Exploring the ICT Potential to Maximize User - Built Space Interaction in Monumental Spaces

The case of the municipal agora in Chania, Crete

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During the last two decades, the introduction of digital multimedia into the museums, monuments and exhibition spaces describe a new open and flexible institution, which is attentive to the needs of its visitors. In fact, many different opinions, preferences and personalized agendas acquire now a symbiotic relationship with the strict archeological site contexts with ICT. This relationship is established the moment that the actual space comes into terms with the visitors' needs and without compromising spatially, it reveals all the different movement alternatives that could satisfy the visitor. In fact, ICTs create alternative experiences through the juxtaposition of a digital layer on physical space. Drawing on this objective, this paper studies the relation between user and monument by enhancing their interaction in the Municipal Market of Chania, in Crete. The objective of the paper is to examine how state-of-the-art IoT systems can be seamlessly incorporated into the smart cultural heritage strategy of the suggested place. The macroscope is to explore alternatives strategies to enhance sustainable tourism in Chania.

Keywords: *ICT, Digital Heritage, Smart Tourism, IoT Systems, Hybrid Space,*

INTRODUCTION

During the last two decades, the introduction of digital multimedia into the museums, monuments and exhibition spaces describe a new open and flexible institution, which is attentive to the needs of its visitors. This new institution reflects on the existence of multiculturalism, and offering a personalized user experience becomes an important part in contemporary democracy (Cameron F., Kenderline S., 2007).

In fact, many different opinions, preferences and personalized agendas now acquire a symbiotic relationship with the strict archeological site contexts with ICT. This relationship is established at the moment that the actual space comes into terms with the visitors' needs and without compromising spatially, it reveals all the different movement alternatives that could satisfy the visitor. In fact, ICTs create alternative experiences through the juxtaposition of a digital layer on physical space, thus creating a new hybrid.

This new phenomenon is still now under study and implementation in a number of historical cities.

For example in South European countries, the experiments to enhance user experience extends in projects both indoors and outdoors, museums, monuments or transformed and regenerated older structures. The main concern remains the way to motivate the users in order to receive the required data that will frame the overall goal.

Drawing on this objective, this paper studies the relation between user and monument by enhancing their interaction in the Municipal Market of Chania, in Crete. The objective of the paper is to examine how state-of-the-art IoT systems can be seamlessly incorporated into the smart cultural heritage strategy of the suggested place. The macroscope is to explore alternatives strategies to enhance sustainable tourism in Chania.

THE METHODOLOGY

The methodology chosen for this article was based both on empirical documentation but also on the use of ICT in the analysis and stimulation of users in the built environment. Firstly, the group realized an empirical analysis of the morphological entities of the monument. For this step, few parameters were highlighted: a) The alternative flows within the site, b) the moments of maximum interaction between human and built space, and c) the user density within the building. This analysis was realized with a visit to the monument and the collection of the information.

Secondly, based on the Crete 3D platform, the research group tried to investigate how users react to the amount of information received. The Crete 3D, a WebGL platform, is an online service where the users can find replicated morphologies of the main archaeological Cretan monuments presented through a conceptual 3D model. Through the platform, users are able to navigate around the monuments and speculate them at different levels of spatial and contextual detail. The platform allows for switching between seven historical periods and offers a comparative study of their evolution in time. The platform's innovative feature was the potential 'to manage such a large amount of information over the internet, in a transparent, light and simple way for the end user, in addition to offering the ability to compare data over time, during the historical periods.' (Parthenios P. et al, p.1, 2012). The group of thirty users was divided into two equal groups. The first group of 15 users was asked to enter the platform during their visit to the monument and follow real time the research group's instructions. Among though was the collection of a number of user preferences inside the monument.

Thirdly, the research group collected real-time data of the user flows within the site combined with the user feedback on the monument. Through the combination of GPS and an IPS (Indoor Positioning System) platform (Indooratlas), the research group tracked the user movement within the monument by utilizing the magnetic sensor of the user's smartphone. User flows were located real-time and analyzed to better perceive the interaction between user and monument. A few hours after the visit, all users were asked to answer questions regarding their visit. The research team analyzed the subjective data, extracted from the questionnaires and juxtaposed them with the objective data, which consist of the real-time location tracking acquired through Indooratlas. Finally, subjective and objective data were compared among the users that browsed Crete3D application and those that entered without any additional knowledge on the monument. During the third part of the study, IoT serves two functions: on the one hand as a digital layer of knowledge that enhances the user experience an on the other hand, as a significant data acquisition tool.

EXPERIENCE OF THE AGORA: USER FLOWS, HUMAN INTERACTION WITH BUILT SPACE AND USER DENSITY IN TWO SCALES

The experience of the Agora is presented in three progressive scales. The first one includes an area analysis, which means the public space of the Agora, before the experimentation with ICT. We argue here that the way the experience is transformed during the implementation of ICT affects the imaginary and

perception of the area in its entirety. Then we examine the relation of the agora with its immediate surroundings, as well as the possible impact of the projections at the scale of the block. Finally, the analysis illuminates the way in which ICT can affect the overall user experience and bring about important insights for future consideration. The next two subsections present the two architectural scales and how they affect the flows, human interaction with the building and user density. The following two subsections exhibit the momentum of interaction between a user, space and ICT as well as the user behavioral pattern key points, as affected by the new digital layer.

The scale of the building

The Municipal Market of Chania is commonly known as the "Agora". It was built between 1909 and 1913 on the site of the Venetian platform bastion, and materials from the fort were used to actually build it. The overall concept was based on the design of the covered market of Marseilles, with references to the Byzantine design tradition and the construction drawings of the engineer Drandakis (Kavroulaki I, Kaniadaki M.). It acted as a public space, always dedicated to commercial activities during its construction carrying the political effort of embellishing an area that was not in the least attractive for its residents at that time as it was the main rampart of the fortification during the Venetian period. Its urban landscape is greatly influenced by the memories of its first functions and their Venetian past: ¼ as butchers' shop, ¼ as a fish market and the rest as vegetables and fruits markets, enriching today the collective memory of Cretan people. However, since the transfer of the fish market to Souda as well as the vegetable section outside of the city center, many of the shops became touristically oriented shops rendering much of its first heritage immaterial today.

Works of restoration of its old remaining parts didn't start before the 1960s and in 1980 it was designated by the Ministry of Culture as a monument. It is in these transformations that users perceive the evolution of a monumental space to a space firstly with a touristic aim and then to a touristic product.

From an architectural point of view, the place initially extended in the 19th-century limits of the city of Chania. Exactly in the point that united the old with the new city, the building's main entrance was oriented towards the newer city creating a dialectic relation between the new and past city boundaries. It measured in total 4,000 square meters in a surrounding area of 17,200 square meters. It is a cross-shaped edifice with a gate on each wing of the cross (four in total). It is characterized by the existence of a largely shaped corridor placed in the core of the building that leads in all four wings and extruded to that a second cross-shaped space of attaching shops (figure 1, 2) (The Municipal Market of Chania, 2016).

Figure 1
fig.1 the cross shaped market with the different heights by https:\/\/www.christinabeach.gr\/municipal-market-of-chania

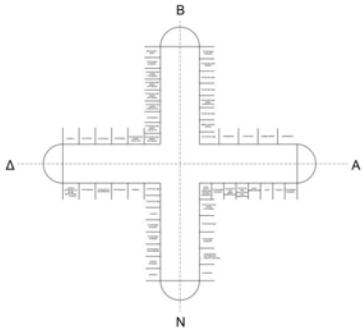


Figure 2
fig. 2 the plan, elaborated by the authors)

In the beginning, the eastern and western part accommodated the butcher shops, the western the fish market, while the rest were housed on the north and south wing. Today it houses in total of 76 shops, such as grocery shops, bakeries, meat, fish, cheese stores

while many of them sell the local Cretan herbs. There is also a pharmacy and some restaurants and cafes frequented by the locals during the day. In this way the two crosses, although parallel and attached, mix with people flows. Seating areas in different places as well as stop areas make this mixture smoother and enhance the perception of events (Tschumi B, 2005) to the user.

Furthermore, the building was mainly built by cement, brick, blended with steel construction on its cover. Its southern facade is made entirely of the carved pyrite while many materials from the old fortress were recycled. The facade design includes renaissance elements while the entrances and main openings are all of curved forms. The two different heights add more lighting in the interior of the building as the upper part is all made by steel and glass while the lower part consists of a series of windows all illuminating the interior of the space. Additional technical lighting illuminates each shop, showing the marketing tendencies of the local traders.

During the visit to the monument, different data were empirically observed: users are of three categories, locals that visit the market for commercial reasons, tourists and locals that use it more social reasons. The first category creates an intense flow in the main corridors of the building with additional stops in the facades of the local products. They are characterized by the velocity in their moves and the familiarity with local buyers. This first category interacts with the building only to buy / trade products and therefore the architecture quality seems indifferent. The second category, tourists seem to have similar experience although their attention is focused on the touristic shops as well. They might document architectural elements of the building and create larger densities in the three main points of the building (entrance, main corridor, and exit). The last category ignores the shops and is oriented to the social activity areas (coffees etc). These create bigger densities in the seating areas. In the first case, the materiality of the monument and its historical essence is highlighted by the commercial practices of the users. In the second case, these elements are part of a three-dimensional setting that uses the different depths of the building perspectives to line up with its flows. In the third case, the overall atmosphere smells and experience explain the reason for being there revealing the cultural importance of the building. These instances, all refer to a subconscious awareness of the physical and material consistency of the building, although there is no real material revival of the actual importance of the building. This phenomenon reveals the importance of creating a project/intervention that could transmit the real values of the building to the past and future.

The scale of the surroundings

Today the agora's connection with the surrounding compounds is also different compared to its past instances. While previously, it was constructed as an urban entity attached to others, creating a cluster dedicated to commerce, etc., today a visitor cannot easily perceive its continuity but rather its spatial differentiation.

In fact, in the past the demolition of boundaries with the fortress and the conciliation with the modern city was immediate. The streets connecting the new districts where the bourgeoisie mainly inhabited, such as the Courts, Halepa and Nea Chora, as well as the road from the Perivolia to the great metochia, all started and ended up in the Agora, something that is still obvious. At the time of its construction, the city council proceeded to a number of other projects such as internal tiling, construction of a shed, construction of reticulated cages in butchers and marble tables in fish farms as well as for the construction of gutters. For this reason, the spaces around the Agora were formed appropriately so as to create adequate urban voids. The Market lately is tree-planted, a square and a parking spot are opened, the stables were set, the glass panes are painted with olive-colored white so that the sun does not come in and spoil the products.

Today, the perimeter walls of the agora although they remain in conserved conditions, and the ad-

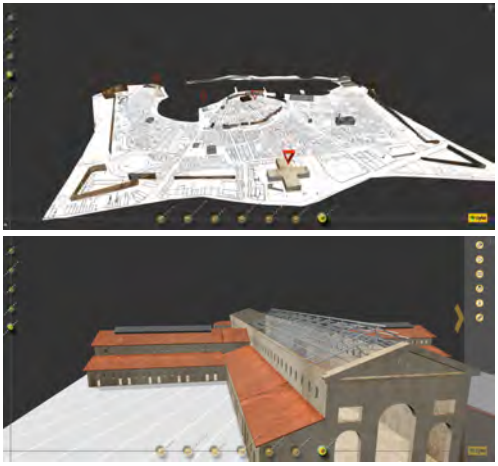
Figure 3
fig. 3 Crete 3D - The macroscale of the monument

Figure 4
fig. 4 Crete3D - The microscale of the monument

ditional projects of the exterior spaces create a friendlier environment, however, the nonpermeable perimetrical walls and the less dense environment outside of these spots reveal the tendency of the architect to guide the accessibility areas. In these specific parts, all cars are parked while at the main entrance all social life is gathered. The multiplication of the ground designed through the various staircases offers to the visitor an idea of monumentality as they augment the overall height. This allows the user to identify the actual dimension of the building, the boundaries, and the scale. Some of the previous functions in relation to the rest of the perimeter walls are left to their biggest part to the users' imagination. A new portico is created in the north entrance creating a covered pre-entrance meeting place and reinforcing the building.

The digital layer of the monument

The authors used Crete3D to apply the new digital layer on the physical space of the monument was. A group of fifteen(15) users selected for the research experiment explored Crete3D as a user-friendly tool that offers a comprehensive view of the wealth of Crete's cultural heritage and its evolution in time (Parthenios et al. 2014). The people that participated were advised by the research team to feel as flâneurs, or in other words, to act like people that are subject to the stimulating influence of the urban environment (La Rocca, 2017). Urban users are not urban experts but have a piece of very specific knowledge about their place. The scope of the experiment was to record any human interaction with the building, being commercial, architectural or simply observational. Users were given access to the platform just before entering the building and were navigated to the different scales, from the macro-scale of Crete to the microscale of the Agora roof and facade detail (Fig. 3,4).



Each user was allowed to navigate through the platform without any time restriction. Most users explored the monument scales and concentrated to the architectural details visualized at the 'monument' scale of the Y-axis. Almost 60% of the users entered the pop-up menu and browsed the information section, where historical data were briefly explained. A small percentage of users chose to explore more monuments of the platform and quickly scroll at other Cretan regions and cities.

Tracking users within the hybrid space

Following the Crete3D navigation, both user groups initiated their visit in the monument and were advised by the research team to circulate freely within the building and interact loosely with the surrounding elements. All circulations were being recorded through IndoorAtlas application, an Indoor Positioning Platform which is currently in beta version. IndoorAtlas is a platform that uses the magnetometer, accelerometer, and barometer of the smartphone to track the geomagnetic coordinates of the smartphone. The alignment of the IPS geomagnetic coordinates with the GPS coordinates is implemented manually through the mapping. 'The mapping process requires the digital juxtaposition of the two-dimensional drawing with the global coordinates'

(Parthenios et al. 2018). In this case, the mapping had been conducted by the research team prior to the experiment.

Users were briefly apprised of the importance of location accuracy during their walk within the building. Once location tracking starts, the signal radius accuracy varies between 10 - 20 meters. A couple of minutes after circulating within the building, the accuracy level increases up to 1-2 meters. Taking this constraint into consideration, users were asked to record their movement after having walked a few minutes to ensure maximum location precision (Fig 5). On their way out of the building, users were asked to fill up questionnaires with questions related to their experience.

Figure 5
fig. 5 User real-time location tracking statistics.

The first layer of analysis consisted of the observation and comparison of the group's flows and waypoints. All users visited the four ends of the cruciform-shaped building. The majority turned left when arrived at the center of the building and spent most of the time at the central, northern and eastern parts of the building. This specific repetitive pattern of movement is probably attributed to the fact that the western part hosts fisheries and butcher's shops with unpleasant smells as well as to the fact that the visit took place around 11.30 am, so the eastern part of the building had optimal lighting.

The most interesting part is the user movement pattern comparison among the users with (Fig.6) and without (Fig.7) previous knowledge on the building through Crete3D platform. At a macro scale, ICT users remained longer within the building and passed through the center of the building more times in proportion to their overall time spent into the building. At a micro scale, ICT users followed straight paths and made fewer stops at the four edges of the building, while non-ICT users made more stops at the commercial points thus following a curved path.

In terms of subjective data extracted from the questionnaires, ICT users rated their experience within the monument higher than the non-ICT users. Another interesting point is that ICT users claimed that their waypoints within the building were made in order to observe the building, while non-ICT users answered that their waypoints were associated with regaining control of their orientation as well as visiting touristic shops (Fig.8). Moreover, when asked to describe the best part of their experience, almost all of them described the moment of re-discovering in the physical space, parts of the roof, the axes and the facade, that had been analyzed within Crete3D platform on a digital level. On the contrary, when asked to describe the worst part of their experience, the majority of ICT and non-ICT users agreed on the smells and lack of lighting and ventilation that restrained their experience.

Figure 6
fig. 6 User movement pattern - non ICT users

Figure 7
fig. 7 User movement pattern - ICT users

Figure 8
fig. 8 Chart showing the reasons of user waypoints within the building

CONCLUSIONS

The past research has focused largely on the benefits of IoT to health and structural monitoring of monuments and little is known about the user-monument interaction (Addabbo T. et al., 2019). In fact, a number of important observations were extrapolated by this experiment. With the internet and digital media support, the laboratory managed to build a creative container of architectural information that was impossible to be found anywhere else. In fact, effective visual knowledge rendering aimed at replacing other means of knowledge rendering, in particular textual. The statistics and play-back videos of the user movement also provide visual material to support the animated and interactive analysis.

Furthermore, it was observed that the new digital layer of the market stands as a display in its own right, almost replacing the historical role of the sequence of objects in exhibition making. It offers meaning, not only as interpretive aid of the generic whole but also as possible knowledge scenarios that are enacted inside and sometimes outside of the museum walls. Through the different platforms and applications, the digital layer respects the traditional museum practices and often disseminates stories and narratives that otherwise would be impossible to acquire. As a result, it seems that it plays a structural role in the production of new meaningful experiences, produced through the interaction of viewers with the installations and their effect on the interpretation of traditional object-based displays. At the same time, the digital platforms and layers allow us not only to create personalized stories and narrations but also to start applying the relevancy model (Tsitsipa, et al 2018). The platform enables visitors/users to live personalized experiences and accomplish their expectations within the monumental space. The digital layer becomes the connector of the flow of the information across various platforms and media (digital or not) as well as the vehicle to describe the context of each user of the museum based on various data sources and lakes. The acquired data could be a generator of the feedback loop, an iterative mechanism that typically offers ways to personalize, optimize, improve or automate services that use an underlying source of data (Girardin, Lathia 2017).

The third is the elaboration of the various layers of information and the establishment and definition of the term virtual cultural heritage, in a specific place. It was suggested that there are three outcomes regarding the definition of cultural heritage there: the first refers to the replicated models, the second to the new cultural social practices that are structured by the data extraction, and the third the new culture which is born.

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