

## CUSTOMIZED PREFABRICATION: A NEW EXPERIENCE OF LIVING

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**Abstract:** *The research will explore the use of precast concrete based on great size components, in order to dispel the stereotype that this construction method and material cannot contain qualitative factors such as flexibility and environmental sustainability.*

*For many years the prefabricated construction method was considered to be of poor quality and had little appeal; this view is related primarily to cultural reticence and to the habit of seeing this technology as applicable only to industrial or commercial structures.*

*Furthermore, the concrete is still considered negatively for the impact it generates during the production process.*

*The intention is to develop a modular housing system, starting from new concrete off-site prefabricated modules. This construction method will be prepared for many possible connections for insertable components, technology and systems, able to ensure: endless configurations of interior spaces, easy future transformations, excellent energy performance and high thermal comfort.*

*Users might be involved during the preliminary design stages selecting additional catalogue options in order to highlight their choices. Through the new possibilities of material composition, customization and assembly of prefabricated parts and through the use of parametric tools capable of monitoring performances, we can examine a number of industrial control processes, materials, construction costs and environmental sustainability, in order to support a research with measurable obtainable advantages.*

## 1. INTRODUCTION

For many years prefabrication has been viewed as a low quality construction method. In some parts of Europe (with particular focus on the Mediterranean Area and Italy), this has been considered as something connected with industrial and commercial structures: this idea has led the general opinion to think that prefabrication could not give that kind of design and energy efficiency which are crucial in modern housing. The industrial areas built in the '80 and '90 consolidated this thought.

On the other end the recent rising of “green building” has put prefabrication on a bright spot as it seems to be the most suitable construction method for this building sector.

Therefore, as explained by Guido Nardi: "An industrialized intervention involves two basic assumptions that help to define the characters that organize the operation itself: the amount and mass production of the product" [1].

The advantages (costs , construction time) are those that determined the success of precast reinforced concrete from the end of the seventies of the twentieth century until.

In particular wooden houses are among the most available prefabricated buildings as they benefited of a good marketing campaign.

In addition to a lower environmental impact, prefabrication has the advantage of having a lower time of construction which has been fundamental, for example, in providing a house to people who suffered lost of their homes from earthquakes or other natural disasters (not always with brilliant results).

Are sustainability and building “speed” the key factors that allowed prefabrication to get the importance it has today?

The introduction of the concept of mass production , allows a more direct link with the architectural methodology and with the type and model concept on which is the interactive operation, the standardization is the result of an activity that through a continuous process identifies measurable and recognizable elements of uniformity and quality, therefore it can be possible to have systems that affect only the building structure and systems that provide the complete building.

Another aspect which should be considered in this mix is the economic and social situation in this day and age, (ISTAT - [www.istat.it](http://www.istat.it)):

- . Ageing and inadequacy of general buildings
- . Lack of structural, energy-saving and economic characteristics which does not respond to the need of comfort
- . The percentage of prefabricated buildings is not encouraging in Italy with just the 4% while better situation are present in Great Britain (9%) and Germany (10%). The 40% of Japan seems to be unachievable
- . The general credit crunch from banks which allows to “cover” just the 50% of building value

## 2. THE HOME EVOLUTION IN TIME OF PRECARITY AND EMERGENCY.

The recent demographic growth and emigration have stimulated a reflection of what “housing” means and how to interpret it in these days and age. The new dynamics that can be viewed in our cities are the products of three different factors: social tendencies, economic crisis and the new condition connected with the rising of immigration. In twenty years, the presence of foreigners on the European area has increased about tenfold. It seems to be clear that there is a need in changing the idea of housing in order to face the challenge of a better flexibility and adaptability of it. “Europe is living in an owned house, built before the Second World War, with one or none tenant, and in some cases without a bathroom” [in Romania 38% of housing don't have the bathroom (ec.europa.eu/Eurostat)].

Moreover, it's important to underline how precariousness and insecurity are characterizing the European society and these aspects have a significant impact too. These factors can get architects to think about sustainable design, based on the concepts of transformability, so that they can adjust to the numerous changing of modern lifestyles. In a further note, the dynamics of immigration have extended the idea of “home” with new and numerous meanings connected with the origin of immigrants' people. New uses and customs must be considered when starting a project. For example, cohabitation is a common thing among immigrants who tend to over-utilize the space with additional beds. From this point of view, the projects of Alejandro Aravena appear significant; with ELEMENTAL involves the ability to imagine architectures able to satisfy the housing needs of developing countries, or with a very high poverty rate. Emblematic is the social housing prototype that ELEMENTAL proposed in 2008 at the Milan Triennale: Ten prefabricated concrete panels assembled in just 24 hours. Following a study on the relationship between housing needs and economic resources of the poorer classes, was born a basic residential form of just 18 square meters (kitchen, bathroom, bedroom), plus an additional 18 square meters customizable by the user.

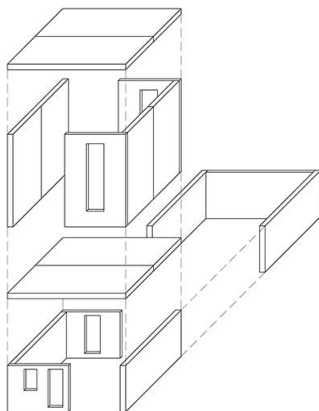


Figure 1 - Housing prototype Milan 2008 ([www.elementalchile.cl](http://www.elementalchile.cl))

Migration dynamics also impact greatly on the instability of society, because they increase the number of meanings of the word home, according to the different cultures,

diversifying the needs of the space, which now has to respond to a wider range of uses and traditions.

Cohousing is such a social phenomenon increasingly widespread in Europe , thanks to the balance between public and private , between conviviality and intimacy , where private spaces are more limited in size than the average of ordinary dwellings . The reason is twofold: reduce the cost of all the operation (because each owner has to pay a percentage for the construction of public spaces ) and try to support a more intensive use of the common areas [2].

Meanwhile, in Italy, the break down of families and the distance of people in difficulty does not guarantee the traditional support and care and this has led to the growth of the number of Care and Reception Centres. As recalled by Federica Verona ‘Milano. Cronache dell’abitare’[3].

### **3. FLEXIBILITY AND REVERSIBILITY AS A PARADIGM OF SUSTAINABILITY?**

The ideas of reversibility and flexibility have an essential importance in facing the challenges brought by the new social&economic situation and brought by the need of sustainability.

Through a different approach in projecting houses, we can identify two main construction methods in order to build a flexible environment: the action on components which can modify the space or the neutrality of the space. Some interesting ideas on the topic can be obtained from the international network Open Building , designed by Dutch architect John Habraken. Flexible urban pattern should be designed, offering the potentiality to raise their urban value, thanks to adjustable parts of them, also conceived removable , when necessary. Using this method, the city would become a developable system, ready to be able to receive the inevitable " upgrades " of which we will always need [4].

This last idea (neutrality of the space) will be the topic of our explanation, with some construction examples made with the help of a prefabrication company based in our area and the researches developed within the School of Architecture and Design of the University of Camerino (Italy).

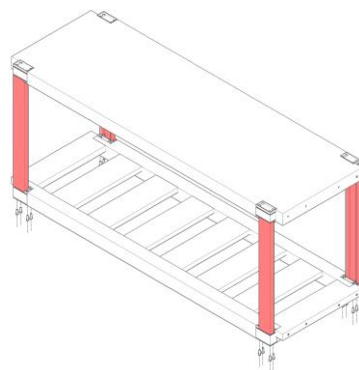


Figure 2 - SMEASY Home, SAAD, Unicam, 2015

This residential module, which would feature a good energy efficiency, will offer good performances in terms of mechanical and energy-saving data. The quality of the production made in a production plant can even match the requirements of the most important environmental certification like LEED and BREEAM. This will allow to achieve the main characteristics of a passive house, like good airtightness, thermal performance and thermohygro-metric comfort.

The result of this case study is related to the quality of raw materials used, the quality of the production of the construction and, in particular, the quality of the perceived space. The goal of this work is to show the level of comfort with a superior level of simplicity, execution and performance than the traditional building work. The designer organizes the general management of the space but leaves the characterization of it to the final users.

#### **4. SMEASY HOME (SMART AND EASY PREFAB FOR HOME)**

The housing module in prefabricated reinforced concrete called smeasy home , has the ambition to get flexibility and reversibility characteristics discussed above , through 5 essential elements:

##### **4.1. Free plan**

The freedom to execution, as an essential factor in achieving the necessary flexibility in a contemporary residence , and especially in a constantly evolving society.

the module, with the simple operation of attributing to the perimeter frames the static function , allows free interpretation of interior space , including the placement of toilets and the kitchen , through a special design of systems : the size of the apartment could vary freely, with the possibility to add / subtract housing modules for customizable cuts. in this example , we compared , a collective housing project of SANAA architects in kitagata, ([collectivehousingatlas.net/2013/07/12/gifu-kitagata-apartment-building-by-sanaa](http://collectivehousingatlas.net/2013/07/12/gifu-kitagata-apartment-building-by-sanaa)) and smeasy module main object of the search.

The project of sanaa (**kitagata apartment building**), is the most important example of public housing , located on the border in the city of gifu , and characterized by its structural slenderness highlighted by the carrier frame of the building , which is constituted by a structure beam to pillar in very smooth concrete. within this structure are placed three-dimensional precast concrete modules that make up the residential housing . the metal staircase that characterizes the main facade, from which you access the long galleries, is a free standing element.

The project offers a variety of internal spatial configurations canceling the typical monotony of the concrete frames , even prefiguring a system of very rigid housing and hardly reconfigurable differently. The project , however, illustrates how the economy of construction and the use of standardized and prefabricated processes ( H = 2,30 / 5,20 L = 5,8ml ) may coincide with customization and innovative concepts of living spaces.

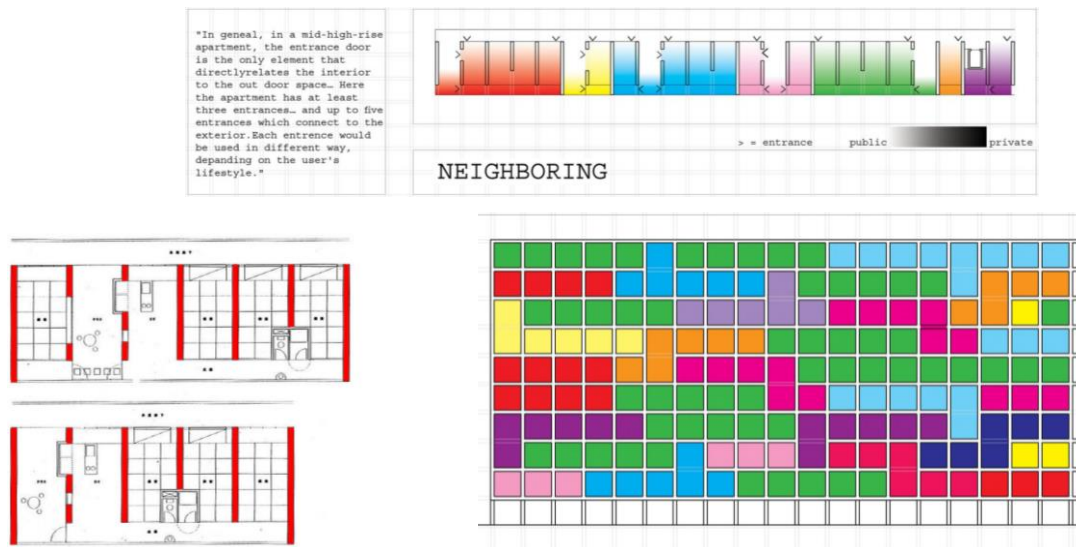


Figure 3 - Sanaa, Kitagata apartment building, Gifu, Japan, 2000

The research on prefabricated concrete residential modules (**Smeasy Home System**), explains the concept of planned human settlement, which is connected with to expected events such as for emergency or tourist accommodation, private accommodation or social housing.

**Emergency accommodation:** it is necessary to ensure the long-term comfortable living conditions for occupants of any age and health condition, as well as the increasing need to have available housing for migrants.

**Tourist accommodation:** it is arranged between stable tourist resorts and campsites which are both flexible and crucial, with regards to the components that constitute them which minimize the ecological footprint of the settlements. They also promote better integration within the environment due to the design of the dwellings.

**Private accommodation:** the modular system is inside the market of isolated dwellings (economic and functionals), providing all the comforts of the home built on site, with customizable and multifunctional spaces.

**Social housing accommodation:** They solve all the difficult situations related to the economic crisis, which prevent many families from having a home where you can live with a sufficient quality of life. The concept of Social Housing will be detailed in this paper through the study of built architectures, comparing them with the innovations made possible by the prefabricated concrete modules, which is the object of the research.

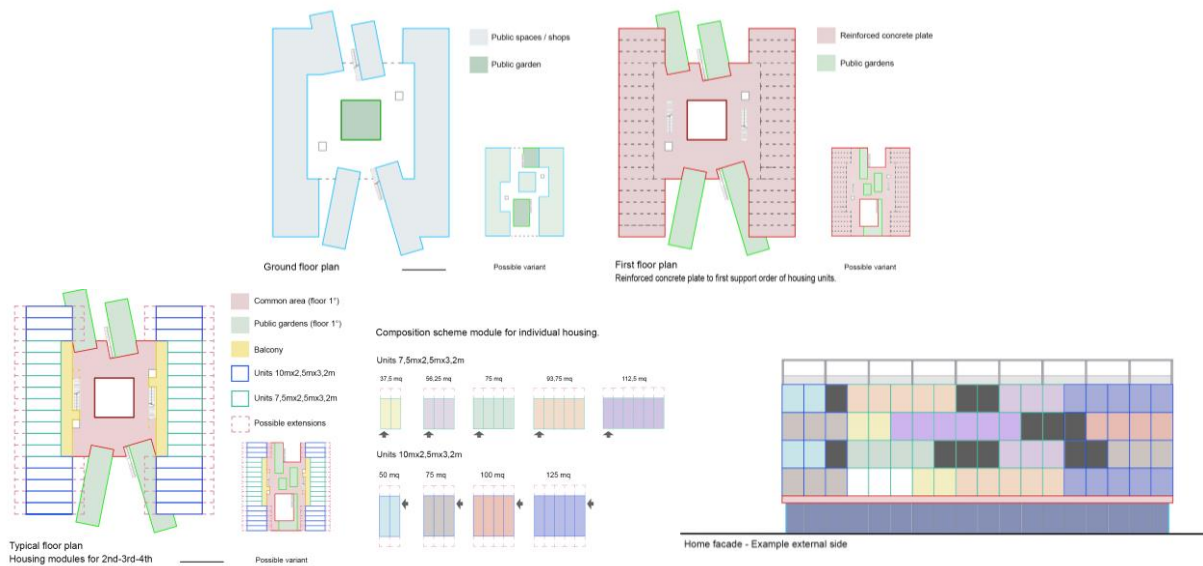


Figure 4 - SMEASY Home (example of aggregation), SAAD, Unicam, 2015

## 4.2. Modularity

The quickness of the construction is simplified ultra pose , by assembling all the structural components within the factory prefabrication , to prevent the slightest error (which could happen if assembled on site) and to optimize the phase of production and assembly, protected from atmospheric precipitation . the only part that must be realized in work will be the ground floor of the building , which constitutes a sort of open-air foundation.

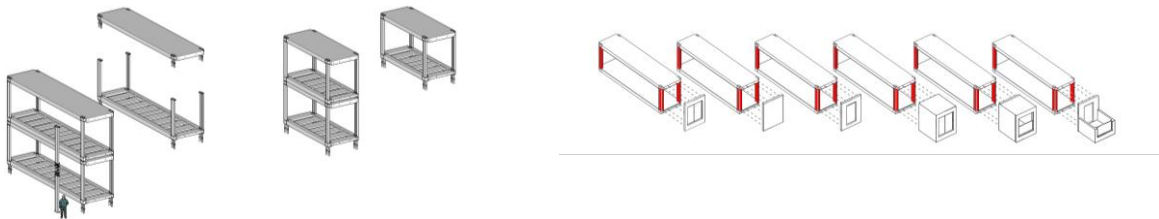


Figure 5 - SMEASY Home, SAAD, Unicam, 2015

## 4.3. Transport

Easy transport , made possible by the size of the modules, designed to optimize the loading on inflated towings suitable for the most common transports , without exceeding the width (2,50m) and height (4,20m) allowed to move in Italian and European roads.

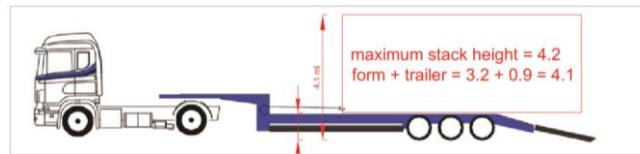


Figure 6 - Maximum height of the cargo floor

#### 4.4. Flexibility/Reversibility

Aggregation of the modules is extremely simple, as it is the possibility to obtain multiple urban conformations, the tower aggregation and the line solution. The common denominator of the possible combinations will be the spatial flexibility as well as its reversibility to various sizes, from 37,5mq studios to 112,5mq multifamily buildings

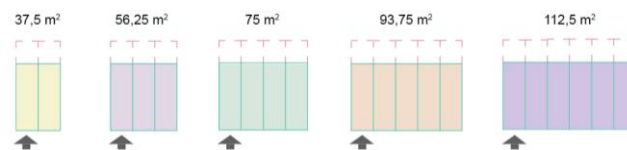


Figure 7 - SMEASY Home (example of apartments sizes), SAAD, Unicam, 2015

**Free systems configuration**, as extreme customization options, both to minimize the overall dimensions of the shafts with the pipes, both for easy future configurations of suitable premises to the leaser/owner, both for simple technical operations from system (inspections, repairs, conversions, upgrades etc...).

Environmental reversibility is guaranteed by the possibility of positioning the hydraulic discharges on the floor cavities.

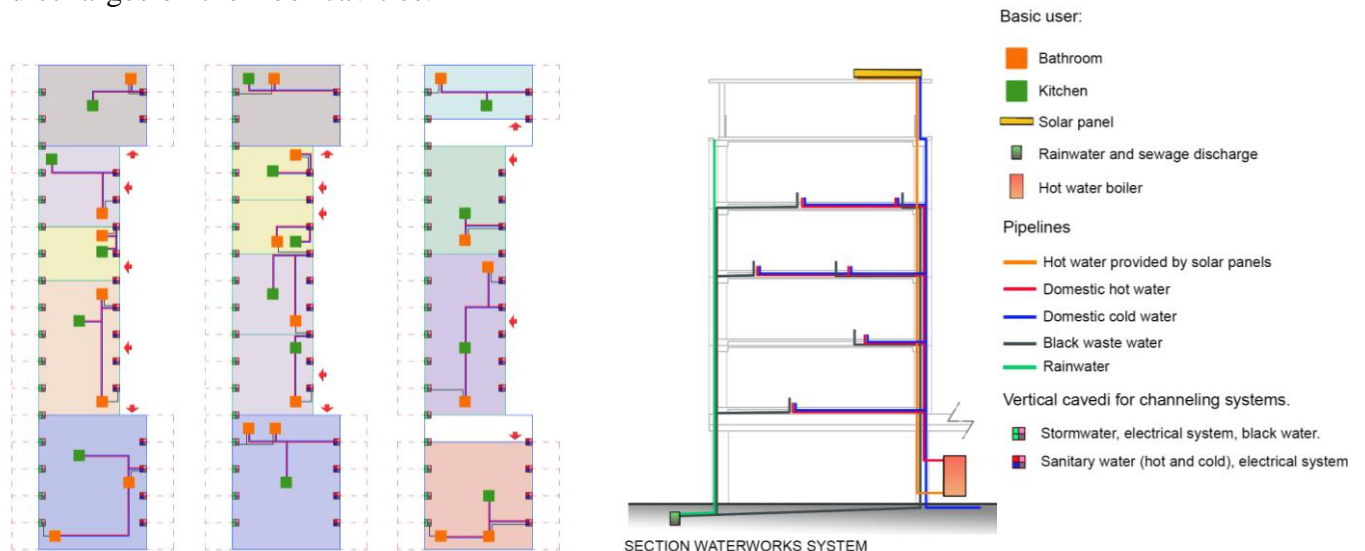


Figure 8 - SMEASY Home (equipment installation system), SAAD, Unicam, 2015



**Reversibility** is understood also as recyclability of technological components and materials in use, considering the architectural components not as production waste, but rather as a resource characterized by its useful life, goods that retain their potential use through different production cycles, and in particular the core design of the module: concrete.

The recycling of the concrete can take place thanks to a synergic action between various business partners planned upstream, which allows to activate a upcycling process (innovative use of waste materials) in order to achieve a new material and more sustainable (Directive 2008/98 / EC has as target for 2020 - article 11 paragraph 2b).

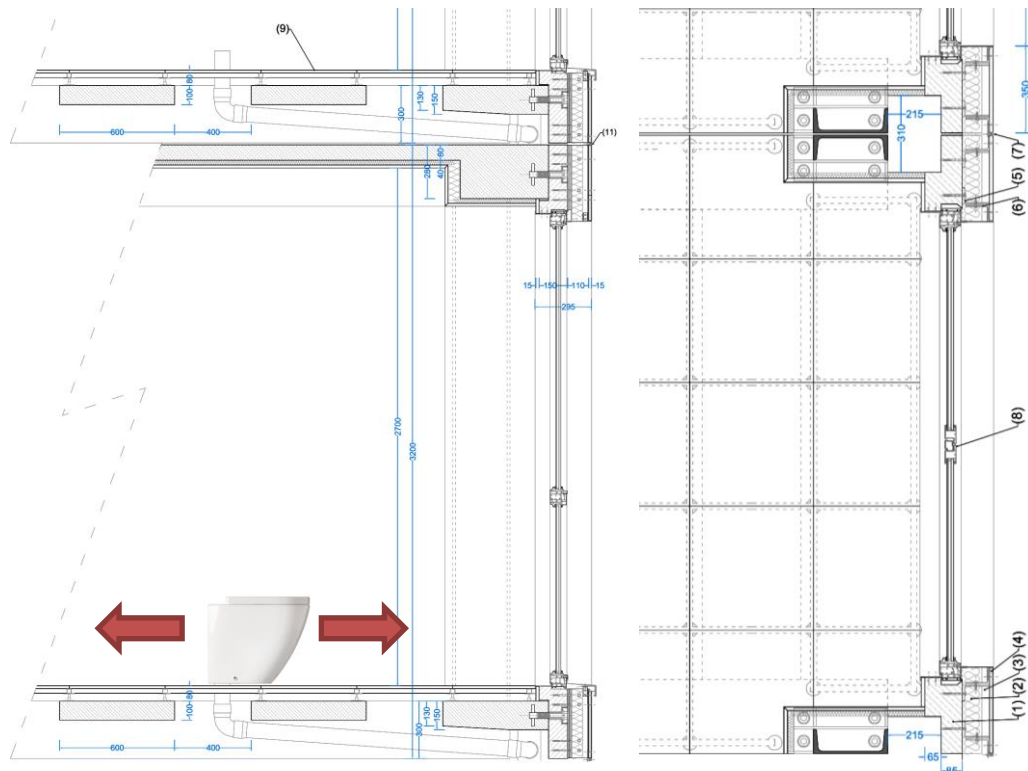


Figure 9 - SMEASY Home (equipment installation system), SAAD, Unicam, 2015

#### 4.5. Energy saving

The housing module casing will be composed of a frame precast reinforced concrete, that acts as a subframe for the windows fixtures as it performs the function of thermal insulation and thermal bridges reduction, hooking the structure and at the same time closing the front of the modules or making an aggregation of modules.

Renewable Energy, through photovoltaic panels installed on the roof, necessary for getting rid of gas for cooking, heating systems, as well as to simplify the installation of gas pipes within the horizontal and vertical shafts of the modules.

Common services are located on the ground floor, a reinforced concrete plate system, where parking areas, co-working, shopping spaces for school and community events workshops will be located.

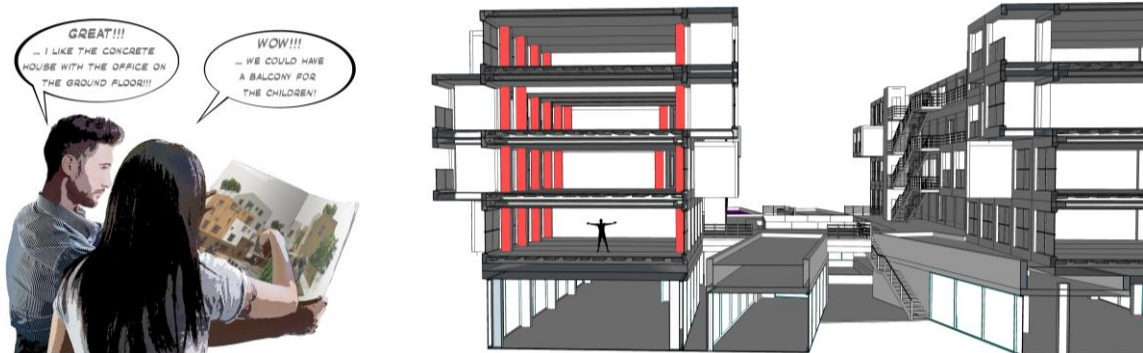


Figure 10 - SMEASY Home (customized prefabrication), SAAD, Unicam, 2015

## 5. CONCLUSIONS

The traditional constructions on site are criticized for their very low quality, especially when they are completed by workers who believe themselves to be prepared, but in reality they make mistakes due to incompetence and a lack of the knowledge required to complete the job. The current situation therefore requires high-quality products, which can only be reached through prefabrication in the factory. Only with the Italian commercial structures, and with foreign companies for residential structures (Germany, Northern Europe etc...), is it possible to achieve the high levels of quality required for passive house standards. It is much easier to reach these standards through a controlled and quick operation that only the prefabrication system can achieve. The quality of the smeasy home module is greater than the quality of the passive house (ex: tightness) and also includes elements of quality such as the possibility of personal customization, and low cost and attractive design!

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