Interdisciplinary Methodology for rethinking the urban layout via Multi Criteria analysis and indicator application

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Abstract: Since the 1990s, due to exponential urbanization, the approach of urban and landscape architecture has been facing new challenges and as a result has been changing rapidly. The ever progressing development of contemporary metropolises has led to a rethinking of the structural composition of human settlements. These days the focus is no longer only on meeting the needs of expanding cities, but finding a suitable method to govern the transformations of existing structures. This paper aims to renew the idea of contemporary city spaces, considering also the requalification of existing urban infrastructure. The main focus of this research is a future configuration of urban infrastructure in twenty years from now, when urban mobility will have developed and be much more sustainable. For this purpose, a range of indicators will be used on the economic, functional and social level that can direct the regeneration of such structures by proposing them in a defined urban morphology and a – depending on those surroundings - flexible system of values. The intention of this interdisciplinary group's collaboration is to develop a multi-criteria method to support the design process of said urban layouts. Following the analysis of urban structure data collected from an area in question, qualitative and quantitative indicators will be identified through a series of strategies. They will then be subdivided by macro-topics such as environment, economy and social life, which serve as main "pillars" of the system. Due to its key role in urban infrastructure, the mobility macro topic intersects the other pillars and will be the main topic of our research. By way of balancing the four macro-topic variables, three different solutions will emerge: a solution of equilibrium, a naturalistic solution and a metabolic solution. A reality based exemplary case study will explain the process as a whole, emphasizing the individual steps.

Keywords: Methodology; analysis; indicators; green technologies;

1. Introduction

Contemporary cities are complex systems in which society, economy and environment interact. As an organism today's city responds to the unstable condition of its components and its process of 'metropolisation' is becoming unhealthy and unsustainable. Citizens are not identifying themselves anymore with the urban and natural spaces they live in. That process has disrupted the city as a place

of living, segmenting it with fences, restricting the collective life, further compromising the environmental balance, without offering suitable places to encourage the inclusion of citizens within their own city, moving towards an society of individuals, devoid of cultural identities and collective memories, moving towards a social implosion in the private space that discredits the urban public spaces. The paper aims to explore how urban planning and architecture can contribute to promote public health and well-being via the improvement of public and cultural urban spaces.

Barcelona has promoted an urban research about re-thinking the main infrastructure of the city: how will “the ring” of Barcelona present itself in twenty years? In October 2018, Barcelona CTPA, an association composed of professors and students from six Catalan architectural schools (ETSAB, ETSAV, La Salle, IAAC, ETSA Reus and the UIC Barcelona School of Architecture) and further international university institutes, organized a hackaton for rethinking the Barcelona city's ring highway as an urban public space. With the support of municipality and region of Barcelona, the event, “Des-cobrir Les Rondes”, has involved multidisciplinary skills, in a multi-level approach: citizens, urban planners, architects, designers, professors, students, administration etc.

2. Urban analysis

To achieve a working sustainable urban model, an integrated process has to be followed. New structural and operating references have to be devised to accompany the transformation of a complex urban system. Biosphere and ecosphere must coexist. The vision on future urban development combines environmental, socioeconomic and morphological points of view. In today’s scientific debate Urban transformations replace Urban expansions (Campos Venuti and Oliva, 1993). The analytical approach of urbanism is becoming the re-thinking of pre-existence structures of cities: places of identity for citizens, places of environmental mitigation, places of social and economic development, a creation of new relations between all these different factors (Ricci, 2005).

2.1 “streets” as structural urban component

The case of “Des-cobrir Les Rondes” was an opportunity to develop this new kind of approach: the integration of the infrastructure’s life cycle in the ever changing city life. With this initiative, Barcelona joins the reflection on the future of circular highways that have already been developed by other cities such as Paris and Amsterdam. The case of the Ronda in Barcelona, a fast-flowing road ring that is a nodal element of urban mobility, represented an opportunity for an in-depth reflection on integrated interventions. These roads are being questioned as they no longer solve the problem of traffic congestion due to their inability to absorb the traffic in the central area. They have been designed exclusively for private vehicles and not for public transport. In the modern and contemporary architectural debate, the role of the street has always been of a central importance. This is observed in the work of architects from Cerdà, Berlague, Garnier, Stubben, Unwin, Le Corbusier, Lynch, Kan up to Leon Krier, Bohigas and Koolas (Rykwert, 1982). This urban component is referring to different meanings. Streets can be the definition of margins or the places of connections. They can metaphorically represent the inner relationships of today’s society or places of disconnection. Streets can be green boulevard as well as places of pollution, networks or borders. The street itself is a structural component of the city which deserves a discussion for its characteristic of being a place of oppositions.

3. The hackaton as a tool of urban exploration

At 37 km in length, the hackaton path of “Des-cobrir Les Rondes” was structured with various stops in different parts of the Barcelona highway, where the participants tried to reflect, discuss, and

propose new visions for this infrastructure. The ring highway crosses many districts of Barcelona of different social status, urban structure, and orography (the Catalan capital rises on a plain inserted between the Mediterranean Sea and a mountain system to the north and it is bordered by two rivers laterally). The different stages have seen the design intervention of different university teams in order to propose interventions for different parts.

The area of Les Roquetes, a suburb north-east of the Catalan city, offered the UIC team and the researchers of Sapienza University of Rome a field of reflection on the requalification of the contextual infrastructure. The selected area has been chosen to focus the analysis on a particular road Ring section of Barcelona: its intersection with one of the main roads, Carrer Julia, which divides the area in four different neighborhoods. The urban analysis of the ring's path was articulated in three different phases. The first step was to recognize the different functions in the area, services and residential tissues, and above all the abandoned and interstitial area, taking care of morphological urban dimension. The second step was to analyze the connection between the most relevant services and public areas, such as the neighborhood market or the public green areas. To understand their area of influence two circles were drawn, according to the historical dimensions of the Cerda's urban square matrix, 100 meters from one another, highlighting the socio-economic dimension. The mobility system was analyzed along with this phase identifying Passeig Valldaura as a structural element of the area: being parallel to the Ring, it intersects Carrer Julia and the main road Avingua Meridiana. The third step was the analysis of the environmental system: the orography, the hydrography, the agricultural surroundings areas as well as public and private green areas.

The urban analysis aims at building quality and quantity assessments in order to evaluate the students 'projects according to specific and scientific indicators. From the student's researches two main approaches have been outlined: the metabolistic and naturalistic one.

4. Metabolistic Approach

The Hackaton Des-cobrir Les Rondes aims to re-think the ring infrastructure as a driver of sustainable urban development to enhance social, economic and ecological resources. The purpose of the future vision about "Las Rondas" is to get to the concept of sustainability as defined in the Burtland report (WCDE, 1987) "A sustainable development meets the needs of the present generations without compromising the possibility to satisfy the futures one's". The Metabolist method reads the city as a natural and complex organism. The critical development which affects the environmental ecosystem has to be stopped. The Urban Metabolism has to solve "un-sustainable settlement processes" (Tiezzi et al., 2007). Contemporary cities represent a fundamental change in human settlement patterns and entail a dramatic transformation of the physical environment (Hosier, 1993). Cities and metropolitan areas, occupying the 2% of world's land surface, use over three-quarters of world's resources and discharge similar amounts of wastes to the environment (Baccini, 1997; Barles, 2010; Giradet, 1996).

The hypertrophy (Carta, 2015) of urban development clashes today with an economic and environmental crisis that requires a development of new paradigms. Reading the city as a living organism is the base of urban metabolism proposes, a complex system within which ecosphere and biosphere interact. "Metabolism", according to its medical meaning, is the phenomena of chemical transformations that take place in cells of eukaryotic and prokaryotic organisms in a coordinated and finalized way, to which many enzymes and intracellular multi-enzymatic systems cooperate. Metabolism's main functions are: to obtain chemical energy from the degradation of nutrients rich in energy, from the environment or from solar energy; to convert nutrient molecules into the basic precursors of cellular macromolecules; to form proteins, nucleic acids, lipids, polysaccharides and other substances using these basic precursors; to form and to degrade biomolecules necessary for specialized cell functions (Treccani). The abstraction from the medical comprehension of the phenomenon applied to the urban and metropolitan transformations identifies proactive strategies as main functions: to produce the energy and materials necessary for the demand of urban life through the use of biotic and abiotic resources (Longhi, 2016) existing within territorial system; to regenerate

through the conversion of places and infrastructures into areas of production of goods and services designed to ensure the biodiversity of the urban system; to recycle "technical nutrients" by inserting them into the urban production cycle since the waste by disposal or by use; to reduce waste elements, polluting gas emissions, introducing the concept of circular economy and short supply chain, thanks to the position and strategic distribution of different urban functions.

A system afflicted by a pathology of urban blight, strictly connected to the chronic demographic increase, is a system destined to extinction. The responsibility to define a strategic vision, able to use resources to produce the energy needed to generate and regenerate itself, is the new paradigm that we are now required to follow. The "slow" metabolism of contemporary cities, capable of assimilating and producing energy through a huge environmental impact, is ending resources without providing for their renewal: “every aspect of urban life weighs heavily on the planet's overall biological balance” (Ricci, 2013). The new metabolic paradigm proposes proactive policies to generate new opportunities related to the quality of urban life. The main actions are therefore that of reducing the environmental impact, the production of green energy, the production and maintenance of biodiversity through the increase of services, products, protected areas, urban food production. The purpose of urban metabolism is to anticipate unwanted events based on present signals, analysing the directions of the various flows of energy, water, nutrients, materials, waste, and quantifies the entrances, exits and parts stored in urban regions. In the early 1970s, the analysis of material flows through urban ecosystems was also promoted by UNESCO, with a program (Man and Biosphere, MAB) aimed at studying natural and social processes in an integrated way (Unesco, 2010). A very well-known index is the ecological footprint (Wackernagel and Rees, 1996) which measures environmental pressures determined by anthropic systems, expressing the "quantity of nature" necessary to support the metabolism of people, cities, regions, nations or anthropogenic systems (Cagnoli, 2017).

5. Naturalistic approach

The features assumed by the design of green spaces in the contemporary city, are the architectural-cultural products of past eras, where modernity and post-modernity have left strong residuals in a framework of unconnected and divergent approaches. Nowadays, with the affirmation of the new values of green in ecological culture, it is necessary to shift the focus of attention from the individuality of the 'interventions' of environmental requalification, to the overall picture of the different natural systems as a synthesis of physical and formal representation of places (WU, 2014). Linking green infrastructures to the other infrastructures of public space (blue and grey), means that they can either overlap, generating tree-lined avenues or green castings, or determine nodes of connection among different public spaces (for example a complementing pattern of green, blue and grey textures in public space).

The main goal is to develop a "green system" that structures the landscape from morphological and functional point of view. To realize such green system as a natural network, it is fundamental "to guarantee the coherence of the regional open space system" for each element of the system (green plots, green belt, rural crown, green band), some intervention strategies (Sdrif, 2013). The common denominator of all strategies, is constituted by the reticular ridges of the urban infrastructures (the threads that make up the great rope of infrastructures). The infrastructural lines can become, in fact, the great public spaces of the future as dynamic elements, fundamental for the city, whose ductility is necessary to the urban system. With this in mind, a new perspective on infrastructures is fundamental; current uses give them an important value: they are accumulation basins where human traces and collective memories are stratified over time; it is the city's facilities that need to be integrated into a new urban concept, rather than being judged to be inadequate to the city. Hence the idea of exploiting the green (naturalistic system), blue (water system) and grey (street system) infrastructures as tools at the basis of green planning. Compared to traditional infrastructures (grey infrastructures) conceived with a single purpose, green infrastructures have many advantages (Yeang, 2009).The use of green infrastructure can provide social, economic and environmental benefits, such as the absorption of excess water caused by heavy rains and the reduction of floods, the mitigation of the phenomenon of

heat islands in urban areas, energy savings, the creation of spaces and habitats for wild flora and fauna, and the spread of places for outdoor relaxation with consequent improvement of health and well-being of citizens (Suškevičs *et al.*,2017).

6. Matrix creation process

This paper highlights the naturalistic approach in line with Landscape's values to guide the urban transformations.

a. Pillars

The latest city planning approaches to urban analysis recognizes three main pillars for identify the opportunities and vulnerabilities of urban areas. This is according to the sustainable development goals announced by the Urban Agenda of the European Commission (Urban Agenda, 2016): Environmental System, Social System and Economic System. Far off from a standard urban analysis, the methodological approach puts into effect a complex procedure of investigation, with the purpose of formulating a general rule that could be valid for different cases. The method follows four different steps: the first step is to observe each individual system using quantity data on the existing conditions; the second is creating different assessment ranks belonging to each type of pillar; the third is to choose two evaluation assessments suitable and common to all the three main pillars; the final step defines these steps, rules and guidelines regarding the "where" and "how" to develop urban projects must be established. This translates into a set of coherent operations aimed at enhancing the green spaces and together with the redevelopment of the landscape, promote the public space (streets, squares, parks, gardens), improve circulation and accessibility between newer neighbourhoods, and ensure the continuity of agricultural land (Spens, 2003).

b. Indicators

In order to create the "Naturalista" matrix, it must be made clear witch aspects of nature the term is actually referring to in this context. Due to centuries of cultivation and exploitation, there is almost no area in Europe untouched by civilization (Assunto, 1994) and more importantly the fact that the site in question is an important inner-city area, the possibility of "returning" to nature, even a renaturation (Clemént, 1991) - in the sense of it being recaptured by nature - is out of the question. However, answering this question is of major importance for the function of the developed matrix.

The analysis-based objectives have to be described precisely, in order to have a clear mapping of the resulting strategic "tools", which might comprise very physical i.e. technological solutions as well as more process oriented or social courses of action. Wherever possible, the question or task itself should be formulated independently of already known solution strategies, which is one reason that makes interdisciplinary working groups so valuable (Lehmann, 2010). The possibility of seeing the same objective from different professional perspectives qualifies the immediate search for a solution. For a collection of possible strategies in the field of "nature" that can respond to corresponding indicators from the analyses, first of all the above-mentioned question of the kind of nature and thus also its significance for the future development of the city has to be discussed. This represents one of differences of the method presented to others already in use: Having determined – via the urban analysis - the need for green space and the rededication of an available urban space as a possibility, the solution found by the different professionals can be very divers and give way to a innovative creation influenced by all participants. As an answer, there might not be only the obvious solution of a city park as a recreational area. In thinking that way it might be possible to create (even possibly required) free green space, but this could at the same time enhance the contrast between city and nature even more. Instead, the implementation of nature and nature-based technologies as part of the citizens daily life could be further developed, maybe even including elements previously unknown or perceived as separate from human life (Austin, 2014). This way, the permanent inclusion of a concept in the development of a society is ensured.

The special element in this case is the combination of the search for a conversion of an existing structure, which in its present use is considered obsolete in the future, into an element or a symbol of something inherent to humans - nature. Another noteworthy fact regarding this aspect is that natural elements have always been a desirable part of the environment of human dwellings (Benton-Short and Short, 2008).

Building physics or ecological aspects such as the improvement of the urban climate through regulation of temperature, retention of rainwater, reduction of noise and particulate matter pollution, or also a possible improvement of the carbon dioxide balance, have already been researched a lot and are still topic of ongoing studies. According to the study “Cities alive: Green building envelope” - performed by Arup in 2016 - covering many of these technical issues (Pauli and Scheuermann, 2013), the “most important” finding is that "green infrastructure, irrespective of where it occurs or how much space it covers, always elicits positive responses from people, because it is an aesthetic asset and an asset perceived as an improvement of the quality of life" (Pauli and Scheuermann, 2017).

c. Assembling the Matrix

Once the importance of integration has been recognized as such, there are a number of ways to bring about the presence of green or nature in the city. In this example, various variants of public and private green spaces, environmental or urban climate influencing elements were included as well as didactic, productive or transport related aspects. Depending on the desired scale or level of detail in planning, these strategies can then be further developed with the help of qualitative as well as quantitative assessment and with the same principle of sequential interdisciplinary analysis. When the strategies found are confronted with actual technologies, the options on new combinations grow, enabling innovation and thinking outside known paths. If desired and for a further deepening of the topic, an optimized and especially adapted use of technological possibilities for the site can be found such as an application of the various variants of roof or facade greenery, rain-, gray- or blackwater management, the countless and currently daily evolving possibilities of urban farming and distribution, or novel modes of mobility solutions, to name just a few.

At the building scale, the “Naturalista” matrix proposes passive bioclimatic solutions for the technological environmental requalification of the existing built heritage: the building system is in harmony with the surrounding environment and tends to use the natural thermodynamic and fluid-dynamic flows; it use the material and immaterial physical forces coming and available from the micro-environment (Tucci, 2006): sun, water, wind.

Among the main solutions that can be considered implementable in the field of energy consumption of the building: the naturally ventilated building envelope, the buffer zone, the solar greenhouse, the bioclimatic hall, the insulating or capturing glasses, green roofs, green facades; in the field of indoor air quality: natural ventilation system, ventilation chimney, indoor greenery; in the field of total water consumption mainly the collecting rainwater system. The proposed solutions are based on analysis related to building orientation / lightning conditions, climate zones, solar / thermal analysis and technological analysis.

7. Data Visualization and information design

Today society, our countries, our cities even our houses can be considered as a data factory that produces a huge pool of information: the ubiquitous information society (Hanna and Peter, 2011). The necessity to show an information, a piece of life, and idea, could be traced back to the petroglyphs during the paleolithic era – this attitude is essential to human behavior. Books, monitors, computers, smartphones and so forth are just the natural evolution of this aim to communicate. In ancient times, information was circumscribed to “finished artefact” – such as books, while today’s interface is often a sort of screen. Every information must be clearly communicated to be useful, using the right tools and visual language. Data design and information design are the key to understand and share a

complex structure of information to the widest possible audience. Understanding the importance of the research developed and described in the previous paragraphs, the data visualization has to be considered from an aesthetic point of view, but most importantly as key to explain archive the research goals.

The entire research process of "Des-cobrir Les Rondes" has been visualized by three different typologies of graphic panels, each of them characterized by specific communication goals.

The 3 macro categories of panels are:

the Methodological Panels

the Approach Panels

the Scenario Panels

Methodological Panels

This category is composed of 3 main panels, each of them focused on a point of view of the main analysis (social life, environmental, economy). The aim of these visualizations is to explain and clarify the logic workflow of the entire research via a structure of the information that allows everybody to understand the methodology of the process.

The composition layout includes 4 banners of contents (named from A to D) linked to each other according to the logic of consequentiality and sense of reading from top to down.

A Banner defines - by tables and graphics – the amount of data, taken from different sources, used to understand the phenomena of the examined topic. It is helpful to take a general overview of the problems emerging from the Rondas.

Fig. 1. A BANNER – analysis of the actual situation

B Banner (see fig. 2), starting from the analyzed data of the context, it shows the qualitative indicators and the relationship with each other, considering the topic analyzed. The graphic pattern use is a flow diagram scheme.

Fig. 2. B BANNER – Indicators

C Banner (see fig. 3) is the section of the panel used to describe the process implementation matrix, by a horizontal graphic development in order to clearly identify the "before and after" comparison defining what are the key points for a reasonable strategy. The different indicators are visualized by a gradient of black shapes.

Fig. 3. C BANNER – Matrix

D Banner (see fig. 4) represents a visual concept scenario using the graphic technique of the axonometric view - admittedly abstract and non-figurative. The three incremental strategy visions displayed are the result of the intersection of the data taken from the analysis and through the application of the matrix. These scenarios represent the extreme perspectives of the topic.

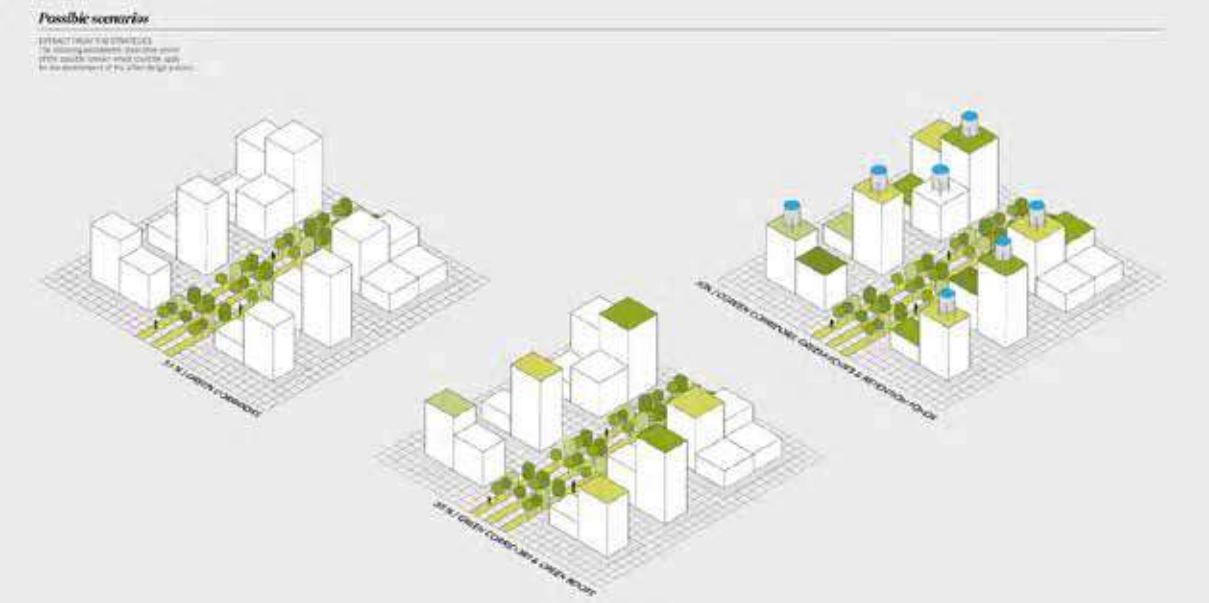

Fig. 4. D BANNER – Scenarios

The Approach Panels

The second category of panels represent two of the possible approach strategies: metabolistic and naturalistic. These data is graphically designed using a flow grid – as seen in the methodological panel – banner B.

The structure allows the identification of the difference between the two strategies and explains the approach and implementation in order to achieve the goals.

Scenarios Panels

The last panel (see fig. 5), is the final combination of the research process carried out by the methodological panels. In this case, the abstract scenarios are upgraded by the "real" data, balancing the topics: environmental, social life, economy.

From an aesthetic point of view, the panel presents three horizontal banners of equal size and kind of contents - described as E banner indistinctly - tracing its origin from the visual style of elaboration of Banner D into the methological panel, and aims to represent a complete reading of the phenomenon analyzed in the research.

Fig. 5. E BANNER – Example of one scenario

Each E Banner describes how – by a non-figurative abstraction point of view – a city could change if the applied strategy focuses more on increasing public and social activities, rather than environmental issues. The data shown remains easily understandable thanks to the use of the same visual language.

Conclusions

The working-method developed was successfully applied in this and should be usable in many other areas due to its generic basis. In any subject of application, an objective analysis of the circumstances is essential, especially for the development of innovative solutions in areas with a large number of influencing factors. The advantage of a interdisciplinary group is evident as soon as the research's results demonstrate new combinations of sustainable visions to remodel urban components. Different

solutions meet the various necessities of the everlasting society's metamorphosis, in a necessary dialog with the hosting landscape. A "strategically obsolete" infrastructure, like the "ring" in this example, can be actively reintegrated into the city body, creating a newly defined urban space. Different scenarios, elaborated through the multi-criteria analysis and qualitative and quantitative indicators, are proof of the potential of this type of component in a strategic urban development. The multidisciplinary team was the cornerstone to create such a number of different solutions.

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