

Environmental Interiorities: Design through real-time data collection and analysis

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Abstract

This paper gathers most of the authors' academic activity over the last two years on smart systems and open innovation and examines ICT as this 'other place' that 'mirrors' the 'human spatiality' (Foucault, 1986). It has the objective of proving that ICT can be an object for theoretical speculation in architecture, when juxtaposing studies for the physical space, behavior patterns and real time data. The architect in this way becomes an intermediate to social, spatial and technological collaborations. By establishing a set of user-oriented methods and data-driven scenarios, the team intends to reinvent the role of the architects in the field of user behavior. Following this aim, the team presents the Hotel Innovative platform concept that aims at reducing energy consumption through predicting and transforming user behavioral patterns. Our desire is to study, design and assess synergies for smarter spaces, architecture and technologies, by constructing techniques for better space performance.

Keywords: real-time data; design strategies; smart city; environmental parameters; user-driven methods.

1. INTRODUCTION

...the total shift to an economy based on knowledge and the simultaneous transformation of cities towards "learning environments" (the innovation environments), represent the strategic instruments for economic growth, human development and environmental equilibrium, affecting both the national and international economy, and the theoretical concepts of simulation and expansion. Komninos, 2002

The close ties with innovation and knowledge's critical stance towards the discourse on architecture and the city, have generated an amount of relevant city paradigms (Komninos, 2015). The smart city is one of them and is constructed by top down or bottom up 'educational' processes that act as the strategic device to change modern urban production factors (Komninos, 2015). This strategy is shaped by the forces of knowledge, creation and diffusion and expresses how knowledge resources, such as 'expertise', or 'know how' emerge with the use of 'intellectual capabilities'. (Drucker, 1969). Smart city, therefore, is not simply the vision of a system of information and knowledge transfer that is capable of overcoming the spatial dimension by use of new technologies. It is rather the idea that "access to information should not be understood and then designed as limited to the performance of a purposely designed educational place, but should be exploded, dissolved and dispersed" (Castells M, 1989).

The latest technological advancement in this goal is the creation of digital or spatial augmented reality technologies, able to reproduce in real time information and offer them to users. Among the

many sectors where these concepts are used, hospitality has gained presence for the ability of these technologies to interconnect managerial objectives and visitors and allow corporations to formulate possible space configurations that can respond to low energy consumption. Beyond the field of sustainability, spatial virtual reality concept describes a rather multidisciplinary context. It celebrates the physical and material consistency of a place with its typological and aesthetic dimension, enhances this conflict between hard infrastructure and contemporary energy challenges and imposes an innovation of methods and tools for a better environmental behaviour. It invokes users to recognition and interpretation of what constitutes a participation to a “higher objective” as if it is their own personal contribution to a better space.

Following this trend, this paper offers a combined examination from two perspectives – architecture and the integration of Information and Communication Technologies (ICT) in space and the way this process enables changes in social practices. To allow the two approaches to cooperate, this study analyzes the case of applying new sensing technologies for energy impact measurement in the case of the hospitality sector, and examines the role of the architect in such endeavor. The study is the result of the ‘Eco Motivate concept’, launched by Anna Karagianni in May 2015 at the e-nnovation business and further expanded to a business proposal by Yiannis Rogan and Nikos Bakker, which has gained mention competition¹ final round , as a proof of its impact.

For both fields the case introduces a series of issues of interest. On the one hand, it shows the spatial survey that new technologies require in diverse settings, and on the other hand, it hints at the changes in social behavior that the presence of ICT in these spaces would bring about. Latent under this integration of space and ICT, there are user - driven actions, and human interaction with artificial intelligence. The combination of these two factors, aim at highlighting the emergency in talking about the changing patterns of our field, the future involvement of architecture in the discourse about the smart city and introduce a new methodology on working with the environmental footprint in the hotel’s sector.

The expected result of the analysis is to build a line of reasoning on how the study of the two interconnected layers (architecture and ICT), can be set as priority in the commercialization of a smart city strategy, and are of equal importance. Specifically this analysis aims at opening up a typological discourse in the interaction between users and new technologies, allowing the fundamental role of architecture to emerge. It also highlights the role of the actor (ICT/data) as a determinant factor in the perception of the new spaces, specifying the role of the “active participant” (user) (Saskia Sassen, 2011) as a testing tool for the successful function of a project for reducing energy consumption in the hospitality sector. It brings in the table the way the smart city seems to offer a possibility of discussing about space and how the architect would offer and advanced ideas for sustainability and regeneration, bridging the gap among the social, economic, cultural, and physical understanding of ICT (Geropanta V, Cornelio Mari E.,2014).

2. MATERIALS AND METHODS

For this paper, we chose an empirical analysis methodology as juxtaposed with literature review in the case of its application in a hotel. The Innovative Platform project was shared between the team members, and a detailed description of the action was written. **From this description, we created a three-action analysis scenario: the first, based on a survey-driven analysis; the second, based**

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(https://www.tuc.gr/index.php?id=2786&&cHash=f4a325caa29c76d06855328a073d7bda&tx_ttnews%5Btt_news%5D=13092)

on data-driven analysis and the third, based on proposed connective technologies and motivation activities that can affect user's behavior. Each of these three scenarios was correlated to each other: empirical examination on how physical, human and hotel recourses bring high-energy consumptions, user data collection and mining for testing new potentialities, and digitalized outsourced technologies for the built and the social environment. From these scenarios came the observations developed in the analysis, which were later framed within existing theories in the fields of architecture, communication and smart cities.

The noticeable gap between the applicable technological strategies and the existing spatial reality frames the first part of our research. Explorations related to the way this possible linkage can be realized or envision possibilities in terms of spatial decisions, have led us to choose the Hotel Innovative Platform concept. This concept presents how we can reduce energy consumption in the case of the hospitality sector by motivating users in consuming less during their stay inside the hotel facilities. The basic objective of the proposal is that sensing technologies will be applied in specific places in the hotel, and through an application owned by the same entity; users will be able to interact with ICT and therefore attribute to the overall goal of saving energy. At the same time, facility managers will be able to track user's energy and intervene when energy consumption levels exceed the average. By being part of the platform, guests not only gain access to the real-time visualization of their behavioral patterns, but also enter into a pool of rewards that are offered to them when they reach low consumption levels.

2.1 SPACE IN THE VISION OF ENERGY CONSUMPTION

The intersection of space with the ICT concept in the field of sustainability is not a new field. However, the spaces that have been investigated so far in this framework, are mostly residential or office buildings (Tuan Ahn Nguyen, Marco Aiello, 'Energy Intelligent Buildings based on user activity'). The prediction of user behavior in the field of hospitality is a field that has not been yet explored despite the fact that hotels intensely integrate many functions and activities of different people. Getting a big sample in less time is the most effective tool to predict human behavior and construct mobility patterns and behavioral models.

Our team agreed with the hotel manager to conduct a survey to one of the Group hotels in Rethymno, Crete, Greece. We visualized this hypothetical scenario as part of an architectural R&D project, and conducted discussions with the main executive managers assigned to building management and environmental footprint reduction. During this specific survey, the first step was to create the layout of the hotel, dividing it by type of user. Facility spaces were grouped together, public spaces such as reception, pool, bars and cafes formed the second group, hotel rooms were the third group and detached luxury suites formed the fourth group. We roughly calculated all data extracted from the spaces where energy consumption is not directly related to user behaviour (mainly facility spaces such as kitchen, laundry room etc.) and we proceeded in choosing and identifying the most adequate spaces for such an endeavor. By this identification, we made a list of the most popular spaces for users such as the reception, the dining room, the hotel rooms and the detached suites and decided empirically to draw their differences in terms of dimensions, height, electrical and water consumption.

Although ICT is established within all areas of interest, its impact is fundamental since it totally transforms the perception of the places when the users are inserted in the data mining process. This catalytic presence of ICT and the way it sets a number of interrelated activities reveals the necessity of our field for parametrizing space, and offering spatial methodologies that facilitate the interaction

between user and ICT. These include scale, context, method and the piecing together of different ideas and approaches both spatial and theoretical as to implement a spatial strategy able to fulfill the desirable linkage.



LAUNDRY SPACE



BOILER SPACE

After a number of design documentation, we proceed in a flow, movement, geometrical diagram to reveal the latent connection between hard and soft infrastructure and energy consumption, elements that add to an energy reduction (physical light, shadowing, temperature, materials) and understood that the results of the documentation are exclusive and specific for each typology, and therefore require a narrowing down of the survey to each spatial module differently. This helped us create a methodology plan for the work with space once the sensors are installed.

Specifically, we showed that local spatial form, local type, and social norms, define both performance limits but also positive modifiers for reduction of energy that outweigh the ability of technology to overcome. That became the first prerequisite for the establishment of the development approach.

2.2 DATA AS A DEFINITIVE ACTOR

ICT offer to humans the ability to capture and transfer real time data towards different directions. Each human activity (work, living, leisure) is connected and measured through installed sensors, and the data cloud allows the possibility for this connection to be visualized and transferred towards both users but also hotel managers. To understand this connection we observe the existence of: a) visualized data, b) the space working as a layer where the users can extract and insert data, c) the space that hosts the required technologies. Important role in the juxtaposition of the three conditions

is the existence of a user who on the one hand experiences the data set, and on the other projects his / hers story onto a data set. Therefore, the user becomes the core participant in that outcome.

We chose to work with electricity Wi-Fi sensors, as well as sensors that relate energy leak detectors. Among these also water leaks, electricity and temperature. The sensors have the ability to work in a 360 degrees of information extraction, both spatial but also focused on the user.



ELECTRICITY WI-FI SENSOR



SMART WATER-LEAK DETECTOR

This means that at the core of this discourse is located the data itself. The data does not reveal the possibilities of interaction, and thus does not create new architectural stories without the permission of the participant. However, it allows the user to have access to a larger sea of information, than previously possible. They eliminate space in terms of square meters, but they enrich/ facilitate social activities and services in existing space. In architectural terms they shift the attention from the form and shape of the design of spaces, to the strategy of how the cloud can be used more efficiently. In other words, traditional practices of design that used to place the user's needs at the center of the process are now focused on the access and use of the cloud. Hence data is becoming a central actor for architectural attention where the setting is the hotel and knowledge. This data has become knowledge and then shape the alternatives to users. Two are the highlights in this perspective. One reflects in a wider sense on how we can review the places of cooperation, and the second reflects on the mechanisms that make this trajectory work, which derive from the user practices that is at the foundation of this structure.

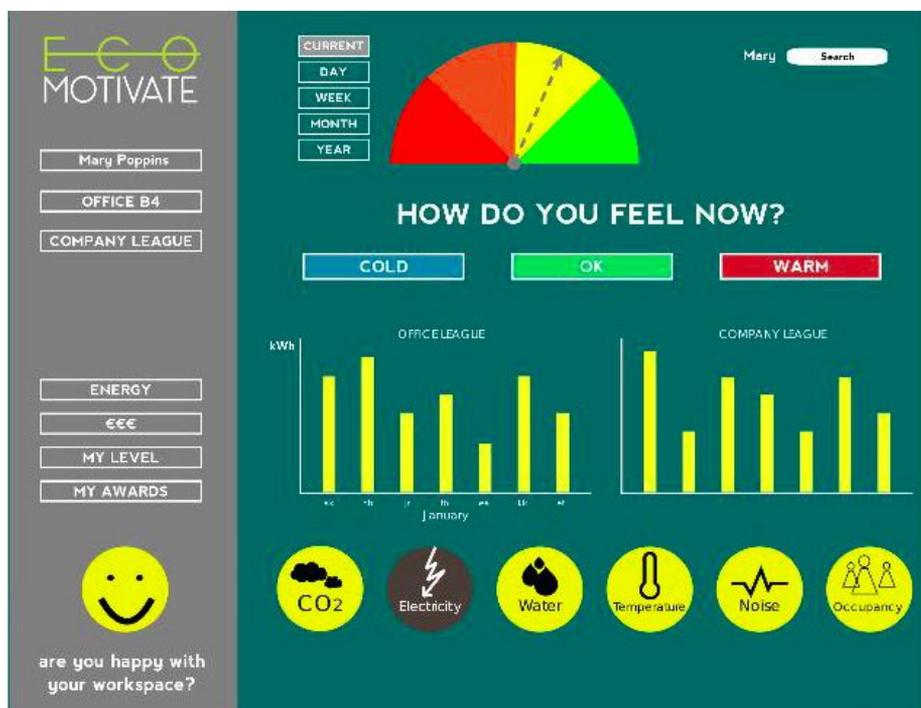
The outcome of process demonstrated that the accuracy of the behavioural model and thus on the redefinition of space through data, depends entirely on the accuracy of the measurements. Data becomes the new 'metrics' of the building. Those data are strongly connected both to information related to the user but also to the performance of the space itself.

2.3 PRACTICES AND ICT – THE USER AS DETERMINANT FACTOR

Aiming to deduct realistic data regarding user behavior and investigate behavioral patterns, the integration of a real-time mechanism in the space under investigation is fundamental.

As a result, we suggest that the platform consists of three interdependent entities: The sensor network, which is placed on key areas of the building and transmits data wirelessly - the data cloud where data is stored, and finally the interface, which the end user will be interacting with.

The decoration along with the typology of the collective space becomes obsolete as a focus during this step. Conversely, people could be everywhere and communicate from everywhere as long as they have access to the network of Internet and apps. This transforms every space with a solid use (e.g. dining) to a multifunctional space (e.g. interaction room). The standards of being clean punctual and according to the hospitality rules would not be related anymore to the images of well-designed hotels, which will be a process of disembodiment. A new entity is born every time by the way users interact with the digital layer. This crossing of uses is not new, but what is new is the elimination of time and access to information that changes the spatial perspective.



EcoMOTIVATE INTERFACE

The innovation of the application is based on two principle differences in comparison to existing applications and technologies. On the one hand, visualization in real time, a feature that will enable the end user to have a direct feedback on the relationship between the behavior and corresponding power consumption thus allowing to compare their consumption with the average of all people residing in the hotel unit under the same circumstances. On the other hand, it will give the possibility to measure the energy consumption on an individual level and motivate the end user through the platform by the means of a rewarding system, which is planned to be soon integrated into the platform based on the investigated behavioral patterns.

RESULTS AND DISCUSSION

As anticipated, our survey demonstrated that energy is not equally consumed in different areas of the building.

It was also proved that energy consumption levels depend fundamentally on the shell and the mechanical systems of the building. This substantiates our intention to focus the research on hotel rooms and suites where users can drastically alter the consumption through behavioral change.

Moreover, our approach would lend itself well for use by a wide range of buildings dedicated to the hospitality sector. In that case, it seems inevitable that the platform can be commercialized without parameterizing a number of factors that differ from one building to the other, such as facility spaces, hotel rooms, public spaces, as an enormous effort to remap each hotel would be needed in that case.

It also presented a new use of the existing physical space, which is transformed into projection modes (tablet, cell phone) where information flows as extracted through the collaboration of users, data, space. Therefore, this new interwoven space has the characteristic of being created under the

use of a physical space (like a corridor or window) and a projection layer. For instance, when the users arrive a list of micro sensors and technologies that sense their presence they delimitate an area to offer the service that will be mostly adequate to their needs. For the architects this will require a consideration of these elements along with the future projection through the app. This marks a transition. Before, the space could act as an intermediate area between two actions; now it reacts to the arrival of the user and it changes visually by allowing the actor to interact in the digital platform.

4. CONCLUSIONS

The concept of bringing architecture in the core of the discussion for the project of reducing energy on a user-based data mining has set the background of this interdisciplinary research. Under this spectrum, a set of conclusions opened up a discourse that can have repercussions at the practical and theoretical level.

In this study, the role of the architect can be defined as acquiring the following values:

- 1) Applying ICT and expecting users to interact requires a definition in scale, and material limitations, that can be highlighted by the architect for creating the survey part;
- 2) the space of the network, the space between the user and the devices, the new collective space born by the interaction of the user with ICT, the projection of data on the traditional spaces are part of the parametrical organization of the architect.
- 3) The space in the smart ecosystem is also a reactive environment where the user interacts with the sensors and with the network as an actor embodying artificial intelligence.

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