INTERCONNECTION VS INTERDEPENDENCY: DIFFERENT URBAN RELATIONSHIPS IN THE SMART CITY ERA

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ABSTRACT

In case of emergency due to natural or artificial causes, one of the most compelling issues is the real-time response. In this field, urban contexts are often extremely fragile. The more connected the world is the more interconnection couples with interdependency. Electric grids, water supply, transportation networks, ICT networks and so on are all interdependent: a breakdown in one of them can generate a cascade failure and the collapse of the overall infrastructure that makes the emergency and disaster management harder and unprecise.

Dealing with an emergency means dealing with unpredicted events, even in the framework of already predictable disasters. Most of the Italian cities are exemplary cases: the compresence of an ancient urban tissue made up by an intricate streets system, with an unsustainable traffic loads condition and, sometimes, a role of strategic commercial node, they are always at the emergency threshold. On top of that, cities like Messina, Palermo, Naples, are constantly expecting a terrible earthquake or a volcanic eruption. What could be the consequences and real-time disaster management in such an unmanageable context?

This paper is an early-stage study based on the hypothesis that a possible way to prevent the infrastructure breakdown in case of disaster can be thinking the urban networks made up of nodes, both physical and virtual, that can be defined “islands”, with a particular grade of independence one to the other. In a sort of a new Mathias Ungers’ archipelago, where interconnection must overcome interdependency, the architectural point of view can add a fruitful contribution to the ICT field for emergency management.

KEYWORDS: interconnection, self-surviving nodes, cascade failure, infrastructure breakdown, emergency management, archipelago city, smart city

INTRODUCTION: INTERDEPENDENT NETWORKS

The city has grown smart, and we didn't notice that. We got used to it. The role of the digital world in daily lives has become pervasive, and we hardly can get rid of everyday use objects such as a smartphone. Everything looks to be under control. For this reason, when something occurs, let's say a change in the normal condition, that determines an emergency of some kind, the interdependency characterizing all aspects of our life turns into a weak point: a blackout, a failure in the internet connection, and the control fails, all looks to come back in the past of a century. Everything stops; everyone feels unease. What does it happen if the emergency is serious, if a flood, or a big earthquake, or a volcanic eruption happens, and the strictly interdependent networks our cities are made of start collapsing one after the other? If the earthquake determines disseminated fires, interrupting the electric grid, making people crowding the streets, the collapsed buildings prevent the rescue means to get the places where they are needed: the city does not look so smart after all.

A 'smart city' aims to achieve sustainability using technological and digital innovation, which has the potential to realise higher environmental efficiencies in a variety of fields, notably energy consumption. Nevertheless, the efficiency is measured especially when the system crashes. Dealing with emergency and robustness of the cities starts with the assumption that the city is both physical and digital: living in a city nowadays is like inhabiting a huge cyber-physical system, that is an embedded structure coupling physical and cybernetical layers. Using this metaphor also allows understanding that the studies about the city, from an urban point of view, should take into account both these aspects of the matter. The physical relations making the city the organism we study are affected by invisible and still invasive networks that physically move people, construct buildings and streets, lead vehicles.

This paper will focus on the interdependence and interconnection between the built environment and the empty spaces, because it is still an actual way to study the urban organism. On the other hand, it will try to find a possible solution to avoid the interdependency, by the definition of urban islands, as an advantageous way of rethinking the structure of the city itself to face natural or artificial disasters. Underlying their deep difference with the zoning mentality, the islands could be a key for the city to be smarter and resilient and to maintain efficiency to get a higher life quality for inhabitants.

Here it is proposed a way to read and understand and, eventually, also to rethink the city by learning from Unger's Archipelago City, to limit the cascade failures and to increase networks faults control to increase the self-sufficiency by a contemporary and complementary growth of architectural and data science tools.

Finally, a parallel interpretation of architectural and informatic representation of the "islands" is proposed, trying to understand the common underlying points.

THE GOAL: ENHANCING THE CITY RESILIENCE FOR EMERGENCY RESPONSE

As a huge cyber-physical system (Carroll B. 2002), the city has been described by some literature as a cyborg. "The emphasis of the cyborg on the material interface between the body and the city is perhaps most strikingly manifested in the physical infrastructure that links the human body to vast technological networks. If we understand the cyborg to be a cybernetic creation, a hybrid of machine and organism, then urban infrastructures can be conceptualized as a series of interconnecting life-support systems". (Gandy, M. 2005). So, it can be read as a hybrid, complex system where everything can be objectively measured. In the following paragraphs, the concepts of resilience and of the "sensitivity" of the city are presented, in order to apply them to the issue of the urban self-surviving islands.

Resilience

Resilience, as a very fashioned word, is a "combination of keeping errors small and of improvising workarounds that allow the system to keep functioning" (Weick, Sutcliffe, 2007). In order to manage the unexpected, the advantage of considering urban islands in facing the emergency consists into the concepts of self-surviving areas whose capability to react and self-sustain themselves in case of emergency is a featuring element. The interpretation of the cities as forming a lagoon of islands could increase their resilience, the possibility to discretize the faults, exploiting the hybrid nature of the contemporary city. This method could be suitable for small cities as well as for a megalopolis, by identifying districts whose inner behaviour can be made independent in some way. On the other side, modelling emergency scenarios for planning the pre-event conditions in order to efficiently recover after the event is an actual issue in computer science. The purpose is to provide

a cooperative spatial unite to be managed by the software, exploiting the interaction of cyber and physical system.

Smart because sentient?

The erosion of public spaces threatens the public sphere. And so urban leaders are pressed to rehabilitate derelict spaces, reintroduce cafes, fairs and bazaars in public places, pedestrianize streets, plan multifunctional spaces (such as medical clinics in shopping malls) and recognize the importance of vernacular moments such as parades and street festivals. With the Internet of Things, cities can use a powerful tool to manage their ordinary and extraordinary activities. The only questions will be: when smart cities fail, how much damage they cause when they crash, and how to make they fail less and in a kind of "controlled way". The sentient city (Crang M., Graham S. 2007) in this sense is a smart city that can feel the danger to come: it can preventively organize by collecting and learning from real-time analysis of urban life and infrastructure by all the instruments in the field, taking advantage of the "urban ubiquitous computing systems".

ISLANDS IN A LAGOON

In Cities within the city, Matthias Ungers describes the condition of Berlin, and he gives a proposal for future planning of the city with the introduction of the archipelago-city (Ungers M. O., 1978).

He establishes a reasonable city size in 250.000 inhabitants, underlying the inverted proportion between the city size and the quality of life. Therefore, he proposes to point out areas of the city to be preserved, forming «a green urban archipelago in a natural lagoon» (4th thesis). The particular condition of Berlin at that time was the occasion to rethink the way urbanization should proceed, and it triggered a reflection that had started with the clustered city by the Smithsons.

If we look at the present days, since the urbanized population is now more than 50% of the world people, this number (250.000) appear to be very small. On the other hand, it looks to be more and more compelling to get a sustainable way to live just in those huge and wide cities of tens of millions of inhabitants. Then, the "islands" can also be the output of another way to look at the issue, not only as green areas, but like independent urban structures in an urban lagoon, conceivable through a sort of a fractal lens. The following paragraphs will define the issue through various point of view, to better understand the metaphor of the "islands" in the contemporary urban problem.

- Fragments of cities beyond the zoning

In Italy, the main legacy of modern urbanism was the 70's zoning. Since then, planning should respect some standards that corresponded to a precise amount of space to be reserved to public green, schools, housing and facilities. It was in terms of square-meters and it determined sectorial zones. For sure, islands are not zones. On the contrary, they could be seen as heterogeneous fragments of the city whose structure can grow indefinitely (in a scalable way), whose empty infrastructural space is public and it is the way to connect islands each other, but with the constraint of maintaining the balance among its composing parts.

- Infrastructural lagoon

Is public space still important even in the era of the individual city? The issue has been at the centre of the urban debate for decades: anyway, streets and squares, along with malls, are the most public spaces of the cities. The infrastructural layer, both physical and digital, is the glue keeping all fragments together. How much infrastructure is needed to define a single island? To answer this question, it is useful starting from the following statements:

"As this great demographic and geographic shift continues, humankind will become ever more reliant on functioning systems of urban infrastructure. Indeed, the very nature of urbanization means that every aspect of people's lives tends to become more dependent on the infrastructural circuits of the city to sustain individual and collective health, security, economic opportunity, social well-being, and biological life". (Graham, S. 2010).

The dependence on the infrastructural layer is more and more compelling. It constitutes the metaphorical water where the "islands" stand — analysing the urban tissue to identify the borders of the so-called islands in a corresponding balance of infrastructural networks to get self-sustainable areas able to efficiently react to an overall network interruption (physical and digital). The metaphor of the archipelago can also refer to the fluidity Maurizio Carta talks about (Carta, M. 2016), as one of the keywords of the contemporary city.

- An issue of identity: the dialectic centre-periphery

If a feature of these areas is heterogeneity, how is it possible to find an identity? Then, let's think about the couple inside/outside has this conception still any sense today?

If we look at the scale of the "island", distinguishing among urban and peri-urban means again looking at the relationship between empty areas and the built environment. The reference should be that of the countryside, where the extremely dilatated relationship made the "lagoon" very "watery", and the islands can be seen as single-family houses or farms. This balance, no-more searchable in urban areas, must be found by identifying a new liveable relationship among those built districts and their corresponding public space. It is not a matter of historical centre, or monuments to be isolated or distinguished, but on the contrary, it means to focus on the strength-relations that are necessarily different shifting from a very dense small Italian village or a sprawled periphery.

This should deal with focusing on the ordinary city (Robinson J. 2006) to get to the definition of islands as part of "highly successful cities in the future will likely consist of a network of compact urban districts where resources and amenities of daily life are in proximity, allowing people to live, work, play, and exchange ideas in walkable, vibrant communities" (Larson K. 2018).

By collecting all the information above, it is possible to start a definition of the metaphor of the archipelago: the islands are self-surviving areas where the interruption of the overall network does not immediately affect the inner life-cycle of the area's network for a determined period.

Dimensions matter (or "how smart is to be that big?")

"The city is everywhere and in everything. If the urbanized world now is a chain of metropolitan areas connected by places/corridors of communication (airports and airways, stations and railways, parking lots and motorways, teleports and information highways) then what is not the urban? Is it the town, the village, the countryside? Maybe, but only to a limited degree. The footprints of the city are all over these places, in the form of city commuters, tourists, teleworking, the media, and the urbanization of lifestyles. The traditional divide between the city and the countryside has been perforated." (Amin, A., Thrift, N. 2002).

Even if the distances are cancelled, or at least much shortened by contemporary transportation and invisible networks, the city is still a matter of size. The dimension of the cities is known to play a fundamental role in social and economic life (Schläpfer et al., 2014). Early 20th century writings suggested that the social life of individuals in larger cities is more fragmented and impersonal than in smaller ones.

About this concern, what does it mean to be smart for a city? It could be useful to understand a dimension where the interconnection of things (infrastructure, housing, facilities, green areas…) does not turn into some unmanageable monster, whose only smartness lies in the pervasive presence of internet. Again, it is very actual considering the issue of bigness in a Koolhaas' perspective (Koolhaas R., Mau B. 1995).

The question this paper wants to ask is the following: is rethinking from the perspective of the islands a way to reduce the size of the city and to increase then its smartness?

Interconnection Vs Interdependency against the disaster: conceptual models and ontologies

Here we go to the real point of all this issue: the reason why it should be useful to rethink at the urban text in an island-lagoon relationship is relating to the pervasive presence of networks and the need to prevent disaster by increasing urban resilience.

As a very abused word, resilience deals with the ability of the system to react and be robust to unprevented changing conditions. Relating to the cities, this could be the way to rethink the embedded system we live in to face the interdependent networks, increasing their interconnection but making them robust in case of failures. Avoiding interdependency is not easy. The interdependency problem "is compounded by the coupling of physical infrastructure with information technology systems for communications and control" (Graham, S. 2010).

The paradigm here proposed tries to point out (or add on) the infrastructural joints to the infrastructural overall networks, to allow the so identified "islands" work for their own in the response of an emergency (e. g. an interruption of the electric supply), and so avoiding the cascade failure. It can look like a cellular paradigm, where single cells communicate drown in a fluid, but a single failure does not compromise the entire tissue.

Plus, the non-physical streams of data, i.e. the cyber part governs all the physical structure. Even if the dematerialization of the information is evident to all, it "still works to deny the materiality of cyberspace infrastructures themselves, and their absolute reliance on other less glamorous infrastructure systems—most notably, huge systems for the generation and distribution of electric power" (Graham, S. 2010)

Nevertheless, the software part plays a crucial role in the shifting of the paradigm. Indeed, in computer science, there is a field of study researching modelling interdependencies. Meta-models and ontologies are developed to foresee human behaviours and design scenarios. The conceptual models rely on the European Commission life cycle for disaster risk management, and they aim to provide adaptive frameworks that cover real-time collection of data to set the new initial conditions and for this reason, adapt.

If the software layer can affect both the sides of the circle, analysing and planning must act in the pre-event side, that can have long-term prevision and 'take their time'. Both must operate in coordination, and the one must support the other.

CONCLUSIONS: A MATTER OF SPACE

Although the software systems are everywhere in our lives, the outcomes are always in the physical world. In some way, it is the matter of the CPS, coupling digital and physical systems all embedded: in a broad sense, our entire world is becoming a cyber-physical system.

Our cities became real-time (Kitchin, R. 2014). Still, every modification happens in the physical world. The smartness imposes a reflection on both the sides, and urbanists and architects must deal with space more than ever.

The key is not to add devices but starting from the physical space. The issue is how to manage it by exploiting the available and future technologies and to improve the everyday places to gain a better life.

Cooperation and interaction between ontologies and meta-models and spatial analysis and planning can be the next step for the future cities, and a key is starting from the emergency response: if the city could deal with an effective response to a crisis, then the everyday life will be necessarily better. This paper provides a proposal in rethinking the built urban areas as forming a lagoon (recalling Ungers' archipelago) in which islands can be identified. The metaphor of the islands should imply independent areas composed by residential blocks, infrastructures and facilities interconnected but not interdependent one another. Avoiding the interdependency is the key: the software role is crucial in determining the interconnection nodes and to find the points where the infrastructures could be joined. The final aim is to rethink cities as embedded cyber-physical systems, where software and urban reflection could go together to trigger new future ways to live and plan the city.

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REFERENCES

Ungers M. O., 1978. La città nella città. Proposte della sommer Akademie per Berlino, “Lotus”, n°19, pp. 82-98.

Koolhaas R., Mau B. 1995. Small, Medium, Large, Extra Large, Monacelli Press.

Amin, A., Thrift, N. 2002. Cities. Reimagining the Urban, Polity, London.

Davis, M. 2002. Dead Cities, The New Press, New York.

Gandy, M. 2005. Cyborg Urbanization: Complexity and Monstrosity in the Contemporary City, in “International Journal of Urban and Regional Research 29”, n°1, pp. 26–49.

Robinson J. 2006. Ordinary cities. Between Modernity and development, Routledge, London – New York.

Crang M., Graham S. 2007. Sentient Cities, in “Ambient Intelligence And The Politics Of Urban Space, Information, Communication and Society”, vol. 10, n°6, pp. 789-817.

Kruchten P., Woo C., Sotoodeh M., Monu K. 2007. A Human-Centered Conceptual Model of Disasters Affecting Critical Infrastructures, in “Proceedings of the 4th International ISCRAM Conference”.

Shepard M. 2009. Sentient City Survival Kit: Archaeology of the Near Future, in “Proceedings of the Digital Arts and Culture Conference – After media: embodiment and context”.

Graham, S. 2010 (edited by). Disrupted Cities. When Infrastructure Fails, Routledge, New York and London.

Kitchin, R. 2014. The real-time city? Big data and smart urbanism, in “GeoJournal” n°79, pp. 1-14.

Shelton T., Zook M. and Wiig A. 2015. The “actually existing smart city”, in “Cambridge Journal of Regions, Economy and Society” n°8, pp. 13–25.

Carta M. 2016. Planning the Augmented City, in “Urbanistica” n°156

Larson K. 2018, Beyond Smart Cities: Emerging Design MIT Media Lab and Technology,