence of the success of this application in China, it is possible to find QR codes everywhere, capable of providing the most diverse information, from the discounts present in a shop to the personal information of a specific user, up to making possible fast payments. As a development of this technology already used massively, in 2017 the company released the so-called mini-program²⁸, an application built into the already existing WeChat that users can use at their convenience without being tied to downloads or installations on their device mobile.

²⁸ Cheng, A., Ren, G., Hong, T. and Koo, C., 2019. The WeChat Mini Program for Smart Tourism. *Asia Pacific Journal of Information Systems*, 29(3), pp.489-502.

Following this release, multiple tourism-related agencies and entities promoted their personal mini-programs on this platform to promote their business and attract new tourists. Based on the enormous availability and capability of the already existing WeChat database, for users is now possible to search for mini-programs in the surrounding area, or in the cities of greatest interest, plan entire trips based on information acquired from these programs but also, of course, share interesting information and experiences with friends and acquaintances. The first Italian city to follow this new trend and to launch into this new service was the city of Milan in 2019, with the profile solely dedicated to the city, called YesMilano²⁹.

3.3 NFC

The NFC³⁰ technology invented in 2002 is, as clearly expressed by the name, a technology that exploits a series of communication protocols for interactions between nearby devices, or at least devices no more than ten centimetres apart. To all intents and purposes, we can consider **Near-field communication** a sort of short-range wireless technology. This technology was originated and subjected to the wider technology called RFID³¹, or radio-frequency identification.

NFC technology has some very interesting features. For example, it offers the possibility of establishing a low-speed connection starting from simple setups, which in turn can then be used for more complex wireless connection systems. One of the best features of NFC is that it does not require any internal form of power source but at the same time allows you to transmit data over short distances. Furthermore, this technology has three major advantages: firstly it is safe, in fact from the moment when the connections are made at a very short distance it ensures that there are no intrusions and "thefts" within the communication; secondly, NFC technology is easy to use the use of this technology does not usually require any installation of third-party applications or the use of pins and passwords; and finally, NFC applies to a whole range of different services, as well as being usable for the easy transfer of data, images, videos and other multimedia files at a discrete speed.

²⁹Comune.milano.it. 2020. Milano Sbarca Su Wechat - Milano Sbarca Su Wechat - Comune Di Milano. [online] Available at: < <https://www.comune.milano.it/-/milano-sbarca-su-wechat> >.

³⁰ En.wikipedia.org. 2020. *Near-Field Communication*. [online] Available at: < https://en.wikipedia.org/wiki/Near-field_communication >.

³¹ En.wikipedia.org. 2020. *Radio-Frequency Identification*. [online] Available at: < https://en.wikipedia.org/wiki/Radio-frequency_identification >.

NFC uses the so-called **initiators** and **targets**. The structure at the base of this mechanism is composed of active initiators which generate a radio frequency field which activates the passive targets, thus establishing communication. The characteristic and the well-known element of NFC technology are the **tags**. These, often presented in the form of cards, keys or stickers, create in a certain way the core of the mechanism on which this technology is based today³².

This exchange of energy between passive sensors and active sensors, however, creates one of the only weak points of this technology, since the energy consumption, if compared for example to the energy consumption of Bluetooth Low Energy, result higher. Although it is evident how this technology could lend itself well to the realization of large-scale projects, it has not yet been implemented in any major project dedicated to the enrichment of the tourist offer, as can instead be achieved thanks to the use of **intelligent tickets**.

3.3 Example - The application of NFC tags in the Musei Capitolini in Rome.

The greatest example of the application of this technology has experimented since 2011 at the Capitoline museums in Rome. In fact, in collaboration with Samsung, the museum exhibitions have been enriched with NFC tags linked to the descriptions of the works of art, capable of providing more information, links to external links and in-depth pages on the more complicated issues.

This project considered the use of NFC technology as the best choice to provide multimedia, complete, dynamic and multilingual content to visitors while guaranteeing great reliability and reduced infrastructure costs. The Capitoline Museums have understood that enriching the traditional tourist visit by using advanced solutions that allow visitors to access more information on the works than those they may have by reading a static description is the key to creating a new interesting and captivating idea of the museum experience.

³² Boes, K., Borde, L. and Egger, R., 2014. The Acceptance of NFC Smart Posters in Tourism. *Information and Communication Technologies in Tourism 2015*, pp.435-447.

3.4 Internet of Things and 5G connections

As previously mentioned, all the technologies listed so far, such as Bluetooth, QR code, RFID and NFC, contribute to the creation of a broader project at the base, the so-called **Internet of Things**³³. The Internet of Things, presented for the first time in 2005, is considered to be the next evolutionary stage of the already known Internet, and it has been developing with ever-increasing strength in recent years.

It is now clear that thanks to the ability of the IoT to create a pervasive and interconnected system³⁴ between both real and virtual objects with the minimal use of human intervention, we will be able to obtain in the future an environment capable of providing us with ever greater services and benefits, generating new applications capable of improving our quality of life. As we can find well illustrated in the article "Internet of Things: state-of-the-art, Challenges, Application, and Open Issues"³⁵ the IoT is described as

"a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies",

but especially it is illustrated how the IoT will have a significant impact in our societies considering that

"The IoT provides several benefits in the management and optimization of public services, such as transport and parking, lighting, surveillance and maintenance of public areas, preservation of cultural heritage [...]".

In conclusion, obviously, all this technological context would never be implemented correctly and efficiently, without an excellent internet connection that can cover all the necessary spaces.

³³ En.wikipedia.org. 2020. *Internet Of Things*. [online]
Available at: < https://en.wikipedia.org/wiki/Internet_of_things >.

³⁴ Barbato, M., Giacconi, G., Liparulo, L., Maisto, M., Panella, M., Proietti, A. and Orlandi, G., 2014. Smart devices and environments: Enabling technologies and systems for the Internet of Things.

³⁵ Atlam, H., Walters, R. and Wills, G., 2018. Internet of Things: State-of-the-art, Challenges, Applications, and Open Issues. *International Journal of Intelligent Computing Research*, 9(3), pp.928-938.

Specifically, with an eye to the future of Smart Tourism, Smart Cities and the Internet of Things, the application of 5G³⁶ infrastructure will be necessary and fundamental, which thanks to its greater speed and breadth of coverage will make the application of these technologies achievable and efficient.

4. THE PROPOSAL

As already mentioned, the great trend of change, brings to the surface new concepts and applications that not only enhance the experience but also determine to a large extent the way of managing and conducting the overall experience on the part of the institutions and the recipients. The efficiency of the system is characterized by its adaptability and acceptance by all *stakeholders*.

The drive of the outline is not only to increase the efficiency of the museum but at the same time to carry out complex functions without compromising the interaction of the public and the system. The result of the observation is to erect a user-friendly system with five basic pillars. On the first level, the accessibility ensures the users' registration or login without significant difficulties. Then the adaptability, to make it easier for the user to adapt without causing complex problems that will lead to dissatisfaction or misunderstanding on the system's functionality.

Decisively, in terms of acceptability, a system that is user-friendly and does not create inconvenience is what directs its smooth acceptance by a satisfied audience. As a result of the above, the maximum usability and interoperability without any technical barrier derive not only from within the system but also from all the stakeholders who serve the same.

This proposal refers to an already proposed system³⁷ which has theoretically been planned for outdoor archeological sites and by adapting and strengthening it, it becomes part of a multi-layered and multi-faceted organization such as a museum.

³⁶ En.wikipedia.org. 2020. 5G. [online]
Available at: < <https://en.wikipedia.org/wiki/5G> >.

³⁷ Panagiwtakopoulos, Dimitriatzou et al., 2020

The new museum ticket is composed by the museum card with the addition of nfc technology which will be the means of obtaining information and the application for smart devices through which the user would interact in real time with the system. What has been taken seriously into consideration, is that the museum is not only a cradle of culture, but at the same moment is a viable business³⁸, so what is being proposed is aimed at making the aforementioned aspects of the causal relationship more profitable.

In order for the full versatility of the ticket to be given, it has to be emphasized that its purpose is dire and twofold. On the one hand, it is aimed to maximize the museum environment by introducing the greatest possible interaction between the system and the user through *augmented reality*, *transmedia* and *gamification*, that will contribute to its integrated experience, and secondly to the maximum exploitation by the museum organization, which will be able to collect and use information for even greater environmental efficiency.

Preliminary, the interaction with the user will be analyzed as it is the primary objective, and then the interface with the museum organization. The system itself consists of a diverse complex of different technologies and design which, however, will reach the hands of the user with the greatest possible austerity and simplicity in order to avoid any confusion. Its use will be very simple. During the visit to the museum the user will have the opportunity, if he is the owner of the smart ticket, to have a complete experience. All he needs to do, is approach his ticket at the base of the exhibit and through the installed NFC microchip, he will receive all the necessary information about the exhibit on his mobile phone.

It will be possible through the application to see enhanced the reality of the exhibit, and to have real-time interactivity with the exhibit itself. This is based on the purpose of the *transmedia* and the user will be offered multiple functions (such as rotating the display through its digital representation to see all angles). In the context of transmedia, an important process that will further enhance the user's experience and make it even more applicable to the museum experience is the function of storytelling.

³⁸ Komarac, T., 2014. A New World for Museum Marketing? Facing the Old Dilemmas while Challenging New Market Opportunities. [online] Available at: <
https://www.researchgate.net/publication/271829654_A_New_World_for_Museum_Marketing_Facing_the_Old_Dilemmas >

In terms of tourism, the upswing of e-Tourism, m-Tourism and m-Tourism 2.0, has paved the way to a "prosumption" touristic experience where users consume and produce a "participatory culture" with Transmedia Storytelling (TS) to process the experience of a co-created digital content.³⁹ This process through the application of the proposed system will be applied even more personalized. Not only can the visual side of the story be discernible from the museum, but the visitor himself could choose how he wants to see, process and interact with the storyline during his visit.

Another key element that has the ability to be combined to the best degree with the proposed system is the emerging piece of smart replicas⁴⁰ in the museum visit. This process could be further enhanced by the coordination of the exhibits through the application (IoT) so that the user has full control not only of how to interact with the exhibit but also that the elements that make up this scheme will be united and will create an even more enhanced transmedia content. In that way the user is being introduced to an even richer HCI (Human-Computer-Interaction)⁴¹ experience.

The media condition is changed quickly by the consistent individuals' cooperation in the substance creation⁴², rising the abilities on client connection modes, content sorts, designs, semantics, metadata altering and management⁴³. The new crowd's needs are inspected by the conceivable outcomes of the substance's media relocation. Surely, first cross-media and afterward transmedia, arisen by the computing and HCI (Human-Computer-Interaction) which convey a story over all media⁴⁴ which was providing to the users a lushest experience while TS is also considered a marketing tool⁴⁵.

³⁹ https://event.unitn.it/smartcities-trento/TrentoWP_ChiaraDiMeo_1.pdf

⁴⁰ Marshall, M., Dulake, N., Ciolfi, L., Duranti, D., Kockelkorn, H. and Petrelli, D., 2016. Using Tangible Smart Replicas as Controls for an Interactive Museum Exhibition. *Proceedings of the TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction - TEI '16*, pp.159-167.

⁴¹ Lubart, T., 2005. How can computers be partners in the creative process: Classification and commentary on the Special Issue. *International Journal of Human-Computer Studies*, 63(4-5), pp.365-369.

⁴² Buhalis D, Amaranggana A, (2015) Smart Tourism Destinations Enhancing Tourism Experience through Personalization of Services, in Tussyadiah, I., and Invesini, A., (eds), ENTER 2015 Proceedings, Lugano, Springer-Verlag, Wien, ISBN:9783319143422, pp.377-390, DOI 10.1007/978-3-319-14343-9_28

⁴³ <https://doi.org/10.1016/j.array.2020.100020>

⁴⁴ Segerstahl, K. and Jokela, T., 2006. Usability of interaction patterns. *CHI '06 extended abstracts on Human factors in computing systems - CHI EA '06*.

⁴⁵ https://www.academia.edu/12157449/21st_Century_Narratives_Using_Transmedia_Storytelling_in_the_Language_Arts_Classroom?email_work_card=view-paper

Correspondingly, the use of NFC allows the user to act at the same time with two or more exhibits of the same period (even different) and to parallel the information of each so that it can have a more complete historical point of view (comparison, correlation, etc.). In the end, everything converges on a complete content which not only promotes the exhibition but is accompanied gamification, that enhances the interaction and creates in the user the feeling of cognitive saturation through pleasant methods.

Gamification is a motivational technique which applies game mechanics, such as rewards and challenges, to non-game contexts to invoke a positive behavioral outcome. The development of information and communication technology (ICT), including social media, global positioning systems (GPS), and augmented reality (AR), has popularized gamification. Destinations and the IT companies have initiated gamification practices in the last 10 years. For example, visitors can follow the gamified visitor guide, Strayboots, to explore New York City and share their travel experiences. They can also locate themselves by using the interactive maps and enjoy the fun of finding objects in gamified trips, such as Pirate Trail Geocaching Treasure Hunt and Wrocław's Dwarfs. Knowledge collectors are motivated by acquiring more information about the destination.

They treat a gamified trip as an engaging way to earn stories, cultures, and fun facts, and want to “have fun while exploring and enriching knowledge about the destination” and “have connection to the place's history and culture.” For example, the quest for treasure in TravelPlot Porto uses transmedia narrative to tell the story of the destination. The tedious descriptions regarding historic monuments become more attractive. A gamified trip would also be a good way to explore a city and a museum, unknown or familiar, without necessarily taking the tourist-heavy path.

Participants especially pointed out that “It's kind of cool if you spend a weekend with your friends to know more about the city you live in.” However, knowledge collectors are not interested in badges or scoreboards and do not enjoy competing with others. Having a sense of achievement is not an important motive for them⁴⁶.

⁴⁶ Shen, Y., Choi, H., Joppe, M. and Yi, S., 2020. What motivates visitors to participate in a gamified trip? A player typology using Q methodology. *Tourism Management*, 78, p.104074.

At the second level, visitors will be able to use the ticket and in virtual visits to different environments in the same way, interacting in this case directly with the sensors of the virtual objects. Thus, it is observed that the visitor is free to choose the exhibits that interest him most and to adapt this way of interaction with the above. TS projects which use interactive and immersive platforms through social media and sensors, have already been stated that have promoted several tourist locations and cultural heritage sites⁴⁷. As Joseph Pine II and James H. Gilmore state, experience economy relates to transmedia tourism and there have been noticed an existed economic progression model⁴⁸.

4.1 THE USER

As already mentioned, the connection between the user and the exhibition will take place inside the museum, but an overview of all further relationships makes it necessary to use a smart device. Topmost the visitor is free to bring his own smart device in which he will install the application of the museum. However, in case the user does not have the option to bring his own smart device, two solutions will be provided.

The basic idea is for the user to be able to use the ticket from multiple devices that will simply have the application without much difficulty. So the application will read the ticket holder whether he has a personal application account or not. In this way, two conducts can be found in which the user can finally practise all the quality of the experience. Either it will be accompanied by another user who will have the necessary device, or it will be provided by the museum itself.

To make it clear here, the teams that no longer have smart devices are few and far between, even if we are talking about the 50 plus target group, but the environment to which the application is addressed does not discriminate. In this means, the complete experience of all users is ensured without anyone being excluded due to non-possession of the necessary individual units. In the case that the user has a device that could support NFC reading then the user through a log in sprightly to the application could have the full usage.

⁴⁷ <http://nht.ecs.soton.ac.uk/2018/papers/2-vnisi.pdf>

⁴⁸ Pine, J. and Gilmore, J., 2011. *The Experience Economy*. 2nd ed. p.194.

Several times has been already mentioned the trend of personalization. The biggest innovation proposed through this new ecosystem, is the adaptability to the user and not of the user. This means that the information will now be given with the same purpose but in a different way. Through an AI application, the system will recognize the handler and will give him personalized information that will correspond to the respective background (age, cognitive background, etc.). Personalizing the experience will lead to the best possible absorption of information by the recipient with maximum satisfaction.

But how and why? Primary, the way in which the user will receive the ticket must be analysed in order to understand the whole process of acquisition and use. The method will be simple and functional. The user will download the application to his mobile phone, enter his personal information in the application and will choose if he wants to be provided with card from the museum. Because NFC technology is being used, smart devices that support this technology will not necessarily require the card, but for devices that cannot recognize the sensor, the museum will provide an excise ticket with the classic card form but this time technologically enhanced. In case the user is not the owner of a smart device, then he will simply call the museum and give the necessary information. In the last two cases, the receiving of the card can be done either by post or by the user's receipt from the museum itself.

By entering his details, the user agrees to their usage by the system and the museum⁴⁹. The reason for this consent is, in the end, to fulfil the first purpose of the ticket purpose, to provide personalized information to the user. As it has already been labelled, it will recognize the user and be able to adapt the information according to its background (in simple words the same exhibit will be presented differently to a child compared to an adult, even more specifically, differently to scientist and to a worker). This avoids the confusion that can sometimes be created by the complex information that unpleasantly anticipates a potential visitor to the museum and reinforces our ultimate goal of strengthening the museum's common interest and target group expansion.

⁴⁹ https://gdpr-info.eu/?fbclid=IwAR2gIl8wq1iIhcPSIudx8a3Z5fF8ApjM_g24mxlhataSy4iAoOUaJkdmo

However, it does not stop there, the greater the use of the ticket and the more information the interested party collects, the better it will be able to adapt the user's experience (for example, providing him with alternative information about the same exhibit or environment , even alternative exhibitions that may take place in the future and are planned by the museum, or the museums network that use the same system). Taking into consideration that and anticipating with this aspect of the system if the user wants to delve even deeper into the subject (and the initial information from the system are not enough), they will always have the possibility to search inside the app for further material. In this way the system will recognise his interest and the next time will provide interest-cored information to the handler.

In other words, the system could recognise the background of the user and provide at the start point information based on that, but as long as the handler interacts with it then the adaptability of the system provides personalized information in the biggest possible level and it becomes interest-based provision.

With this process the system performs a continuous procedure in the user's profile without the need to intervene in it. Also, through the application, it will be able to see its history and the changes during its use, as well as the way he chose to interact with specific exhibits. Therefore, the relationship of cause and effects, that is being developed between the application and the user, is continuous and uninterrupted. The more the user acts, the more the application adapts and participates in his complete experience.

4.2 THE MUSEUM

But the most important benefits of this system are not for the public, but for the museum itself. Important benefits have been unleashed on which the idea of this new system is based, and the restoration of the museum environment is supported. Initially, as it has already been mentioned, many times social groups avoid museums because they believe they cannot match the information level suggested by the museum.

The process of updating the information and personalizing it enables this social barrier to be broken and there is an expansion of the public that will not only be able to visit the museum but also be a part of the ecosystem without the possibility of misleading the process. In the same way, other groups receive more information according to their own background and do not remain in the general picture of the exhibition.

For the most part, the application that essentially connects the public-ticket-museum interaction has already been analyzed. But what has not been mentioned is the advantages of this information-level process by the same museum organization. It has already been mentioned that the data of each user and its interaction will be specialized in a database from which the personalized information about each user will be stored. However, the same information will be provided in the museum. Observing the data of the visitors the organization will be able to draw detailed conclusions about the behavior of each group in the environment, resulting in not only automated personalization that is done through the application but also the personalized museum services.

These data will be the base of future statistical data and future research and strategies that this time will be based not on external sources but on internal social behaviors. In addition, this data will be acquired gradually but continuously and will be able to be processed more easily and effortlessly with the use of application, avoiding the complex processes that require a large amount of data and time. Another important perspective is that of creating an interconnected network. By adopting this system, a portion of museums will begin to build a well-established network that will not only "exploit" information responses but will also promote each other in a complementary communication marketing.

The information will flow into the system and the informational and digital correlation of the organisms will be promoted. This process could be a big advantage when talking about the cultural poaching of a region, a country or even the cooperation and interconnection of different countries that may share common (or not) history. The process of creating a network, however, does not stop only at the link that has been developed between the museums, but also succeeds within the city itself or the region and in the interaction of both.

Through this experience the user can benefit from specific profits of the city (for example discount on a gastronomic tour of the city in specific cooperating restaurants) and vice versa the stylization of the political network in the museum experience (discount on the ticket price). This creates a similar interaction between many stakeholders of different natures and the promotion of the wider local community and the strengthening of the economy.

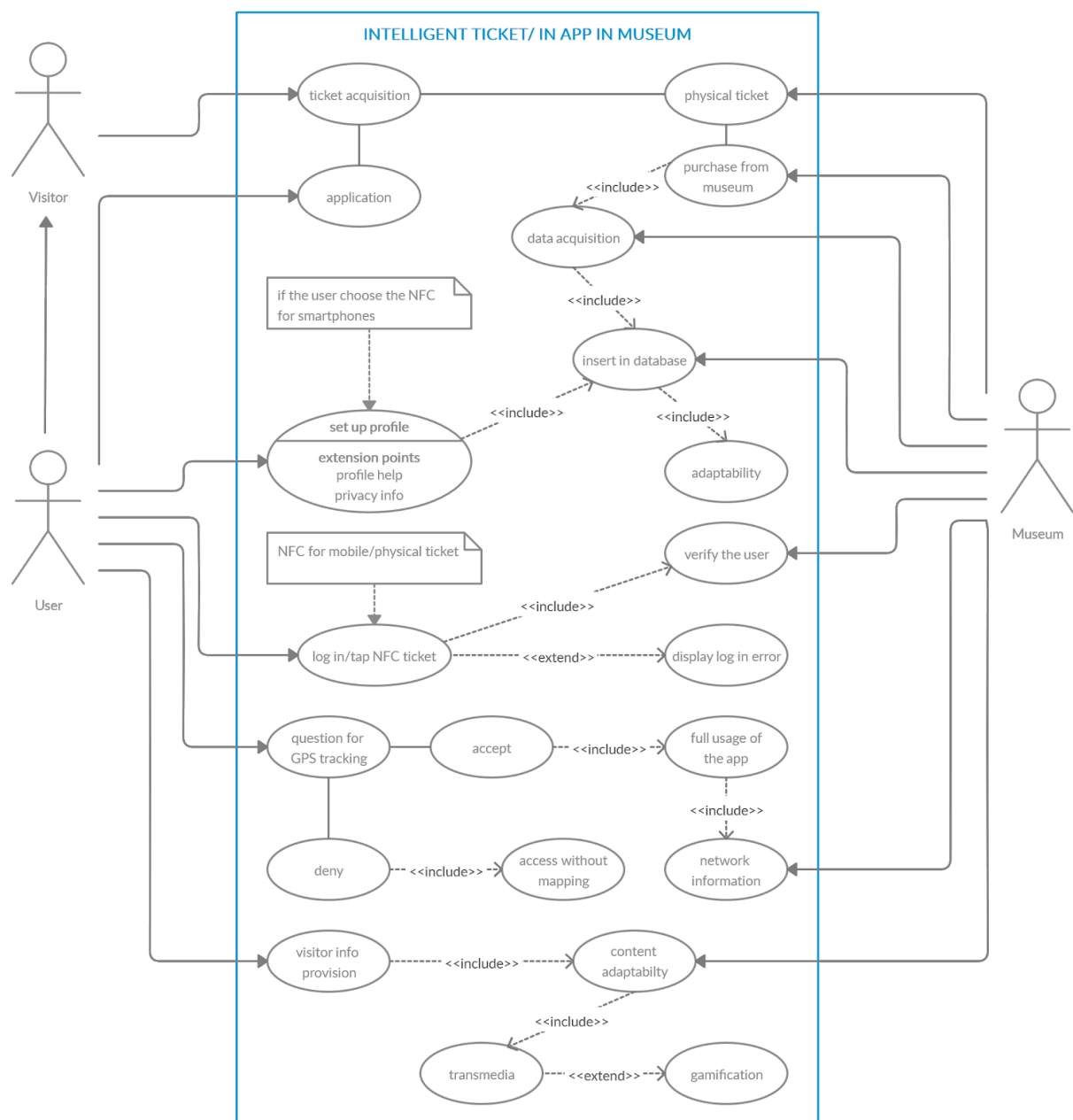
Concluding, another piece that needs to be particularly accentuated is the result of this linked-open database. The process of adapting information and their organization so that they are accessible and used by its stakeholders. This, as already mentioned, will help the network to have full access and to gain a better exchange of information. But what needs to be emphasized is its usefulness as a general repository that will protect and promote the cultural treasures that currently exist in each network and could consist a national digital and digitized report.

5. THE USE CASE

To understand the configuration and application of the system in the museum but of the interactive museum and city network, a graphic and textual explanation of a specific scenario will be carried out. This will be done first in a general use case that afterwards will ultimately be implemented in the three selected environmental museums to present the efficiency of the system in a real space.

The selected museums emphasize to the greatest extent the differences that can be found at a wider range between the museums in terms of size, (small to medium-sized), location, (Bologna, Rimini, Modena) but ultimately in terms of their content (Gallery, Archaeological-Medieval, Car museum). This election is not accidental at all, as the purpose of the work is to verify the efficiency and adaptability of the system to all contents and environments, and to highlight their content and usability. The process it is carried out through intricate and multisystem methods, reaching the level of being a self-service system that meets all the necessary provision procedures for both parties.

In the general use case, it will be defined the distinction between the two interacting sides and in the middle the crossing point of the system with both fronts. The procedure begins with the visitor's choice for the acquisition of the ticket. This could be accomplished in two ways: either the visitor will be provided with the official museum card that will have NFC technology and will interact with the official application, or if his cell phone can support NFC operation he will be able to use only the application and without the necessary tenure of the physical form of the ticket could have full control of the personalized information and the rest of the processes that take place in the system.



In case the ticket is supplied in physical form, then one tap on the mobile device is enough so that all the owner's personal data are registered and automatically run in the app (due to their already entered into the database during the purchase process). However, in the case of acquiring only the app, the user has to enter his personal details so that the application registers him in the database and offers its full use. At this stage, twofold additional possibilities will be offered to the user, a series of auxiliary instructions that will serve him in the possibility he faces some specific difficulties in entering its data or some oddity to be solved, and the details of privacy that the terms and conditions will appear in which the user agrees with the entry of his data in the application (their elaboration by the system to perform its personalized service).

Since all the above steps have been achieved, the account is validated or any problems that may have arisen are resolved. At a secondary level, the user is required to accept the GPS settings of his mobile phone, so that he can receive information for the museum space where he is being located. If the user does not accept this option, then he will not face any kind of problem in the procedure, but he will not be able to receive mapping information and tour guidance. In case of accepting it, there is an automatic update of the system for the user's position inside the building and all the fitting support for him (e.g. the number of visitors in each room)

From now on, the app is ready for full navigation and service of the users, offering a wide range of personalized information according to the interests and the position of the handler. Consequently, transmedia generally, help the experience to be more interesting, by giving the user the opportunity to explore the cultural substance through various means. In particular, the app itself can support applications based in Augmented Reality, Virtual Reality (in the case that this kind of exhibition is organized by the museum and finally an collaborative exhibit-based game which enables the user's interactivity with the real environment (gamification). Thus, a digital TS is created across which is being achieved the complete contact of the tourist with the offered environment of each area and tourist places that are derived from the cultural promotion of the district that has been displayed.

In any situation, the user is free to choose what the activity will be and how he will manage each proposal-information that he will receive from the system. The main purpose of the system is to enhance and smoothly carry out operations within the museum, prevent any tribulations and improve the service of every member of the network but also the efficiency of the entire system.

5.1 THE HYPOTHETICAL APPLICATION IN REAL CONTEXTS.

Starting from the use case just illustrated, we can easily understand how this new ecosystem is easily applicable more or less to any museum reality. In order to give a greater demonstration of the peculiarity of the system, which makes it available and advantageous for several possible scenarios, we decided to theoretically and hypothetically present its applications in truly existing contexts. For this purpose, we decided to consider and choose three quite different museum realities, which have many differences but which at the same time show two points of major contact: they all three are museums and all three located in the Emilia Romagna region.

Starting from this territorial location, we intentionally chose to cover the whole region by choosing a museum in Emilia, a museum in Romagna and a museum located in the provincial capital, Bologna. Therefore, the museums considered are the "**Pinacoteca Nazionale di Bologna**", the "**Museo Ferrari**" located in Maranello in Emilia, and finally the "**Museo della Città di Rimini**", located in Romagna. These three museums are the best example of heterogeneity to which the illustrated system can be applied and on which the network of connections could be created.

The heterogeneity of these subjects is to be considered not only from a geographical point of view, but above all by the type of museum they represent, by the type of structure in which they are situated, and by the type of objects that they have at the basis of their collections and exhibitions. In fact, in order to have a wider range of types of museums, we have chosen the "Pinacoteca Nazionale di Bologna" as a national museum and therefore directly dependent on MiBACT, the "Museo della Città di Rimini" as a municipal museum and finally the "Museo Ferrari" as a private museum.

Furthermore, attention was paid to the size of the spaces that these three museums offer following the same order that previously been used, must be considered as large, medium and small. Obviously, this statement does not intend in any way to evaluate the cultural significance or relevance of their content but only their architectural dimensions.

Finally, as far as concerned the collections presented by these museums we can see: in the first case, a vast overview of pictorial art which covers an artistic period of more or less five hundred years; in the second case a collection of artistic products coming specifically from the area surrounding the museum and an archaeological itinerary dating back to the Roman period; and finally, in the third case, a very interesting historical collection concerning the milestones that made this brand a reason for national excellence and international prestige.

If each of these institutions, in a real situation, would apply the system we proposed according to their own style and needs, we can well imagine how different application opportunities exist for each of them. Starting for example from the "Pinacoteca Nazionale di Bologna" it is easy to imagine how, due to the large spaces, the large collection and the certainly large number of visitors, the application of this ecosystem will be different from the application of the same system in the "Museo Ferrari", which certainly has an equally interesting collection and which is equally largely visited but which develops within a single room. Based on this, the intelligent ticket could be applied by the "Pinacoteca Nazionale di Bologna" for example at the entrance of each thematic area or room where finding a clearly identifiable NFC tag.

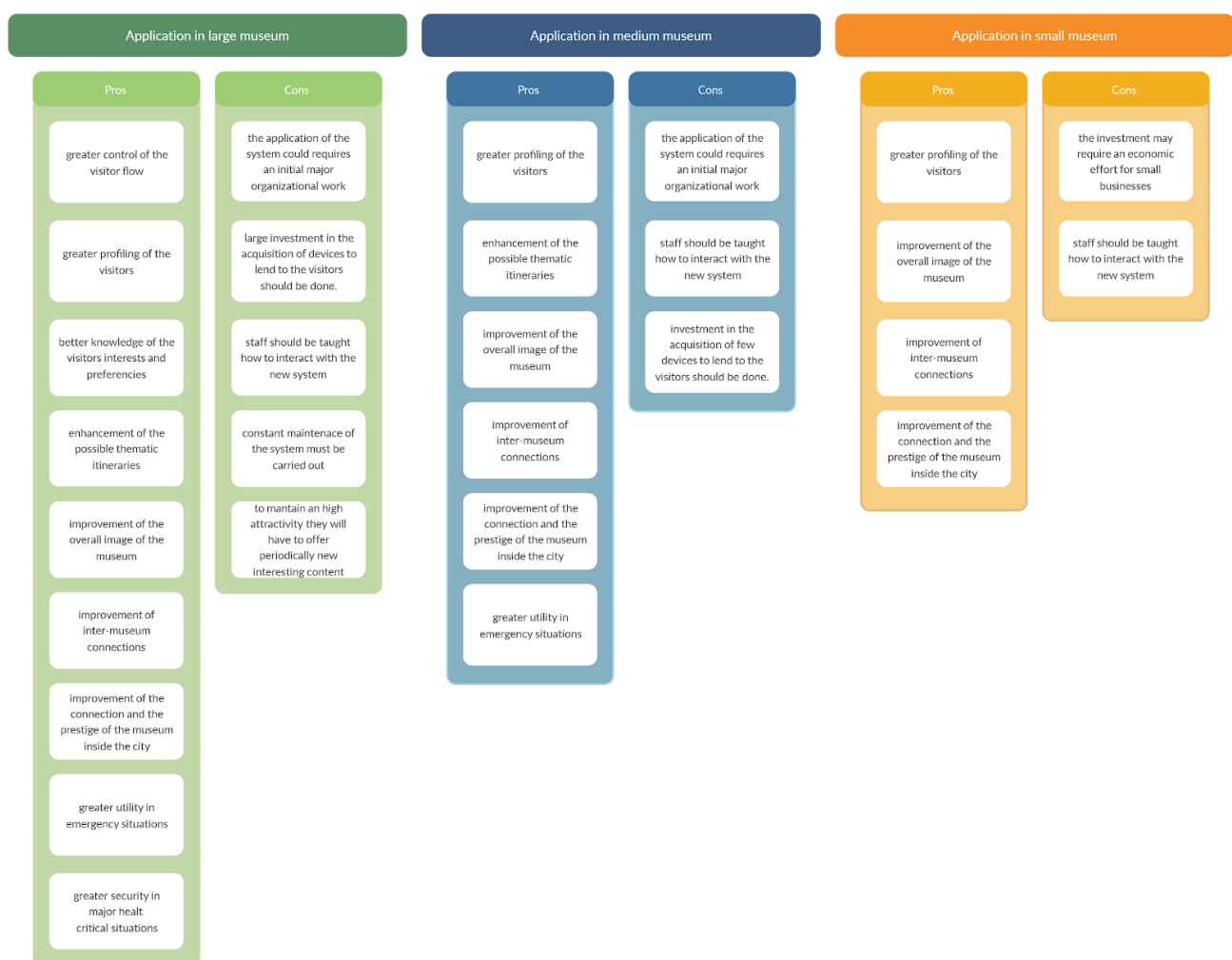
In this way, the visitor could get all the information in advance on what he can admire following that path and therefore consequently deciding for example whether or not to continue in that direction based on his own interest. This action could also be used, for example, to better manage visitor flows and queues, to always have the number of customers in a specific area under control, but also to understand which are the points of greatest interest to the public. For example, this kind of application would not be so useful in the situation previously illustrated in the "Museo Ferrari", due to its small size.

However, this difference does not indicate that the intelligent ticket cannot have relevance in small museums because, as has been stated, the effectiveness of this system is based specifically on the connections that the museum itself decides to make to enhance its content. If we wanted to present an idea of application of the NFC tags in the "Museo Ferrari", which would not be feasible or equally effective in one of the other illustrated museums, we could imagine a more playful and multimedia application, perhaps making available the connection with a simulation driving app or making available multimedia videos that show the performance of a specific car model on the circuit when approaching it and its NFC tag (Augmented reality).

Similarly, the application of the intelligent ticket in medium-sized museums, such as the one of the city of Rimini, can concern various fields depending on the creativity of the people in charge of managing the museum. For example, considering that in this museum we already have a clear distinction between the artistic path and the archaeological path, the use of the intelligent ticket like the one proposed in the very first example may not be effective. On the contrary, it could be interesting to create, thanks to this ecosystem, a tour that leads the visitor to see the works of the same author in chronological succession, or that guides him through the vision of paintings and works that present the representation of the same places, or even perhaps showing how the physical places where the artifacts were found are preserved today.

In conclusion, we can say that the best application of this new ecosystem of cultural enhancement and museum interconnection will depend above all on the effort that the individual management of each museum will employ to enrich and enhance its heritage. Many types of advantages can be drawn from the use of intelligent tickets, both as regards a better and more captivating cultural offer, and as regards better and safer management of spaces. From this point of view, numerous benefits can be identified, as previously mentioned, for example in queue management, or in understanding which routes are preferred by visitors, but also for managing hypothetical emergency situations, for example being able to monitor the position of visitors and advise them, directly through the electronic device, the fastest way to the emergency exit.

Among all these possibilities there is also a large section of experiences that have not been illustrated here, such as the possibility of external collaborations with local corporations or organizations, the possibility of creating all-round experiences that also include the enhancement of the cultural dimension of the environment surrounding the museums, the possibility of creating *ad hoc* discounts for the visitor and many other. These and other strategies can be applied by any museum, large or small, in order to provide a richer and more engaging experience for visitors but at the same time capable of providing useful and indispensable information for increasingly efficient and effective museum management.



6. CONCLUSIONS

It should be initially strong minded once again that the whole system supports, and is being supported by, an application that aims at the personalized service of the users. Endorsing a multifaceted and multilayered visiting experience; the visitor actively participates through the interactive functions and receives a complete tourist adeptness that will be a turning point for future expeditions. However, the system's success is due to the greater efficiency of the ticket itself, through which the bigger functionality for the user and the enhancement of his experience are enjoyed. Due to the fact that an increasing number of sightseers could easier select to stop over to museums which propose singular features (e.g. augmentation etc.), through the proposed NFC technology and the application that accompanies it, the dissemination and promotion of the multifaceted transmedia content is being attained, so that the visitor can form a tourist experience that will endure unchanged.

Additionally, another key perspective of this system is how to target the destination through the new process. Due to the high number of new visitors, certain processes should be reshaped, in order to enhance the efficiency of the museum and highlight its different potentials in the part of the cultural heritage that stands out (e.g. promotional planning, financial growth and technological developments). The result of the above interactions is that the visitor will have the capability not to remain in a superficial touristic experience of the exhibits and activities but to be introduced in the deeper essence of the aforementioned, while at the same time awareness is created towards issues concerning the context.

A developing number of organizations having a place with various divisions, is embracing this methodology, rediscovering, in this manner, the significance of computerized content, which nature is progressively visual, shrewd, cross-stage and can create diverse environment. In the context of the post COVID-19 era, yet another very important issue that needs to be preserved is the necessary social distance. However, in the incident that the greatest notch of functionality within the new condition is not ensured, it will be a basic barrier in the way of the tourism organization. All the proposed system's processes are validated by the function of social distancing that ensures the security of all network stakeholders.

Regardless of the way that an ever-increasing number of corporators become acquainted with the idea of AR, its application through NFC is not yet boundless and may build the recurrence of visits to the region that has been applied to. The combination of the intelligent ticket, multimedia science and the multifaceted interface could benefit visitors, regardless their age or educational background. Before the attainment of the acquired database that supports and enriches the system, the expected content needs to be entirely assessed and evaluated. A natural consequence of the above is the difficulty of their organic implementation. To get to the viability of the system, beyond the theoretical framework that needs to be examined multiple times, it is essential that the system is supported by investment programs and organizations that will produce the necessary tools for the structures (ticket with the acquired technology, readers provision, maintenance costs, software etc.).

In addition, due to the more active involvement of tourists, there is a significant increase in the demand for trading products and their acquisition methods, actively following the research of more customized tourism products and providing personalized service and information in real time and place. The high efficiency of the digital environment that is now dynamically presented through smart devices particularly leads digital locals to search for their own provision.

This network performs an alternation from the representative to the virtual, from the formality to the experience. Not all visitors have the same background, nor do all crave a similar force of data and information. Innovation permits us to adjust to each style of the guest by fusing stories, games, thoroughness, and accounts, all dependent on request. In this way, that innovation is comprehended and contributes particularly to a device for structuring experience and intelligence. The effective plan of renewed touristic sights will clearly not originate from supplanting one method of getting things done with another, yet from the concurrence and the blending of all methods of getting things done.

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