HUMAN AND SOCIAL ASPECTS IN THE DEVELOPMENT OF URBAN DIGITAL TWINS

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The CNR strategic project "Urban Intelligence" (UI) pursues the development of Urban Digital Twins (UDT) able to support the urban governance by integrating the various dimensions of a city, and thus by overcoming the limitations of the smart city paradigm still dominated by sectoral approaches. A relevant asset for UI relies in the capacity of integrating "community knowledge" within the UDT development, with the aim of completing the objective and top-down information typical of the urban sciences, and of extending range, scope and depth of the operations carried out in the UDT (e.g. analysis, simulation, prevision, optimization, decisions support). To this end, UI adopts a participatory method rooted in the "community mapping" theory, and evolves it in the implementation of social innovation processes aimed on the one hand, at exploring community knowledge, and on the other, at empowering the capacity of communities of tapping it for envisioning future scenarios. In particular, a hybrid "phygital" participatory approach is adopted, where analogical engagement for-mats are intertwined with innovative tools for GIS-based community surveys. Finally, a description is provided of the potential contributions of the participatory domain of UI to the UDT development, with special regards to ICT innovations.

Keywords: *urban digital twin, community mapping, stakeholders engagement, experiential knowledge*

1. Motivation and problem addressed

The making of an Urban Digital Twin (UDT) should rely on a direct involvement of the local community, to the extents that the inhabitants of a city are also elements of its physical system, actors and users which determine the success or failure of its functions, sources and receptors of urban dynamics, knowledge, information and services. The strategic project "Urban Intelligence" (UI) of the CNR, by conceiving UDTs as cyber-physical-social systems [1], requires a full connection and integration among these three dimensions.

Paba tells the experiences of Patrick Geddes, one of the founders of the participatory approach in urban planning, with special reference to the "Outlook Tower" [2]: "Geddes invited its visitors to quickly climbing the five flights of stairs, so to reach the basis of the octagonal tower, and to directly climb another wooden stair therein which led to the small terrace on the top, from which it was finally possible to gain a 360° overview on the city from a 80 feet height. This was the first grade of interpretation: the city vision from the height, synoptic, holistic, the city seen in its entirety, from each part towards the horizon". This was followed by a visit to a darkroom, where the city was seen through its image reflected upon a concave mirror. Thanks to a lever it was possible to change the angle of the mirror, and observe the city under every perspective.

The art of city surveying entails the merging of the "top view", which attains the objective knowledge as it may come from sources such as data fluxes of sensor networks, with the "bottom view", which wanders across streets listening to people and collecting stories and emotions. Between these two levels a substantial epistemological difference arises, and thus, of approach. Limiting the exploration to a perspective from the top, or in "third person", induces a behaviourist approach aimed at modeling the community life by means of a mere description of what is externally perceived, and favours the use of Cartesian-like maps which do not correspond to the experience of the city as it is seen in "first person". Assuming such "bottom-up" approach leads to take in a higher consideration the substratum of senses and meanings attributed by people to the spaces of their experiences, which are caught through

a ground perspective constrained by the horizon of the visible. Moving within this mode, people develop "subjective geographies" which, according to [3], are «informed by background knowledge organized into patterns. We rely on these schemas or pattern to acquire new knowledge». Such schemas, known also with the term of "cognitive maps", "are not just a set of spatial mental structures denoting relative position, they contain attributive values and meanings" [4] which pre-orient our relation with the external world, causing potential mismatches with previsions overlooking them [5]. Some relevant indications for the development of UDTs stem from this analysis: first of all, their role as tools for empowering local communities in their pursue of a sense of identity, intended as an essential precondition for consciously shaping their city's future. As underlined by [6], «the re/construction of an image is just apparently a frivolous activity: it involves various symbolic, cultural and even political codes, influencing the wellbeing of who is self-portrayed, but also of those who are in the presence of the image, without being able to intervening on it.» The places of a city are not just filled by the stories occurring in them: their physical settings affect the life of the inhabitants, by opening or closing possibilities, by favouring or hampering connections, by offering or denying opportunities. There is a close link between the physicality of a place, its social value, and its usage. Crucial to this objective is thus the involvement of communities from the very first phases of development of the UDTs, aimed at building an experiential knowledge of the city with three goals: (i) highlighting the modes through which people live their city and assign values to it; (ii) enhancing interactions among local actors in order to generate shared added-values, to co-create shared scenarios of urban evolution, and to activate new social practices for enhancing their implementation. On these premises, Urban Intelligence pursues the transition from a "city-of-use" toward a "city-of-sense" where the human factor is put at the heart of the urban planning and programming processes.

2. Methodology and results

The participatory methodology adopted for UI sees in the development of UDTs a "social innovation process" aimed at empowering local communities to govern their future. This objective can be pursued by running "open-ended processes" where participants undergo some kind of changes about their current practices, aims or modalities [7] and where sustainability of the results achieved is pursued [8]. To this aim, the two fundamental concepts of seeding and infrastructuring are followed, already introduced by the Design-Driven Innovation Studies (DDIS) [9]. "Seeding" refers to the metaphor introduced by Manzini [10] for underlining how the social innovation solutions act just like fragments of a "social sourcing code" which need to be cultivated accurately and adaptively in order to verify the kind of fruits they can produce in a given context. "Infrastructuring" refers to the necessity of coordinating the "innovation seeds" within solid process structures; this concept can be traced back to the Meta-Design Studies (MDS), which are focused not on the final output, but on a reflection about the very process architecture which could guide toward the best outputs [11], as well as to Giddens' "institutionalism" [12], according to which enduring social interactions end up generating recurrent patterns and clusters. These two concepts offer the idea of "process" as an immaterial infrastructure, the constitution of which is an autonomous result of participation, which can be spent for multiple issues and goals. Structuring an innovation process is thus a primary design challenge for the development of an UDT, at the core of which it should be placed the activation and management of connections between actors [13] aimed at establishing an enduring space of mutual dialogue [14]. In particular, UI adopt the "community mapping" principles for understanding cities, territories and communities as socio-economic integrated ecosystems, each characterized by a specific DNA [15]; such mapping engages the various social groups and networks of a community by implementing a set of dedicated participatory approaches aimed at achieving the following specific objectives:
- exploring the city from surveying its material and immaterial heritage [16, 17];
- awakening the latent knowledge of citizens starting from the listening of persons;
- describing the vision of a city and the urban values dispersed in the stories linked to places of life;
- reading the spatial network of the sense connections for representing new urban geographies;
- building a circularity between the social actions and their cultural representations.

From an operative point of view, a hybrid cyber-physical participatory approach is performed [18], based on an interaction between analogical and digital tools allowing for both on-line/off-line, synchronous/asynchronous en-

gagement activities. Among the digital tools, of particular interest are the PPGIS (Public Participation GIS), which enable the development of GIS databases (e.g.. shapefiles) annotated through metadata, and thus, a direct integration of the participatory knowledge with the other knowledge levels of the UDT.

3. Contribution to the field

Many are the potential contributions that the research and experimentation on the experiential knowledge can offer to the technological development of the UDTs and more in general, to the advancement of the strategic process "Urban Intelligence", with special regards to the following ICT fields:

A. Data for the construction of a knowledge base of the UDT extended to the urban community: definition of typologies and formats for participatory data and metadata in view of their integration with the UDT tools and services; development of innovative representations the "urban structures of sense" as the immaterial heritage.

B. Tools for the management of the variegated thematic fields addressed y the UDT: development of tools conceived for supporting hybrid participatory approach aimed at enlarging the community engagement and at enhancing the efficacy of the social innovation process; co-design paths of the use-cases aimed at ideating and calibrating the tools for the UDT for a multiplicity of profiles, and at increasing their diffusion, inclusion and usability towards a wide range of potential users (from technicians, to enterprises, to citizens); development of user interfaces shaped on the needs of the different potential users; immersive 3 exploration of the city, including community contents, and related to both the actual status, as well as evolutive and transformative proposals.

C. Services in support to planning programming and governing the city: multi-disciplinary approaches or the analysis, simulation, prevision and optimization of urban dynamics, integrating community behaviors, experiences and expectations, social and cultural assets; decision support systems aimed to individuating optima scenarios of intervention reflecting the preference structures of the different actors involved in the urban governance.

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