Evolutive Dwelling: A Systemic, Open and Sustainable Approach to the Rehabilitation of the Italian Mass Housing Stock: the Case Study of the Open Building

Sonia Pettinari ¹ and Massimo Perriccioli ²

¹Università di Camerino, Scuola di Architettura e Design “E. Vittoria”, Viale della Rimembranza 63100 Ascoli Piceno, sonia.pettinari@unicam.it
²Università di Camerino, Scuola di Architettura e Design “E. Vittoria”, Viale della Rimembranza 63100 Ascoli Piceno, massimo.perriccioli@unicam.it

PAPER ABSTRACT. The research works on the issue of the Italian mass housing, because it’s believed that housing is playing a key role in the current social and economic situation that involves the entire Country. The Italian mass housing sector is now experiencing a deep crisis in social and economic terms. It’s also living a strong contradiction. There is in fact a great demand for housing, which doesn’t receive an adequate response in terms of functionality and affordability, and at the same time a large, unused and obsolete building heritage, both as regards the new that the existing. This has inevitably bring to a paralysis of the construction sector and consequently of the construction industry.

What we can see today in Italy, despite the goodness of the original intentions of the Big Plans of Sixties and Seventies, is in the most of cases a large building stock become prematurely obsolescent, with a life potential further reduced in the light of the recent regulations in terms of sustainability and energy efficiency, creating situations of precarious housing conditions, fertile ground for social and urban degradation. For this reason the research mainly focus itself on the rehabilitation of the existing building stock.

The aims of the research is to investigate, on one hand potentiality and limitations of the Open Building approach applied to the prefabricated systems of the Italian housing of the Seventies, on the other hand a system and a hierarchy of components that can be industrialized and customized, and their interdependencies. This as a strategy for rehabilitation interventions.

This can become a big ground of experimentation, able to give new rules and a new direction for the future, more efficient and sustainable, building construction. Furthermore it could be a ground of work able to boost the market of the industrialized building component.


AUTHOR BIOGRAPHY:

¹ Architect, Master Degree in Technology of Architecture with a thesis entitled Life Architecture. Open and Sustainable system for a strategic dwelling buildings. Research grant holder in the 2011 for a research project entitled Definition of an Open and Prefabricated Concrete Building System for Single and Multy-storey Houses for New Users, characterized of a Low Energy Consumption, Low co2 Emissions. PhD Student in Design and Experimental Architecture at the School of Advanced Studies of the University of Camerino.

² Professor of the School of Architecture of the University of Camerino. Since 2008 he is the coordinator of the Bachelor Degree course and member of the Board of the School of Architecture of the University of Camerino. Since 2006 is a coordinator of PhD course in Design and Experimental Architecture of the School of Advanced Studies - University of Camerino. Professor of Design of Construction Systems and Technological Culture of Design. Research in field of technological innovation and environmental design, mainly focused in experimentation in design methodologies for low cost, low energy and based on lightweight construction systems housing buildings.

1
1 Introduction

The Italian mass housing sector is experiencing a deep crisis in social and economic terms. It’s also living a strong contradiction. There is in fact a great demand for housing, which doesn’t receive an adequate response in terms of functionality and affordability, and at the same time a large, unused and obsolete building heritage, both as regards the new that the existing. This has inevitably bring to a paralysis of the construction sector.

The reasons of this gap are manifold. The great social changes that occurred in the last fifty years that have led to a fragmentation in the household structure and a trend no longer linear in its development. There is in fact a complexity of needs respect the past (just to mention some of this: single people living away from their family for work, single parent families, childless couple, adults with children who come back to live with parents, families of immigrants with several sons, disabilities that needs specific requirements and changes over the time). In addition to this social fragmentation, the levelling down of economic conditions of a portion of population more extensive and varied than the past, is no longer able to sustain the current market prices. The economic crisis that involved the Country has significantly reduced the spending power of families, the affordability to the home ownership (traditionally recognized as a safe investment in Italy) and the government hasn’t provided strong and adequate public policies to support the social housing sector.

The availability of a large obsolete housing stock inherited from social housing Plans of the Fifties to Eighties, require strong structural intervention and doesn’t meet the current European standards on energy efficiency and environmental sustainability. At the same time the difficulty of owners Institutions to manage and maintain existing building and the rigidity and costliness of traditional building systems in undergoing changes, upgrades and energy efficiency intervention, cause on the one hand conditions of serious precariousness of life for the inhabitants and, on the other hand, phenomena of building’s abandonment and its consequent degradation.

At the physical degradation inevitably accompanies a social degradation and phenomena of illegality, especially in the suburbs of big cities. Frequently are occurring incidents of illegal appropriation of abandoned buildings, until the limiting case of the illegal occupation of privately-owned dwellings, forcing people to a continuous surveillance action. It is important to highlight that in the illegal occupation of new buildings, never finished and abandoned because the failure of contractor, people have in some cases completed by yourself the dwelling. The Municipality, not in a position to provide adequate response to the housing needs in another way or to finish the construction, is thinking of finding forms of legalization of this situation.

All this has serious repercussions in the construction industry, that is experiencing a serious state of crisis.

2 Scenario of the Italian mass housing

2.1 Historical Overview

2.1.1 Post War Housing

The situation that the Italian mass housing is facing originates from the housing policies adopted between the Fifties and Eighties of the past Century. It was in fact in those years that were made Big Plans for mass housing. They were also, in the Sixties, an important ground for a large application of prefabricated systems and industrialized processes of construction and they saw, in some cases, the involvement of the greatest architects of the time.

In the 1949, after World War II, with the law February 28 nr. 43 the Italian Parliament approved the bill measures to increase employment, facilitating the construction of houses for workers, with whom he would set in motion a plan for the construction of affordable accommodation, known as INA-Casa Plan (Fig.1). The plan, therefore, was interpreted and presented as a measure aimed at boosting the economy and the employment, building affordable housing.

The fourteen years of plan assets represented a significant phase of economic policies after the war, and certainly one of the most important, relevant and widespread experiences of achievement in the field of social housing in our Country. His accomplishments, healthy and modern houses within new urban centres or districts, were offered the chance to thousands of families to improve their housing conditions. For the Italian planners and architects the new settlements represented the first real opportunity to give shape to the rapid
and fragmented expansion that the Italian cities were experiencing.

Between July and October 1949 over 650 building sites were opened, giving a shelter to about 560 families a week. Until the 1962 the 20,000 building sites spread throughout Italy, in big cities as in the small towns, employed every year 40,000 construction workers, involving in this experience about a third of Italian architects and engineers active in those years.

The decision to reject the methods of prefabrication arose not only from the objective of respecting the different local building traditions and the character of the built environment, but mainly to expand employment of not skilled labour. The choice of the low mechanization and the high use of labour had the effect of preserving the site and the building 'crafts and traditional'. A choice that, according to some critics, helped to maintain backward the character of Italian construction industry. In the 1963, after about fourteen years, the liquidation of the housing stock of the INA-Casa management and the establishment of a ten-year program to build housing for workers, the experience of the INA-Casa finally was closed. Other institutions, other regulations and instruments have taken its place in the planning, financing and construction of social housing.

2.1.2 Sixties and Eighties: the introduction of the prefabrication.

It was in the 1962, as a result of the law nr. 167 of April 18, that promoted municipal plans for popular and affordable housing, it started the second major program of residential building. This time introducing some prefabrication systems tested in other European countries (Fig.2-7)

Despite the opportunity offered from a massive intervention, justified by entities of the housing needs and the introduction of new technologies and systems, the character of the residential building of this period presents conditions of qualitative backwardness. This because the big potentialities of this new industrialized approach to the construction has been partially undermined by an instrumental use of the scientific research to the logic of increased productivity and entrepreneurial profit.

At the beginning of the Eighties the great season of prefabrication and ERP (acronym of Edilizia Residenziale Pubblica, public housing) large size programs came to an end. These neighbourhoods are now not only a significant testimony of the Italian twentieth century, but are considerable parts of our cities that still maintain their precise identity.
Fig. 2 Aedis concrete prefabricated system, facade window panel.

Fig. 3 Aedis concrete prefabricated system, bathroom unit

Fig. 4. Aedis concrete prefabricated system, installation of floor panels, photo credit Oscar Savio
Fig. 5. Aedis concrete prefabricated system, multi-storey residential building, photo credit Oscar Savio.

Fig. 6. Aedis concrete prefabricated system, installation of facade panels, photo credit A. Carloni.

Fig. 7. Aedis concrete prefabricated system, installation of facade panels, photo credit A. Carloni.
2.2 Current situation

What we can see today, despite the goodness of the original intentions, is in the most of cases a large building stock become prematurely obsolescent, with a life potential further reduced in the light of the recent regulations in terms of sustainability and energy efficiency, creating situations of precarious housing conditions, fertile ground for social and urban degradation. Possible reasons of the failure of this planning may be sought, on the one hand, in the settlement policies adopted, and on the other hand by a bad, and sometimes malicious, interpretation of the potentiality of technological innovation of the industrialization (Ruggiero 2012).

On the issue of the rehabilitation of the existing buildings some European countries are engaging effectively. As for Italy, the experience of the programs called Contratti di Quartiere I (1998) and II (2001) was only marginally able to intervene on large, industrialized housing developments, for whom the idea of scrapping seems to prevail, especially among those, entrepreneurs and administrators, who see in the demolition and reconstruction (with maybe increase of volume) a profitable practice. In the light of the emergency of the issues related to sustainability and the reduction of resources consumption we should ask if is the tabula rasa the objective to be pursued.

We are often faced with a building heritage in a strong state of decay. It is a vast heritage and hardly to scrap and whose constructive intelligence of some cases can be a significant resource on which to base regenerative practices.

Current interventions on the existing housing stock are mainly retrofit actions, with the replacement of non performing parts with new one with better performances in terms of durability, mechanical resistance, energy efficiency, solving just part of the complexity of functional, social, economic, environmental issues related to the dwelling.

3 Open Building approach to the rehabilitation of the existing Italian mass housing.

3.1 Research focus

The research mainly focus itself on the rehabilitation of the existing building stock that represent the main issue of the Italian mass housing. This can become a big ground of experimentation, able to give new rules and a new direction for the future, more efficient and sustainable building construction. Furthermore it could be a ground of work able to boost the market of the industrialized building component to tackle the serious crisis that the sector is experiencing.

Ended the season of big Plans for residential construction, at least of those fully funded by public resources, are now private capital and entrepreneurs the main actors of the realization of big residential intervention. This require more attention to the construction and building management costs, therefore it’s need a more efficient system to achieve best results in terms of quality, reducing resources consumption and waste and able to retain building value over time.

It is necessary a new way of looking at the design and construction of the dwelling. An approach able to consider the importance of the user’s role and of the time factor as a generator of its structure. A structure able to adapt and evolve with it, in relation to the changed internal and external conditions.

All this requires first of all a change of mentality. The abandon of the idea of the home as a scientific product, standardized, concluded, fixed, in favour of a systemic approach, a hierarchy of spaces, components and levels of decision making, as well as appropriate technology to support them.

3.2 Open Building approach

The Open Building is a consumer oriented approach that contemplates technological, organizational and economic solutions for a built environment able to adapt itself to the changing needs.

Developed in Netherlands from N.J. Habraken at the beginning of the Seventies, the main issue of this
approach is that it consider the building as a results of two sub-system Support and Infill, separated but at the same time connected by functional and technological relationship, considering the built environment as a product of an never ending design process, in which environment transforms part by part.

The Support is referred to a part of the building whose construction is entrusted to the building developers, leaving choice and responsibility for the reminder of the building to tenants during the fit-out phase. The base building normally includes the building’s primary structure, the building envelope in whole or part, public circulation and fire egress (lobbies, corridors, elevators and public stairs) and primary mechanical and supply systems (electricity, heating and air conditioning, telephone, water supply, drainage, gas) up to the point of contact with individual occupant spaces. The Base building provide serviced space for occupancy. Supports are residential base building. The Infill is the part of the building in which the user has direct action. Is the total configuration of physical parts that determine each individual occupancy. It’s provided of an high level of configuration and it is changeable over time and demountable (Kendall).

Starting from this main assumption, the Open Building focuses on a complexity of other aspects that necessarily involve the dwelling and the idea of a building conceived as an open system of different parts with specific roles and functions but interconnected. Aspects referred not only to technological and constructive features (component’s specialization, functional and technological flexibility, dependencies and influences between fixed structure and the variability of the fit-out systems, the matter of nodes and interfaces between parts and components, modular coordination), but also issues related to the process (organization of the decisional levels and actors involved in the different phases, organization and management of the information, process optimization, reduction of waste) and architectural and social issues (the role of the user, the project of the unknown and unpredictable, the management of the complexity).

3.3 Advantages of the Open Building approach to the rehabilitation of the Italian mass housing

As previously explained, Italy lost the opportunity offered from the industrialization of the building process and the introduction of prefabricated systems. Evaluating the unexpressed potentialities of the systems mainly used in this residential buildings is possible to find several advantages from an open and systemic approach.

Considering the role of the user in the building process and the building like a dwelling served surface make it possible to create a dwelling space able to physically adapt to the initial and over time needs. In this way people can make their own home depending on their needs and economic availability. Knowing that they can change the dimension and the functional configuration of it when it’s necessary and possible. This has positive effect on the built environment creating a better and long-term relationship between the user and his dwelling and a sense of responsibility of the built environment.

Conceiving the building as a system of two parts with different life cycle make it possible to intervene in different way and in different time on the primary structure and on the infill system. This involves a continuous maintenance of the building, extending the life of the building and retaining the building value over the time.

At the end, the use of the dry construction for the infill systems and components designed to be disassembled, reused or recycled permit a a reduction of waste and consumption of resources.

4 A matter of culture

When habits are already formed, a different way of conceive the building and a new way of working can occurs when it’s become generally accepted. Despite the goodness of the intention this become an important aspect that can decide the fortune or the failure of the idea. This is in part the reason because, together with logics of speculation, we lost the opportunity offered from the prefabrication to work with open systems to improve the quality of the building product and the dwelling environment.

In Italy the house has always been a fundamental asset, conceived to last over time and a safe investment. Until the Sixties it was the place of life of different families and in many cases included spaces of work. It was in the Sixties, in consequence of the economic boom that something changed, also changing the relationship with the dwelling space. We have witnessed to a gradual standardization of the living patterns, followed and in some ways emphasized to the standardization of the living conditions and construction.

It is also for this reason that the building sector has represented for long time a strong sector of the Italian
economy with considerable profits. The aim to increase the profit brought to the attention on reduction of cost at the expense of quality of the products and working conditions and to focus on established building practices. All of this caused resistance to the introduction of innovation able to improve the quality level of the building production.

Consequently the industry has focused more to put in place strategies to reduce cost instead to improve performances and qualities of the products, following the market. Moreover, the rigidity of the production process related to the available technologies and the lack of flexibility of the production lines has made the production inadequate and economically inefficient to adapt to the realization of diversified components as required by a more evolved and open prefabrication.

Today the framework has changed considerably as a result of major social, economic and environmental changes. In its criticalities it contains opportunities to openness to a stronger change that must be seized.

The standardized living pattern in functional and constructive terms adopted in the Post war mass housing is in crisis for two main reasons. First of all the life habits have changed and diversified rapidly. Secondly the economic crisis that involved the Country has significantly reduced the spending power of the families and the accessibility to the ownership of the house and the job precariousness has made it difficult to access to the financial credit. The dwelling dimensions are gradually reduced to meet the market, generating greater functional and constructive rigidity and a greater incapacity to accommodate future needs and then to establish a long-term relationship.

Moreover, the concepts of prefabrication and dry construction, despite the initial resistances and mistrusts, are gradually becoming part of the common practice on the base of the obtained results in terms of rapidity of realization, cost optimization, control, evaluation and certification of performances thanks to the transfer of most of the work from the site to the factory.

In an economic context so deeply changed and in a shrinking market the industry feels the necessity to innovate its structures and processes and to propose new products aiming to the quality and the cost optimization obtained through the process optimization and the reduction of waste. Great progress in the industrial production have been made, also thanks to information technology, with more efficient and especially flexible processes. The flexible automation is in fact able to maintain competitive production for large products families, with low to medium production volume, regardless of the project, the application, by changes in the product mix. This inserting appropriate redundancy in the system that make it easy to adapt the production system to the new requirements. New development scenarios are opening thanks to the possibilities provided by the 3D printing applied to the construction.

It is also necessary an adequate regulatory system to support the development of this method but, according to N.J. Habraken, if you believe in the power of invention, once the car was known, the roads got built.

5 Methodology proposed

5.1 Prefabrication systems in the residential building of Sixties and Eighties

Through the analysis of the residential building interventions realized between Sixties and Eighties the mainly used industrialized system for casting concrete (Banches-Tables, Tunnel, climbing formwork, predalles, HBS) and prefabricated mono-dimensional, bi-dimensional, tri-dimensional construction systems (concrete and steel) are recognized. Each system, is studied in its specific aspects (formal, functional, structural) to define constraints and possibilities of the primary system (Fig.8-29).
Fig. 8 Banches Table, metal banches in position for the concrete casting

Fig. 9 Banches Tables, couple of banches in position for the concrete wall casting.

Fig. 10. Banches Table, moving and positioning of the Tables on the seventh storey for the realization of concrete floors

Fig. 1. Banches Table, Table used for the realization of cast-in-place floors
Fig. 11. Tunnel, formwork positioning.

Fig. 12. Tunnel, formwork positioning.

Fig. 13. Tunnel, formwork positioning.

Fig. 14. Predalles, positioning of Predalles floor.

Fig. 15. Predalles, concrete casting.
Fig. 16 HBS system, moving of load bearing wall formwork.

Fig. 17 HBS system, moving of precast slab.

Fig. 18 HBS system, load bearing wall casting.

Fig. 19 HBS system, scheme of structural element.

Fig. 20 HBS system, load bearing wall casting and lifting of metal formwork.
Fig. 21 HBS system, installation of facade elements.

Fig. 22 HBS system, complex of completed buildings, Nichelino, Torino.

Fig. 23 Peruzzi system, multi-storey pillars.

Fig. 24 Peruzzi system, positioning of floor slab.

Fig. 25 Peruzzi system, positioning of facade panels.
Fig. 26 Load bearing wall system, M.B.M. Meregaglia.

Fig. 27 Load bearing wall system, M.B.M. Meregaglia.

Fig. 28 Load bearing wall system, M.B.M. Meregaglia, vertical and horizontal nodes.

Fig. 29 Load bearing wall system, M.B.M. Meregaglia, multi-storey building, Boviscasa neighbourhood, Milano.
Related to each construction system are then identified examples on the existing built environment to be used as case studies (Fig. 30-36). This additional step has the task, based on the data previously acquired, to add information related to the introduction of a construction system in a specific historical, social, environmental context for a more thorough knowledge framework. The selected case studies are studied through a systemic approach, operating consideration on each subsystem on the typology used, the state of conservation and on the degree of efficiency in terms of mechanical, functional and energy performances.

Fig. 30. Corviale, Roma, 1972, project Architect Mario Fiorentino. Photography by Sonia Pettinari.

Fig. 31. Corviale, Rome, 1972, project Architect Mario Fiorentino.
Fig. 32. Selva Cafaro neighbourhood, Napoli, mid-Eighties. Photography by Sonia Pettinari.

Fig. 33. Selva Cafaro neighbourhood, mid-Eighties, Napoli. Photography by Sonia Pettinari
Fig. 34. Vele di Scampia, Napoli, 1964.

Fig. 35. Vele di Scampia, Napoli, 1964. Courtesy of Panorama.

Fig. 36. Vele di Scampia, Napoli, 1964. Courtesy of Panorama.
5.2 Open Building case studies

In parallel of this activity is made a selection of a significant number of case studies of building constructed according to the principles of the Open Building (just to mention some of them Maison Médicale Student Housing 1974, Dwelling of tomorrow in Hollabrunn 1976, Molenvliet -1977, Sterrenburg III 1977, Next21 1994, Pipe-Stairwell Adaptable Housing 1994, Keyenburg 1984 Fig.37-46), using different construction types and for each of them is drawn a document according to a set format. The aim of this document is to subdivide the project in different classes of information related to the physical and qualitative aspects of the building (dwelling typology, structure, facade, roof, partitions, utilities, dimension, year of realization, state of conservation, degree of flexibility etc.). What is expected from this activity is a better understanding of the possibilities and constraints of this approach related to a specific requirement.

5.3 Building’s reading map and matrix of intervention

Matching the results obtained in these two work phases is possible to create a reading map. A work tool in way to provide a systemic reading of the existing industrialized residential building to evaluate for each part of the building system specific features, potentialities, constraints, also in relation to the state of conservation. All this in order to identify the degree of practicability of an open approach as a strategy of intervention on existing industrialized residential buildings stock.

6 Conclusions

The research, working on a new and open approach to the rehabilitation of the Italian existing mass housing stock, aim to stimulate more socially, economically and environmentally sustainable practices, also opening scenarios on which to engage the basis of a new way to think about the Italian mass housing and stimulating the development of specific methods of intervention, technological components and regulatory instruments, able to provide a more sustainable processes and practices in the residential building construction and management. An approach capable to balance individual needs and the sustainability requirements of the built environment, also becoming a boost to the Italian construction industry.

Fig. 37. Molenvliet, Frans der Werf, KOKON Werkgroep, Papendrecht, Netherlands,1977. Architect proposal of the facade.
Fig. 38. Molenvliet, Frans der Werf, KOKON Werkgroep, Papendrecht, Netherlands, 1977. The support structure before receiving its infill.

Fig. 39. Molenvliet, Frans der Werf, KOKON Werkgroep, Papendrecht, Netherlands, 1977. The facade after 1 year and after 20 years.
Fig. 40. Next 21, Osaka Gas and Nex21 Planning Team, Osaka, 1994

Fig. 41. Next 21, Osaka Gas and Nex21 Planning Team, Osaka, 1994

Fig. 42. Pipe-Stairwell Adaptable Housing, Ma Yunyue, Zhang Qinnan, Beijing, 1994. Floor plan layouts.
Fig. 43. Pipe-Stairwell Adaptable Housing, Ma Yunyue, Zhang Qinnan, Beijing, 1994. Diagram of piping.

Fig. 44. Keyenburg, Frans der Werf, KOKON Werkgroep, Rotterdam 1984. Dwelling layout. Image source Kendall &Teicher 2000.

Fig. 45. Keyenburg, Frans der Werf, KOKON Werkgroep, Rotterdam 1984. Dwelling layout. Image source
Fig. 46. Keyenburg, Frans der Werf, KOKON Werkgroep, Rotterdam 1984. Dwelling layout. Image source Kendall & Teicher 2000.

References


Age van Randen, *Nodes and Noodles*, (originally published by Delft University Press 1976 under the title De Bouw zit in de Knoop)


Bernard Leupen, *Frame and generic space. A study into the changeable dwelling proceeding from the permanent*, Rotterdam: Uitgeverij 010, 2005


Marcello Grisonti, *Industrializzazione e prefabbricazione per l’edilizia residenziale in Italia: prospettive per un ampio processo di industrializzazione*, L’industria italiana del cemento, no 9, 1977, 707-711

Federico di Varmo, *Industrializzazione e prefabbricazione per l’edilizia residenziale in Italia: analisi dei procedimenti costruttivi impiegati e delle realizzazioni*, L’industria italiana del cemento, no 9, 1977, 711-756


