Resilience in architecture: housing as a process

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ABSTRACT

This work starts with a hypothesis that housing design process can be an open system, whose resilience becomes positive when it is understood as a process with multiple agents, among one of them is the architect. Current housing production presents inadequacies and flexibility problems that bring this system to an unbalanced situation, which makes it more difficult for people to modify the space they live. This work aims to identify if and how the insertion of other architectural strategies in housing production could foster its resilience. In order to reach this objective, this research uses an explanatory approach based on a literature review on the theme and case studies. Firstly, the concepts of system and resilience are explored under approaches that cover the reductionist and the systemic paradigm. After that, some discussions regarding housing and counter-hegemonic practices are presented. Finally, selected case studies are analysed from the perspective of the resilience characteristics in order to verify if they develop the concept of housing as a continuous process. The results enforce the need for shifting the emphasis of current housing schemes to a new configuration of dynamic balance and highlight the role of open and informational processes to achieve this goal.

Keywords: Housing, Resilience, Flexibility, Autonomy, System.

INTRODUCTION

The contemporary concept of housing has been increasingly associated to actions developed by people in a network of experiences, which goes beyond the housing unit as a physical object. According to Pelli (2006) and Ortiz Flores (2011), it relates to the possibilities of inhabiting the spatial and social fabric, with a strong exchange between the domestic unit and the city. This approach connects with the concept of the right to the city, developed in the 1960s by Lefebvre (2001), according to which people's lives are shaped by a complex network of relationships. In this sense, some relevant concepts are diversity, flexibility, plurality, among others. Flexibility in architecture is understood as a building's capability to be changed under social and technological circumstances (Schneider and Till, 2005a). Its constructive technology is seen as a way to foster inhabitants' preferences along the house's life cycle, with optimization of resources (Costa *et al.*, 2017).

Examples of approaches which do not consider flexibility issues from the beginning can be found in several mass housing developments, such as recent Brazilian social housing schemes. For instance, there are a series of problems caused by the inadequacies of the greatest housing programs in the country's history, the Minha Casa Minha Vida Program. Through this initiative, hundreds of thousands of housing units have been produced with similar layouts in several cities in the country, using low cost, obsolete systems of construction, and structural masonry - in most cases, it is impracticable to rearrange size and disposition of the rooms (Andrade, 2015). Some authors point out that the profit made in Brazilian housing production is due to the exploitation of workers in low-tech construction sites, rather than being a result of the technology being applied efficiently (Santo Amore *et al.*, 2015; Ferro, 2006). Customizing social housing is an issue that merits inclusion in the agenda of discussions on housing policies in progress in Brazil. Some authors emphasize that it is possible to have a conceptual clarity to enunciate personalized architectural proposals for the reality of self-builders by identifying how they make their habitat, and understanding the variables related to the conformation of their dwellings (Pina *et al.*, 2002; Mororó *et al.*, 2015).

At the same time, informal settlements are constantly increasing and acquiring new approaches. As Ronconi (2016) analyses, in the construction market, work is conducted mainly through informal ways, which consist on small tasks performed by informal (25%) or self-employed workers (36%). Even though these informal buildings are produced by the average population as a way of empowerment, the lack of planning (evolving space, money or another issue) leads to a low quality of construction and of the urban design specially. These arguments highlight the necessity of autonomy of users as co-creators of their living spaces, and the urge for a change in how professionals position themselves in the civil construction framework and in the design process, mainly architects and urbanists. Barros and Pina (2012) discuss a specific approach for the intermediation and support of architectural and urban design decisions, involving the possibility of change as part of the design process and housing program such as an important perspective for the recovery of a humanizing characteristic of city living.

The understanding of housing embedded in a broader context can be related to a systemic perspective, which considers the connection between the dwelling and its surroundings, as well as the relationships between humans and the inhabited space. Frequently, this chain is confronted by situations of stress, such as the demand for changing the space plan to accommodate a new room, changes in urban infrastructure and services, and even the need

for removing people from an area due to disasters or major urban redevelopments. In that sense, the notion of urban resilience considers the capability of citizen groups to overcome collapses (100 Resilient Cities, n.d.). Thus, architects, designers and urban planners play a key role in addressing those challenges in pre-configuration and reconfiguration of spaces.

This work is directed to built environment production activities that adopt counter-hegemonic approaches. Figure 1 represents the conceptual framework of the article. The main objective is to identify if and how other strategies in the housing production system could contribute and foster its resilience. Concepts of system and resilience are going to be explained and applied to architecture and urban studies, to argue in favor of this resilience. The study also intends to highlight the need for shifting the professional actuation emphasis to a new configuration with a dynamic balance. To do so, a literature review and a discussion about those research topics were developed, followed by some case studies about housing produced by counter-hegemonic practices, which culminate in a systematization of how those processes and concepts are applied by the practices analyzed.
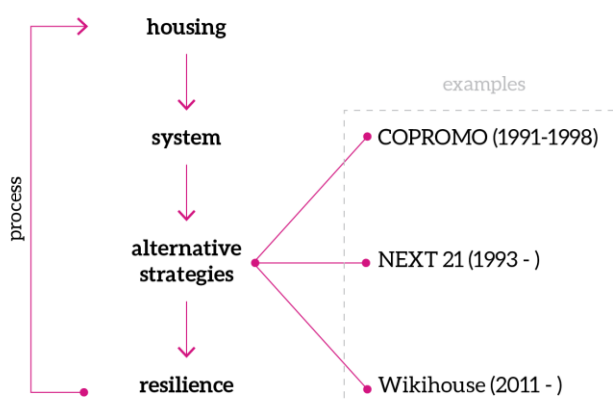

Figure 1: Conceptual framework.

1. SYSTEM AND RESILIENCE: CONCEPTS AND APPLICATIONS

The concepts of system and resilience applied to the architecture and urban studies fields are not unanimous among researchers. Some authors understand resilience as an essential attribute to urban sustainability (Tumini, 2016), while others defend that it can maintain negative situations (Baltazar, 2010).

This article considers architecture as an open system where resilience is desirable to contribute to user's autonomy, and it can consequently raise the quality and the sustainability of the built environment. In order to support this argument, the discussion of the concepts of system and resilience becomes necessary.

Vieira (2000) studies systems under the complexity perspective. Systems are defined by the author as aggregates of interrelated elements with shared properties and well-defined characteristics. Those are called parameters, which are divided into basic or fundamental, applied to all systems, and evolutionary, which can vary with time and from one system to another (Vieira, 2000). The fundamental parameters specified by the author are *permanence*, *environment* and *autonomy*. *Permanence* of a system is its tendency to stay in the same situation; the *environment* is the wrapping, which means a larger system that exchanges energy, information or material; and *autonomy* refers to a system's memory. The understanding that all systems have a permeable wrapping, whose exchanges are essential for it to be *permanent*, makes it possible to infer that they are always open in some degree. The same author also defines evolutionary systemic parameters hierarchically: *composition*, *connectivity*, *structure*, *integrity*, *functionality* and *organization*. Among them all, there is the free parameter of *complexity*. In this study, it is relevant to highlight *structure*, which concerns to the number of links among the components of a system, and *organization*, the highest configuration of complexity, which is the combination of the five initial parameters.

The behavior of *structure* and *organization* parameters in the city is discussed by Baltazar (2010). As an example, the author tells a story about some conflicts faced by a favela inhabitant that received an amount of money and acquired an apartment but did not manage to adapt to their new situation involving neighborhood relationships, financial questions and socio-spatial limitations. The changes in housing and economic situation are then identified as an unsustainable *structure* due to the conservation of *organizational* relationships, controlled by capitalism (Baltazar, 2010). According to the author, the reason for the urban space not to be considered as a resilient system is that it needs to be changed in its *organization* (Baltazar, 2010).

The city as a closed system, whose *structure* and *organization* are necessarily fixed, confronts Vieira's definition (2000) that every system has open and changeable *structure* and *organization*. Baltazar (2010) argues that the application of capitalist hegemonic rules of production to the urban space leads to a misconception that the city is a system.

Buschbacher (2014) introduces the concept of socio-ecological system to contextualize the contemporary thought about resilience. This kind of system promotes the interaction of multiple groups of interest and objectives, developing socio-economic activities that impact the biophysical environment, at the same time that they are being influenced by it (Buschbacher, 2014). According to the author, those are complex, open and adaptive systems, and it is important to develop a new comprehension of balance in order to describe

them. Closed systems have a negative feedback because they are ruled by the reductionist paradigm, which brings new situations back to original settings. In contrast, complex systems have a positive feedback because they create unpredictable trajectories that widen the perspectives of change (Buschbacher, 2014).

The aspects of this new paradigm demonstrate that resilience in dynamic systems is related to a transitory balance or, as discussed by Buschbacher (2014, p. 15), to a "theory of non-balance". The author defines resilience as the capability of keeping essential structural and functional features after a collapse. That means it combines opposing ideas, such as stability and dynamics.

Even so, this kind of resilience considers a fixed regime, even if its dynamic balance enables a variety of states. Baltazar (2010) discusses the existence of a negative resilience caused by the conservation of an unfavorable regime, like the capitalist planning, which acts as a barrier to alternative ways of production. The author indicates that capitalism takes advantage of resilience to maintain a status quo, through the exclusion of spontaneity and practices which are not directly linked to profit making.

In contrast to the accelerated reality and the complexity of connections, agents and existing interests in socio-ecological systems, Buschbacher (2014, p. 20) defines a kind of resilience unlinked to the conservation of a regime, called "general resilience". The author complements that this sort of resilience uses characteristics of *adaptation*, *learning* and *self-organization* to deal with unpredictability. Since it widens possibilities by its dynamic character, the general resilience is always positive.

Back to the space production, it is possible to recognize an alignment between the concepts discussed by Vieira (2000), Buschbacher (2014) and Baltazar (2010), despite the apparent contradiction. As debated, the denial of the city as a system occurs when Baltazar (2010) considers it as a closed system, what would happen in a reductionist paradigm. When it is understood as a socio-ecological system, the parameters defined by Vieira (2000) and the characteristics listed by Buschbacher (2014) emerge.

Permanence in architecture and urban studies fields could be seen as the perpetuation of social groupings such as the house, the neighborhood and the city. The parameter *environment* is related to the diversity of scales, when a system is always contained in a larger one: from the individual to the community, from the house to the city. *Autonomy* could be associated to material and immaterial heritage, to the memory incorporated to space, and

to the people who live there. The porosity between scales shows that this sort of system is open; therefore, there is a possibility of energy, information and material flows, between public and private, in their multiple dimensions.

Baltazar (2010) raises a manifesto for the city as an open interface, concept that addresses issues of *adaptation*, *learning* and *self-organization* described by Buschbacher (2014). Thereby, to assume that practices in the built environment are relationships in dynamic systems can contribute to its general resilience if the focus happens on the process rather than the final product.

2. COUNTER-HEGEMONIC STRATEGIES: OPENNESS IN ARCHITECTURE

Considering the housing concepts described by Pelli (2006) and Ortiz Flores (2011), where housing is directly related to an infrastructure network, which integrates transportation systems, leisure equipment, services and even social relations, the current strategies in housing production seem to be distant from being resilient. On the other hand, counter-hegemonic strategies that have emerged in the last century change the concept of dwelling as an object to a holistic approach where housing is a process, notion linked to the concept of open system and consequently more inclined to achieve resilience.

John Habraken (1999) was an intense critic of mass production processes in post-World War II Europe. For the author, there should be two decisive moments in a housing development, one collective and one individual. The starting point of his critique is based on the inherent universalization of mass production, in contrast to effective housing construction. He argues that, in mass production, housing is seen as an object of consumption. Therefore, in order to be fulfilled, it eliminates dwellers' influences, as the focus relies on the design of a housing development as a whole, not on the unit. The author also emphasizes that this approach considers dwellers as mere statistics.

According to Habraken (1999) and Harvey (2014), it is a mistake to consider that mass housing and industrialization go together. If that was true, there would be a surplus in housing production, which has not yet been achieved. Habraken believes that individuals should have more influence in the housing production and development chain, particularly regarding daily elements related to feelings of happiness, dignity, and sense of belonging or ownership over something (Habraken, 1999). He states that the "natural relationship" is the basis for everything that concerns the act of inhabiting, such as impulsive variations, daily inventions, spontaneities, and search for improvements.

Habraken's theories strongly influenced the Open Building movement. Created by the Stichting Architecten Research (SAR), Open Building has become an international network of researchers who share ideas about how to produce housing (Nascimento, 2012). Briefly, the group understands that interventions in the built environment occur at several levels and that space is constantly changing, so the involvement of all participants in the process is essential (Nascimento, 2012).

In this perspective, Tatjana Schneider and Jeremy Till, architects and theorists who research about housing as a process since the 1980s, use the concept of flexible housing for situations when users can interfere both in terms of use and construction (Schneider and Till, 2005a). This concept is then subdivided into degrees of flexibility, involving questions of internal (different arrangements of social use) and external (diversified physical arrangements) adaptation, prior or during occupation. The authors advocate that long-term thinking is necessary to deal with unpredictable demands (Schneider and Till, 2005a).

This concept of flexibility is closely associated to a redefinition of the architectural exercise towards spatial agency (Schneider and Till, 2009). Agency is defined in its sense of transformation, as an action that has social change effects, when the architect becomes an additional participant in the production of space instead of the main one (Schneider, Till, 2009). The notion of authorship is confronted with that of authority, which means that abdicating a dominant position in favor of a more participatory approach creates new opportunities in the design process, as the spatial intervention could be shared among several individuals and creativity could be directed to the proposition of different methods (Schneider and Till, 2009).

Those studies on spatial agency also highlight individuals' attitude of taking control over their environment and recognizing themselves as interveners (Schneider and Till, 2009). This point of view has opposite implications to those applied today by the real estate market, where housing is seen as a product, an element to be sold. This situation means to take a political view of design and construction processes, as well as of the concepts that surround them (Schneider and Till, 2009). From this perspective, the Spatial Agency project was initiated by Schneider and Till, made available on an online platform (Schneider and Till, n.d.) and published as articles and books. In their website, the materialization of buildings is displayed as one among many other activities of the architectural practice. This platform focuses on examples ranging from pedagogy, publishing, networking and making policies, often in a hybrid manner (Schneider and Till, n.d.).

Sérgio Ferro, Brazilian architect and theoretician, is featured in the Spatial Agency platform. In the 1960s and 1970s, he strongly criticized the dichotomies of work relations at the construction site and how it creates a series of contradictions between design and execution (Ferro, 2006). For him, one way of incorporating the workforce and users' performance in housing production would be to change the construction industry strategies. For example, the dissociation between structure and internal elements would make it easier to organize them in the course of construction. Some of these proposed strategies were conceived in partnership with other architects, Rodrigo Lefèvre and Flávio Império; and the three of them founded the Arquitetura Nova group. Their theoretical and practical production was small in quantitative terms but brought important elements to the debate on the architectural practice (Ferro, 2006; Arantes, 2002).

Ferro (2006) also discusses the Brazilian construction sector with the lens of work exploitation. He points out the low technology applied in the sector to increase profit by the employment of non-specialized people. Thus, the employer has to use ordinary materials and techniques in order to decrease the need for investments in machines or other technical instruments. This situation could be changed with the introduction of new production strategies which combine worker's specialization and the implementation of new approaches in the sector (Ferro, 2006).

Ferro's debate on workers' alienation during the construction process is closely associated with authorship as authority. About this, Carpo (2011; 2017) discusses the shift in the architectural practice that occurred during the Renaissance, what he calls the "Albertian paradigm". After that, "works of the intellect, regardless of their material complexity, are expected to be ideated by an individual author and to be the expression of just one mind" (Carpo, 2017, p. 135).

Carpo (2011) argues that an integration along the design and construction process could occur both horizontally and vertically. According to him, horizontal connection has to do with the understanding of agency, which presupposes sharing authorship and responsibility among all participants, from architects to users. Vertical integration, in turn, is related to the incorporation of digital technologies into the design process through file-to-factory procedures and web-based platforms, blurring the lines between designers and makers, or architects and construction workers (Carpo, 2011). Both are being experienced with rise of contemporary participatory trends such as Open Design.

The Open Design movement comes with the promise of rationalization through the widening of technological ways of thinking and manufacturing, which could mean a big shift in situations like the Brazilian case. According to Menichinelli *et al.* (2017, p. 2), *"*the Internet and World Wide Web have allowed the scaling up of projects in ways that were previously considered impossible, in a way that complexity stops being a problem and could become a positive feature*"*.

With the use of shared platforms, Open Design also encourages information and experiences to be exchanged, making this system an accessible and easy way of logical and creative thinking. However, because it needs a basic knowledge of software programs and access to manufacturing spaces, such as Fab Labs or Makerspaces, Menichinelli *et al.* (2017) say that it is a new modality of work, a very recent movement, different from everything that have already existed.

Avital (2011) defines Open Design as the possibility of user-driven creation and production processes enabled by distributed manufacturing. According to him, it is possible to identify four main layers in Open Design: object, related to design specifications; process, or fabrication; practice, which has to do with work relationships; and infrastructure, or institutional foundations. He discusses that a well-defined infrastructure is essential for an open system to work properly, leading to adaptive and powerful designs (Avital, 2011).

Menichinelli *et al.* (2017) argue that the joint between the specialized tradition of manufacturing and craftsmanship and the participation of common people through the hacking of ordinary objects is inventing new creative ways of impacting social networks with innovative products. However, rather than the technological innovation itself, an important contribution is an innovation in the organization of work mediated by technology (Menichinelli *et al.*, 2017).

It is also interesting to mention the parallel between Siefkes' (2007) and Ferro's thesis (2006). Ferro (2006) criticizes the exploitation of the workforce in the housing production with the perpetuation of the capitalist system. In contrast, Siefkes (2007) considers Open Design as a scenario of a peer production society, where it becomes possible for workers to take control over the means of production, in a contemporary revival of Marx's theory, with the allowance of personal manufacturing. However, despite this fact, Bianchini and Maffei (2012) discuss that those new strategies of making design are still a new form of capitalism, independent, distributed and democratic, in a micro scale.

3. CASE STUDIES

Considering new ways the architect can act, as one among other agents in the process of designing and developing housing solutions (Schneider and Till, 2009) and based on a systemic view of the dwelling within the parameters of resilience, some relevant cases were selected for analysis, taking the Spatial Agency platform as a starting point. The selection of cases considered only housing examples produced through non-authorial approaches with enough material available for analysis, users' influence in design and production processes and variability of technologies, in a range of national and international references.

According to Buschbacher (2014), it is possible to verify the resilience of a system by observing its reaction under a collapse situation, and it is important to notice that the three fundamental parameters - *permanence, environment* and *autonomy* (Vieira, 2000) - are always interacting with each other. Therefore, the analysis methodology consists on applying a hypothetical collapse condition to the systems in each case study, checking the results related to the resilience characteristics - *adaptation*, *learning* and *self-organization* (Buschbacher, 2014) - as shown in Figure 2. Thinking about housing as a system, the fundamental parameters are applied as it follows:

Permanence can be understood as the relationship between the family and the house, that is, the willing to stay;

Environment can be thought as the urban infrastructure, the social fabric surrounding a housing unit;

Autonomy relates to a families' (or community's) capacity to change or choose a new approach to do something related to the house.
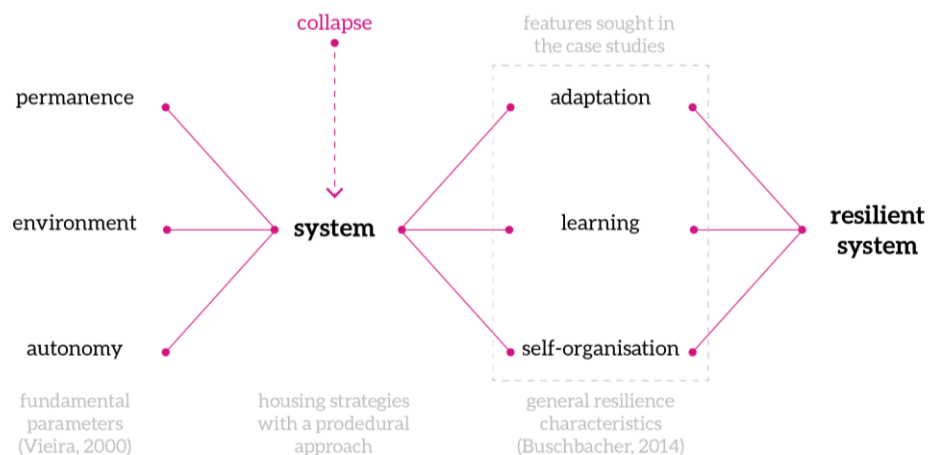

Figure 2: Analysis methodology

3.1. COPROMO (1991-1998)

COPROMO is a short term for "Cooperativa Pró Moradia de Osasco", that could be translated as Osasco's housing cooperative. According to Vilaça and Constante (2015), this group had its beginning in 1990, when the leadership of Terra Nossa Association started a registration of the needy families in the region. Almost ten thousand families passed through this register just in the first week of work and it had showed the need for some urgent housing strategies in the community. With the assistance of the group Usina Centro de Trabalhos para o Ambiente Habitado (Usina CTAH) - a technical consultancy that acts in the articulation of processes involving planning, design and construction by the workers themselves - they started a project to design and build several housing units (Baratto, 2015).

The assistance group and the families worked together to develop the house plans, keeping in mind important issues such as the construction system they would choose, specificities in the houses and the community work logic (mutirão), which implied simplification and standardisation (Vilaça and Constante, 2015).

An innovation adopted in this project was the use of metallic stairs in independent structures that were built before the masonry walls (Arantes, 2002; Baratto, 2015; Vilaça and Constante, 2015). It provided the workers with more security in the construction process and also represented a plumb to the building. Usina CTAH has worked close to social movements and organised groups through meetings that reinforce the process of de-alienation, in other words, the deconstruction of consensus that exists on the figure of technicians as knowledge holders, as opposed to those who are told to execute them (Usina CTAH, 2015).

The group of architects gave assistance to the cooperative only during first and second years of work, being the six following years headed by the cooperative itself (Vilaça and Constante, 2015). In 1998, the work was finished with fifty buildings built by this cooperative in the land, a sum of one thousand housing units in a good location in the city, surrounded by schools, hospitals and health centres. The families themselves defined which unit would each family occupy, according to social bonds (Vilaça and Constante, 2015).

Regarding the *adaptation* feature, even though the group is able to change its way of working and adapt, the building is made out of structural masonry. So, dwellers do not have much flexibility to reorganize the space plan, for example adding or removing a room, if something changes in the family.

As for the *learning* characteristic, considering that the group have constructed the building by themselves, there is a big possibility they have learnt through this process and will be able to integrate new approaches in a collapse situation, which gives the group possibilities to develop different solutions.

Finally, in a hypothetical collapse, there is a big possibility of *self-organization* within the group due to the social bonds that were established along all the construction process. This opens up possibilities to collectively rebuild some damaged part or new buildings utilizing the approaches that have already been developed, besides from setting up resistance in the community in face of supposed threats from the real estate market.

As a final evaluation the COPROMO's approach was considered positive in regard to *learning* and *self-organization* characteristics, and negative in the *adaptation* aspect.

3.2. NEXT 21 (1993 - …)

NEXT 21 is a multi-familiar housing project developed in Osaka, Japan, as an unfolding of Habraken's (1999) theory and the Open Building movement (Nascimento, 2012). It incorporated the Skeleton Infill idea (Schmidt III and Austin, 2016), with rigid, social structure and free, private infill, where each family can develop their specific arrangement. The skeleton construction ended in October 1993 and infills of units were finished in December 1993 but considering families can move in and out and change the plans, the building is still under construction (Kim *et al.*, n.d.).

The site is well located in the city, close to a series of other residential buildings and schools. According to Habraken (1999), the industrialization of a building is essential, and it can be achieved through the pre-fabrication of construction elements. This strategy was applied in NEXT 21. Considering the building as complex system, four subsystems were established as a strategy to design: structure, cladding, infill and plumbing, dividing the whole process in different parts that contribute in each other and some of them have the participation of users in its design process (Kim *et al.*, n.d.). The main objective, however, is not just to invite inhabitants to participate, but to rescue their presence in the decision-making processes, as stated in Habraken's interview to Nascimento (2012):

> I prefer not to use the term "participation" because it usually means that professionals are willing to listen to would-be inhabitants, but in the end will make all decisions. "Decision making power", on the other hand, means that professionals do not make certain decisions but seek to provide a context in which those decisions can be made by inhabitants (Nascimento, 2012).

During the beginning of the process some interviews were conducted with future occupants. After that, general design objectives for the full project were established, followed by strategies to achieve those goals (Kim *et al.*, n.d.). According to Kendall (2004) and Kim *et al.* (n.d.), several groups of architects have worked on different capacities: one firm was responsible for the building infrastructure, and others for infills and individual housing features. Thirteen architects carried out the design of units' internal subdivision. This degree of adaptation facilitated and encouraged the innumerable modifications made by residents.

Considering the building was developed using an approach that focused on *adaptation*, this characteristic is a positive point, even though professional participation is necessary in the adaptation process if it has something to do with structure, for example. In a collapse where only infills were destroyed, it would be perfectly possible for residents to make changes by themselves.

As a matter of process, *learning* in this case can be considered as the contact with other residents that have already done internal changes or following a user manual, for example. Indeed, according to Schmidt III and Austin (2016, p. 36), "(m)odular coordination is established through a rulebook to ensure cohesion between the individual units and the neighborhood". This feature was considered positive.

Concerning *self-organization*, even if the inhabiting families could be considered a community, it does not mean they are a cohesive group; maybe they do not know each other, and each family possibly has done their refurbishment individually. Since it was not possible to identify if there is this kind of organisation within the group, this aspect was considered neutral.

As a final evaluation, the NEXT 21 approach was considered positive in regard to *adaptation* and *learning* characteristics and neutral in the *self-organization* feature.

3.3. WikiHouse (2011 - …)
Wikihouse is a wooden joints system conceived for the production of houses through Computer Numerical Control (CNC) techniques (Open Systems Lab, n.d.). Projects developed through this system are easy to customize, manufacture and assembly. It follows an open source approach, which means that anyone can have access to source files to modify them according to their own needs and, after that, they can have their design produced via distributed manufacturing (Open Systems Lab, n.d.). This whole concept is inserted into the

Open Design movement, according to which changes in the ways of making, using and consuming products also change the relationships between people (Thackara, 2011).

Wikihouse was created in 2011 by Architecture 00, a firm from London. It has received many improvements over the years and nowadays is managed by the non-profit organization Open Systems Lab. According to Parvin (2013), one of the collective founders', the incorporation of new digital technologies into the architectural practice transforms design and building strategies, as well as the relationships between all parts involved. He argues that:

> What these technologies are doing is radically lowering the thresholds of time and cost and skill. They're challenging the idea that if you want something to be affordable it's got to be one-size-fits-all. And they're distributing massively really complex manufacturing capabilities. We're moving into this future where the factory is everywhere, and increasingly that means that the design team is everyone (Parvin, 2013).

Such connectivity is only possible because it works beyond the physical space. The *environment* of those contemporary practices is a hybrid between the physical and the digital, creating a third environment. As discussed by Castells (2013), this intersection of the urban space and the cyberspace creates an enabling environment for *autonomy* in communication.

By imagining a house built under the Wikihouse system after a collapse, it is possible to analyse its resilience. First of all, the Open Design principles make *adaptation* an achievable feature. If the dwelling is completely destroyed, or in case it is necessary to add or modify rooms, inhabitants could customise their homes accordingly and have pieces cut in a Fab Lab or small factory. However, the Wikihouse system does not yet include an appropriate user interface. Even though there are manuals available in the Wikihouse website, inexperienced users would need architects to carry on the design process within the system.

Regarding the *learning* aspect, Open Systems Lab seems to be working on the already mentioned manuals, which gives guidance to all stakeholders. Besides, the collaborative aspect of Open Design, with source code sharing in online communities and the worldwide communication through Web 2.0 enhances *learning* with knowledge being available anytime, anywhere.

The *self-organization* characteristic has many similarities with the *learning* one in this case. For example, the user guides are not simply produced by Open Systems Lab; instead, they are made available in open source platforms for users to contribute. Likewise, to have a community of people creating and manufacturing under the same circumstances in different

places means that there would probably be someone with the necessary skills to help in the case of a collapse.

To summarize, all the resilience characteristics were identified as positive, even though improvements are necessary for the *adaptation* feature to work properly.

4. CONCLUSIONS

The discussions about the concept of system applied to housing, under the complexity perspective, made it possible to recognize several aspects that characterize it as a socio-ecological system, with an emphasis on the fundamental parameters of *permanence*, *environment* and *autonomy* (Vieira, 2000). The introduction of the notion of general resilience (Buschbacher, 2014) raises questions about how current housing production is constrained by the real estate market, which is resilient according to the reductionist paradigm, by maintaining a negative regime tied to the capitalist control.

As seen, the complex, open and adaptive character of housing is not sustained by the traditional exercise of architecture. Authors as Pelli (2006), Ortiz Flores (2011), and Schneider and Till (2005a) disregard the quality attributes of mass housing developments. However, the idea of flexibility described by Schneider and Till (2005a; 2005b) is strongly connected with the adaptability of socio-ecological systems. Therefore, searching for a general resilience in this kind of system shares the same principles of counter-hegemonic practices.

The analysis of three case studies demonstrated, through a variety of approaches, that all of them act as complex and resilient systems. The strategies adopted by the alternative practices are related to the conscious use of technology, the involvement of users from initial stages of the process, the presence of diversity, the creation of products directed to inform and educate and, finally, the strengthening of networks, whether local or global. Figure 3 summarizes these findings.
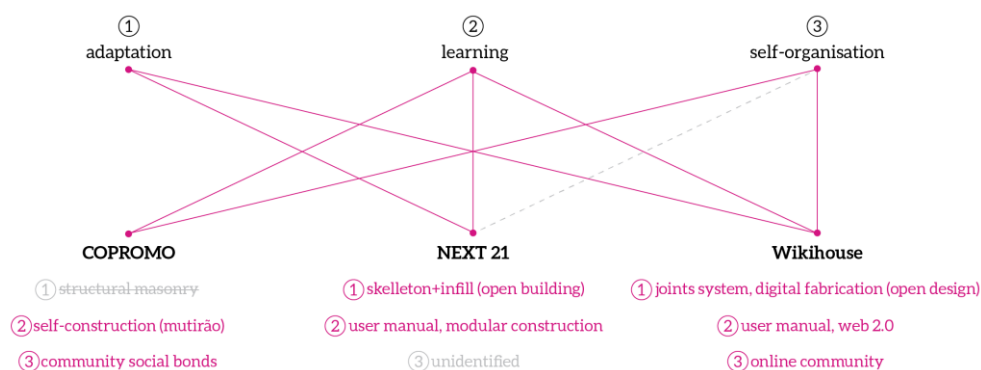
Figure 3: Synthesis of the general resilience characteristics identified in the case studies.

It is important to notice that just one approach marked positive in all the resilience characteristics, the Wikihouse case. Even so, it still lacks an appropriate interface to give users autonomy over their spatial production. For now, the proposed system seems to be accessible only by experienced people, such as architects, designers and engineers, which maintains the authority and authorial professional perspective similar to what have been discussed by Schneider and Till (2009) and Carpo (2011; 2017).

Wikihouse also presents some issues such as the detachment of its approach from the urban context, with a focus on single family housing, which may not be applicable to dense occupations. The integration among all stakeholders is also a key aspect. Aiming to solve some of those issues, Open Systems Lab is working on a new project called BuildX, which focus on providing a digital platform to cover many phases in the supply chain, such as user inputs, cost estimates, manufacturing, delivery and assembly (Open Systems Lab, n.d.).

The Open Design movement was born in a hybrid environment where some strategies, such as open, peer-to-peer, diffuse, distributed and decentralized systems (Menichinelli, 2016), are only possible through an internet connection. Even though it relates to this contemporary condition fostered by the digital age, its origins can be noticed even in practices that do not presuppose any kind of digital platform, such as NEXT 21. In the practices analyzed, this philosophy is perceived not only in their creative processes, based on parameters of *permanence*, *autonomy* and *environment* (Vieira, 2000), but also in their fabrication and construction. In the case studies, the final outcome is not more important than the process through which it was made.

Finally, this study made it possible to observe that counter-hegemonic approaches in the production of space can be directly related to issues of resilience, which promotes spatial improvements. As stated by Schmidt III and Austin (2016), there is not a single solution for

adaptation, and the same can be said for resilience. In addition, all the examples manage to strengthen community bonds and encourage new ways to apprehend space and learning. Next generations are going to deal with challenges that have never been faced before, like legal questions concerning sharing of ideas and responsibility in user-driven processes. But they are also going to experience a revolution in the production agenda, guided by technology and new informational processes.

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