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ID 1585 | DECODING AND MANAGING CITIES: TOWARD A COMPLEX AND DYNAMIC SYSTEM APPROACH

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1 INTRODUCTION

Due to the rapid growth of cities and their social, cultural, economic and technological evolution, the policies and legislative instruments need to adapt to this change. By 2050, United-Nations estimate 6.4 billion people[1] are expected to be living in cities (Riffat et al., 2016), with relevant consequences on resources, emissions and services[2]. In spite of this, the development of Europe"s cities and the relations among them constitute one of the most important driving force for the future of Europe (Rotmans and Van Asselt, 2000).

The complexity of the urban phenomena needs to be investigated in an integrated manner, through the management of the systems and processes making up the city. Indeed, the city is recognised in literature as a complex, open and adaptive system, that evolves in time and space (Portugali et al., 2012), (Healy,

[1] The recent report by the United-Nations (2014) estimate 3.9 billion urban population in 2014 itself.
[2]http://ec.europa.eu/eurostat/statistics-explained/index.php/Urban_Europe_%E2%80%94_statistics_on_cities,_towns_and_suburbs

2006). Its components (i.e. buildings, infrastructures, human agents etc.), with own lifecycle, interact among them and are not predictable linearly, not even separable, but are based on the principle, attributed to Aristotle, that "the whole is greater than the sum of the parts". Furthermore, the cities, as "systems within systems of cities", should take into account the interdependencies with their territories. Each city should study both the relationships within itself but also with the urban boundaries, urban region, in an inter-scalar vision.

Facing the complexity of above mentioned urban challenges, traditional methods and planning techniques appear obsolete and static, ever more characterised by the highly diverse and intertwined ways of how the community actually uses the urban space (Zhong et al., 2015), (Faludi and van der Valk, 2013), (Healey, 2006), (Hartman and De Roo, 2013), not contemplating the dynamic and complex behaviour of the city , as recommended by the main United Nations conferences on the development issues of the cities in the world (i.e. Rio Earth Summit in 1992, Habitat at Istanbul in 1998 or at Quito in 2016).

In order to obtain a resilient city, adaptive to urban dynamics, defining new strategies of urban governance are required to support cities to manage the continuous change and the interrelation between city systems (spatial and human), trying to "unravel" urban complexity.

For the authors, an opportunity for a paradigm shift could reside in through the interoperable platform as methodological conceptualization, enabled by the Information Technologies. In this work the methodological and technological framework BIM-based (Eastman et al., 2011) is described as an opportunity to decode and manage the urban dynamics complexity. The innovative use of the Urban declination of the Building Information Modeling (BIM) methodology, already consolidated for building application, and other interdisciplinary approach to cover technological gap (like Product Lifecycle Management – PLM or Geographic Information System - GIS) (Terzi et al., 2010)(Maguire, 1991), could assist to better understand the planning issues, that are in the most case complex "not only because the problems themselves are ambiguous and difficult to define, but also because they involve multiple stakeholders with multi-attribute preferences" (Lai and Huang, 2016).

Starting from the analysis of a case study based on the absence of an integrated management, that represents as the complexity of an urban transformation reflects its impact on the urban system, the objective of this research is to propose a methodological framework able to model and to simulate the interrelations between the main “actors” and components involved (i.e. stakeholders, officials, business people and citizens), by digitalizing and by making clear the processes. In fact, usually, a urban transformation/construction project “involve complex sets of relationships between parties under different professional background in order to achieve complex goal. The complexity of these projects are resulting from a thousand of documents and drawings that being used manually, that could lead to mistakes in construction process, drawings are not updated, delays, cost overrun, etc.” (Latiffi et al., 2014).

Moreover, the systematized and integrated management of these relationships produce data, which are processed into information and then knowledge (historical, present and future) (Innes and Booher, 1999), enabling predictive analyses or different simulation for the best and participate solution. Moreover, this study shows how the proposed interdisciplinary approach referring to the organizational and dynamical aspects of a city sub-system and network as a whole, may improve the management of the “city-system”, by arguing that there is the necessity to change the way we think, by integrating "system thinking" (De Roo, 2012).

The present paper is structured as follows: Section 2 gives a brief review of the state of the art and of the literature for decoding and managing cities. In Section 3, it is presented the research aim and methodology. Section4 is based on the description of the criticalities of an actual urban process: the student housing in Bari, useful for highlight the actual process problem that are overcame by the description of the efficient solution framework in Section 5 “toward a complex approach: preliminary result on the innovative model for complex urban management”. Finally, in Section 6 it is provided conclusions and discussions about possible extensions of the current formulation.

2 DECODING AND MANAGING CITIES

“The processes that drive spatial and economic urban change are increasingly interconnected and interact with multiple levels of scales” (Hartman and De Roo, 2013) and it is impossible to predict all the criticalities. As a complex system, the city is dynamic (Batty, 2008), in contrast with the static vision of the urban plans and it is an open system (White et al., 2015) because of the continuous interactions with multi external agents. In an ideal vision, the future urban system should be so resilient to adapt to potential disturbances, by learning from the past experiences to better plan and simulate the future action. Furthermore, the improvement of a single sub-system that composes a city not significantly increases the resilience and sustainability of the urban system. A “system-of-systems” approach is necessary that at the same time strengthens individual sub-systems as well as the overall system of a city. The “management of complex systems such as cities requires the use of innovative, sophisticated planning tools that can assist in monitoring current conditions and projecting future developments. It also requires a well-structured participatory process of creating social support by stakeholders for long-term city visions” (Rotmans and Van Asselt, 2000).

Moreover, cross-disciplinary research approach for analysing complex dynamics of cities are needed. In detail, the know-how in the industrial engineering sector, characterized by integrated approaches[1] with great experience in complex processes and actors management, may be useful to decode and systematize the urban processes, by leading to a „smart city“ with a global vision and a local action. For example, in the manufacturing industry, for decades collaborative 3D modelling, visualization and simulation of complex products have been used to anticipate and test the behaviour of complex systems before prototypes pass into production, taking into account the interaction between stakeholders, by finding bottlenecks system and optimizing processes, time and costs.

By carrying this knowledge to the urban phenomena could be strategic, even though cities are not a complex product but are composed of integrated and interrelated systems like a complex system. Nowadays, the tendency is to customise product complex lifecycle management platform, or building lifecycle management tools, oriented toward the city understanding and management, by providing the foundation for the virtual technology used to create urban environments and objects, such as buildings, utility, mobility systems and infrastructures.

An example is "Virtual Singapore: A Platform to Solve Emerging and Complex Challenges"[2]. The National Research Foundation (NRF), Prime Minister”s Office of Singapore, and Dassault Systèmes are cooperating to find solutions that give Advanced information and modelling technologies through a

collaborative platform based on a realistic and integrated 3D model with semantics and attributes in the virtual space. The tools and services development address the emerging and complex challenges Singapore faces thanks to a rich data environment and visualisation techniques that will be used in a collaborative manner by Singapore”s citizens, enterprises, local administrator and research community.

Another study of Xu et al. (2014) explains the potential benefits of CIM, City Information Modeling, a framework of integrating BIM technology into GIS with the goal of bringing great benefits to the urban construction and city management.

So, there is the need for a perspective system and strategic approach, by integrating the cross-disciplinary academic insights and the latest practical innovations, to enable resilient and sustainable urban system, looking towards the industry 4.0 technologies and focusing on the asset management.

The following paragraphs, starting from a case study, aims at providing an integrated approach for future planning and management within the urban complex system through the design of an innovative framework based on the integration of collaborative and technological approaches.

1 PLM - Product Lifecycle Management as holistic approach for complex product in manufacturing industry
2 https://thebimhub.com/city-management/

3 RESERCH AIM AND METHODOLY

The current approach used for the management of urban transformation process is not considered sufficient to decode the complexity. Starting from this consideration, this research aims to propose a customized BIM based methodology for the urban management. The work is based on a case study analysis, wicked example of management of an urban transformation, to demonstrate how “systems thinking approach” can improve the management and planning processes. In particular reference to an urban subsystem case study, the research highlights the necessity to insert and integrate the subsystem in a greater complex system (in an inter-scalar vision), by avoiding the compartmentalised action, by reaching resilient and sustainable actions.

The first phase illustrates the weaknesses of actual process and how an innovative framework can improve the understanding of system components and complexity. It consists in an empirical inquiry based on a qualitative method that investigates phenomenon within a real context: the interrupted construction site of a student housing in Bari, South Italy.

This research deepens the urban transformation conflicts, and how they arise in the context of cities development. The survey is done strategically for understanding sociological and planning processes and interactions within actors at different levels and with environmental, economic and political domains.

A qualitative research on project management processes is carried out. Data collection, which began in September 2016 and finished in March 2017, involved analysis of project history, the documents (project plans, contract documents, reports) and semi-structured interviews with stakeholders. Face-to-face interviews with the principle actors of the process involved unstructured and open-ended questions, by covering a range of topics related to the multiple reasons for the site construction interruption, the involved actors and interactions with external actors, the information exchange method, documents management, and used technologies. In this way, the researcher had the possibility to record a lot of information for rebuild the long period of the project, started in 1996, by analysing the criticalities, bottlenecks and responsibilities. From the data collected, a process workflow and information management were mapped, and the set of information was systemized of the whole period.

The second phase shows the proposed innovative and integrated framework BIM-based in order to "unravel" the urban complexity by the systematization all the process, by identifying the urban subsystem, the involved actors. Strong emphasis was put on the interaction among different domains involved in a planning transformation, to exceed the sectionalizes approach. The new vision proposed for an urban transformation is scalable at the whole urban system.

4 DESCRIPTION OF A CURRENT URBAN PROCESS: THE STUDENT HOUSING IN BARI

The analysed project is a university residence, which construction was interrupted. The building is located in the south-west of the Mungivacca district of the Municipality of Bari, Puglia Region, South Italy, and it is part of a larger "Integrated Urban Renewal and Recovery Program" aimed at promoting a functional and social mix. (Figure 1). The project process started in 1996.

Figure 1 – The Student Housing, Mungivacca District, Bari, Puglia Region, South Italy[1]

The case study includes all the requirements for a complete and complex reflection: lack of a clear and programmed management, multiple strategies change, planning and constructive mistakes, until the possibility of rethinking the project for respond to new urban needs, by including the social and economic analysis. The general project of urban renewal, nowadays recognised as a successful intervention, was addressed by the municipal administration to strengthen the student vocation of the district, through an organic urban regeneration characterized by the use of available areas for services, green and university facilities for the creation of an integrated system for leisure and social exchanges.

The construction started in 2011, envisaged the realization of an extensive building for 100 student apartment, with university facilities. The project started about twenty years ago, promoted by the Autonomous Institute of Public Housing - IACP (nowadays named ARCA[2]). The work had to be completed by September 2012, but due to different unforeseen developments ("persistent obstacles to a rational and rapid execution"), they have been prolonged over time, until the construction site blocked in 2015. Due to the construction stopped, the ARCA requests confirmation from ADISU, the Regional Agency for the University Study Right, in mid-2016, of the actual need for the approximately 300 bed places for non-resident students. At the end of September 2016, the ADISU denied this need due to the "declared" full coverage of the current student bed places demand.

This change of plans, in addition to the problems connected with the abandonment, has an influence on the other systems of the city: the hypothesized formation of an Academic Corridor (Wivel and Perry, 2013) is compromised, structured on the theme of old and new university residences in this urban quadrant (Martinelli et al., 2016), along the strategic axis of Bari – Taranto; waste of public money; impairment of the quality of public space; a sense of urban deprivation and insecurity.

The described case is a clear example of public and/or private "absence of management" and due to the high number of stakeholders involved, the complex process has slowed down until the construction site blocked, by producing misalignment between "demand and supply", but also misalignment with urban regeneration policies. This case would have required a dynamic approaches and project feedbacks, which in our institutional contexts and in our traditional process are completely absent.

In this regard, in recent months the involved authorities, including the Puglia Region, the ARCA, the Municipality of Bari and other stakeholders, have been forced to rethink these student housing by

[1] Source: Rielaboration of the authors from Google Maps and http://www.arcapugliacentrale.gov.it/a-p-c/patrimonio-immobiliare/progetti-e-interventi/1-nuove-costruzioni/3-mungivacca (on April 2017).

[2] The new name of the Authority for public housing of the Apulia Region "Regional Agency for the house and for living" http://www.arcapugliacentrale.gov.it/a-p-c/patrimonio-immobiliare/progetti-e-interventi/1-nuove-costruzioni/3-mungivacca

changing their original destination, targeting their social housing, in response to the new housing and urban needs (ie young couples, separated parents, elderly people, immigrants, etc.)[1]. But despite this, there aren't the appropriate methodologies and tools to take on this changes as rapidly as possible and in an efficient manner, by optimising time and costs.

It emerges, therefore, the need to analyse these changes through the lens of complexity, arguing on the integrated analysis (Schwaninger and Koerner, 2004) of the urban systems and the phenomena dynamic, on the integration of new needs, new targets, and the involvement of various public and private actors who will inclusively have an active part in the process, from the initial planning phases to the management. The authors believe that an alternative hypothesis is now made possible by the use of new models that provide new technological infrastructures to support urban complexity and the continuous evolution of the city , as described in the following paragraph.

5 TOWARD A COMPLEX APPROACH: PRELIMINARY RESULT OF THE INNOVATIVE MODEL FOR URBAN MANAGEMENT

Starting from "interrupted" example for misalignment between urban policies, action and socio-economic changes, in the current context of public policy uncertainties under the effects of the global crisis, the proposal is to trace models backed by ICT tools, which can help the decision makers to formulate strategies that respond to new economic and social urban needs based on clear public-private management processes and active community engagement. The research intends to contribute methodologically to reinventing the process, making it dynamic, optimizing the resources employed, and operating urban regeneration actions that will produce benefit both for the community and the private. The framework, named Urban Common Data Environment, scalable to other urban transformation intervention and in general to the management of urban subsystems, is based on the use of a BIM/PLM/GIS as Methodology, Technological Platform and tools, deployed on the urban scale, in an interoperable and inter-scalar vision.

In detail, Building Information Modeling (BIM) is “a set of interacting policies, processes and technologies generating a methodology to manage the essential building design data in digital format throughout the building‟s lifecycle”, according to Succar (2009). It is centred around an Information Model, which is the virtual representation of the physical characteristics, that in the present research is extended to other urban subsystems. The enabling technologies of BIM methodology are not yet mature enough to handle maintenance phases.

Product Life-cycle Management (PLM) is a strategic business approach for the effective creation, management and use of corporate intellectual capital, from a product‟s initial conception to its retirement (Amann, 2002). It is useful for the methodology because offer a robust base for the standardization of the whole process, with particular attention to the maintenance phase, technologically weak in BIM methodology.

The Geographic Information System (GIS) (Maliene et al., 2011) is a system designed to capture, store, manipulate, analyse, manage, and present spatial or geographic data, that enables the scalability to the BIM methodology to the urban scale, creating a standard for the data exchange.

The main platform objectives are the complex urban action process management, the interaction between the actors involved, the creation of a cognitive/informational knowledge base that will cover the various phases over time, overcoming the sectorial vision. It is hypothesized, as exemplification, its application at the integrated management of the whole conversion process of student accommodation.

At the center of the process there is the structure digitization, according to a three-dimensional information model that allows the definition of spaces according to the technical-functional requirements, by guaranteeing the storage of all the necessary data and by enabling participation thanks to the strong communicative capacity of the 3D model, via feedback systems.

[1]http://ricerca.repubblica.it/repubblica/archivio/repubblica/2017/04/06/le-case-per-studenti-in-totale-abbandono-socialeBari04.html http://www.lagazzettadelmezzogiorno.it/news/home/409870/appartamenti-per-studenti-in-realizzazione-a-bari-gestiti-dal-costruttore.html

The platform will allow all phases project tracking by enabling active involvement of all public-private actors for conversion/management, through the requirements collection, digitization, and maintenance. The benefits are numerous:

- a single referential system to ensure management;
- improved business and resident participation, the interoperability between the actors involved (managing body, PA, administrators, associations, resident, etc.) and used technologies;
- the ability to make transparent every action and every economic investment by simulating the various solutions and interactions with other systems (infrastructure, mobility, utilities, services, etc.) and dimensions (economic, environmental, social);
- the ensuring compliance with the legislative framework and time limits and the ability to identify the "bottlenecks" of the process in a clear and univocal way;
- archiving information and facilitating maintenance phases;
- increased transparency, reliability, scalability and sustainability of services.

The innovative framework is based on a collaborative model for managing urban complexity in a System of System approach. The integrated platform will link the stakeholders from all city domains in a urban common data environment and will enable access to a single informative DB linked to the 3D urban model, which constantly and dynamically will update with new process data. This framework will be managed by the strategic figure of the city manager (Sancino, 2008) for the urban management and as a Decision Support System for city administration. In addition, the authors consider the management as central phase in the whole process for the important investment and the complexity of action. It will follow the PAS methodology of Asset Management. Figure 2 explains all the process, actors, level, and city subsystem.

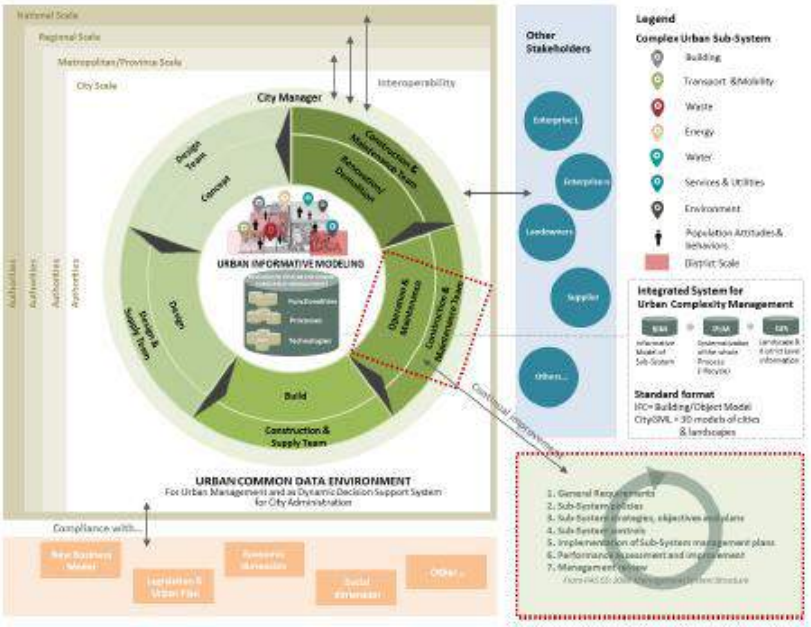

Figure 2 – The Integrated Framework: the Urban Common Data Environment

6 CONCLUSION

The research highlights as innovative and integrated approaches are needed to improve the quality of urban planning and consequently of the urban space and services, shifting the attention to the management of cities, by adopting the complexity lens.

Thanks to the specific case described, at the district level, it was possible to understand the importance of the relations among different levels, like the national level (for the possible financing), regional level (strategic vision) and local authority (operative vision).

Moreover, it is emerged the necessity to rethink the management of the public action for optimize the process, through innovative technologies, today used or for the Building level (as the Building Information

Modeling, rarely used for the urban scale) or deriving from another discipline like the PLM (that focalizes the attention to all lifecycle, really important for the city maintenance)

Using innovative and integrated platform for decoding the complexity (characterized by human and physical dimension) and manage the city could generate the new virtuous shape of urban regeneration. In addition, the authors believe that a new figure in the city manager is strategic to handle the whole process, with urban, managerial and technical skills.

This proposed methodology is intended as a preliminary phase of a broader study that wants to overcome technological and/or methodological gaps that prevent a full adoption of BIM base technology to the city management.

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ID 1647 | AN INFRASTRUCTURE-BASED PLANNING AS A MODEL FOR ADDRESSING COMPLEXITY AND UNCERTAINTY

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1 INTRODUCTION

The conception of the Territory, or in other case of the city or the urban as a part of the previous one, as a Complex Evolutionary System, full of diversity and uncertainty due to its continuous transformation, it is clear that it has important implications for Planning. So, if Planning is considered as a way of thinking and future-oriented action based on decisions of a spatial nature taken in the present on a complex and constantly changing system. The main consequence is the impossibility of formulating an all-encompassing and finalist Planning, since it is not possible to intervene on all the elements of the system, which are also in continuous evolution and transformation. Then, in a spatial context of strong uncertainty, due to the non-linear combination of different coevolutionary changes, it is not feasible to formulate a finalist image of the territory, or city, for a future time horizon. Therefore, Planning has to change its traditional budgets and accept that in a complex, diverse, evolutionary and uncertain environment its role will be very different. For that reason, Planning must accept that its fundamental objective will be the formulation of alternative solutions for each spatial problem posed, evaluating different evolutionary trajectories of the territory, in order to facilitate and improve collective decision making.

Thereby, given the impossibility of acting on all the elements of the complex, diverse and uncertain system that is the territory, Planning as a mode of action for collective spatial decision-making has to select on which variables to act or intervene. In this sense, and in order to maintain a certain global vision, Planning has to act on its Spatial Structure, that is to say on the smaller number of elements that allows to obtain the greater knowledge and understanding about the performance and morphology of the territory. Therefore, Planning will intervene in the territory, and in urban space, by transforming the elements of its Spatial Structure, which at the same time and in a coevolutionary way is conditioning and transforming the rest of the elements of the system.

Within the Spatial Structure, a priority object of Planning, Infrastructures are key elements, since they are the framework or skeleton that articulates the Urban System, supporting the relations between the urban and land-use elements. In addition, Infrastructures through their spatial effects condition the location and evolution of Urban Systems components. Therefore, a new model of Planning based on intervention on infrastructures, as the key elements of the Spatial Structure of the Territory, is proposed. The action on the Infrastructures of the Spatial Structure implies a selective model of Planning, in order to transfer series of collective values and interests by acting on key elements of great transcendence and influence on the global set, at the same time as it allows a certain margin of freedom and self-organization for the rest of individual space decisions. Therefore, an infrastructure-based Planning model arises, resulting from the action on the key infrastructure of the Spatial Structure through a process of collective decision-making.