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MINIMALIST HOUSING UNITS. ECO AND SMART TRENDS

Ralitsa Stavreva-Pancheva
University of Forestry, Sofia, Bulgaria
e-mail: rgstavreva@gmail.com

ABSTRACT

Minimalist housing units are a contemporary tendency that has developed widely in recent years, motivated by changing lifestyles and demographics, global social, economic and environmental problems. This requires reconsideration of needs and requirements of society in connection to the living environment and its sustainable development. The aim of the scientific research is to evaluate the contemporary architectural forms of the small urban dwelling and its interior environment peculiarities. This research presents an analysis of innovative examples in the context of the minimalist housing unit and its affordability. The focus is on the development of the small urban dwelling both for the benefit of the contemporary consumer and as a tool for dealing with many global problems and environmental changes.

Key words: minimalist housing unit, eco, smart solutions, affordability, sustainability.

INTRODUCTION

Today, mankind faces serious challenges related to demographic and environmental changes, social and economic problems of nations. They all have different appearance depending on their geography, regardless to this they are a precondition for change in the way of life of contemporary consumer society worldwide. The transformation that generations are experiencing, delayed marriages, increasing divorces and life continuation, cultural changes and trends related to minimalism through simpler living and future sustainability, the growing unaffordability to buy or rent a home, form differences in housing needs of the society that requires an adequate response and alternative solutions. An acute tendency that has developed widely in recent years, motivated by the changing world are small urban dwellings. A key factor in their development is the affordability and the ability to respond the needs of different target groups. In addition, it is considered that micro dwellings have a lower impact on the environment. A universal definition does not exist. There are a number of terms, which are not supposed to be exhaustive, but they all characterize them as dwellings with an area of less than 40 m², through the increased density of which significantly increases the opportunities to have affordable homes for more people. In the last fifteen years, regarding new urban apartments a decrease of the size is observed. This downward trend is mostly noted in the last ten years, where their average size has decreased by another 10 m². Almost 30 years ago, the small apartments offered an area of approximately 55 m², today they have areas smaller than 40 m² or even under 10–15 m² called minimalist housing units. This decreasing tendency shows no signs of slowing down. With the expected increase in the number and density of the population worldwide, the average size of apartments is anticipated to decrease even more. Up to 2050, the number of people living in big cities is expected to reach 69% (UN Urbanization Report, 2014/2018). With the supposed urban population growth rates and its concentration in certain places around

the world, the problem is gaining unprecedented scale and efforts are being focused on finding new housing models that meet the challenges. Furthermore, the environmental changes facing the world set new standards in the design, construction and furnishing of contemporary homes.

METHODOLOGY

The report adopted research method based on a comparative analysis of selected innovative examples in order to reveal the contemporary performance of small urban housing in connection with some eco and smart trends. The aim is to trace the peculiarities of the architectural form and interior of the minimalist dwelling units in response to global demographic and environmental changes and socio-economic problems, without claiming the same to be exhaustive on the subject.

1. SEARCH FOR NEW ARCHITECTURAL FORMS IN THE CONTEXT OF THE MINIMALIST HOUSING CONCEPT. REASONS

1.1. DEMOGRAPHIC CHANGES

Today, the world population exceeds 7.7 billion people, 56% of which live in cities. It is expected by 2050 to reach over 9.7 billion people, 6.6 billion of which or approximately 69% will form the urban population. At the same time, the size of households around the world is gradually decreasing; the number of single households is increasing, which in some places is over 50%; the metropolitan cities are increasing, the number of which is expected by 2030 to be 662 cities with a population of at least 1 million people, including 41 cities with a population of over 10 million people; the migration of population is increasing due to the constant movement of students, tourists, young people traveling for work, etc.; immigration increases; the poor and homeless population is growing, which according to the latest UN figures exceeds 100 million homeless people and 1.6 billion people who do not have an adequate home; the number of elderly people and people with special needs is increasing, which globally is over 1.4 billion (UN, Department of Economic and Social Affairs Disability/Ageing and disability). This reality clearly outlines the need to take immediate action in relation to the present needs of society and the search for new housing concepts.

Facts:

During the last ten years in Hong Kong the number of single households has doubled, accounting more than 18%. In the Asia- Pacific region, Japan ranks first with 30% of single households, in Tokyo with over 50%. The situation is similar in North America and European countries, which occupy leading positions in the number of single households. According to a report by the Swedish Bank in Sweden, they represent over 40%, followed by other Nordic countries.

The rate of urbanization varies globally. In Africa it is 43.5%, 51.1% is in Asia, 74.9% in Europe, 82.6% in North America, up to 93% in Japan. Australia is one of the most urbanized countries in the world with an urban population of 89% concentrated in the five metropolitan cities. In some European Union countries, urban communities account for a record high percentage, such as Belgium 98.1%, Germany 77.5%, Poland 60%. (World urbanization prospects 2018, UN).

Every year, more than 50 million people migrate to cities. Until 2025, their number is expected to exceed 1.6 billion. In China, the migrant population increases by 1.5 million people annually representing 20% of the total population (about 300 million people). A large part of this migration flow is formed by students and tourists who temporarily live in a certain area. Only in Europe in 2015 about 4.6 million foreign students graduated, which

is an increase of 130% compared to 1999. Their number is anticipated to reach 8 million by 2025.

According to the latest UN figures, more than 100 million people worldwide are homeless. For example, in Africa out of 54 countries, 25 are in the UN list of least developed countries. Its population is the fastest growing in the world over 1.3 billion, of which 30% cannot afford a home.

1.2. ECONOMICAL TERMS

Constantly rising prices for housing and rent, for living costs, lack of credits, accompanied by static wages and reduced employment are serious motivators in the search for alternative housing concepts, which are affordable for the contemporary customer. Searches diverse and are directly related to geographical location. Hong Kong, however, is without comments the best example of illustrating new housing sizes trends. Square meter of living space in the city center cost exceeds 30 000 USD. The rent for one room apartment is over 2 250 USD/month, for three room apartment more than 4 826 USD/month. Prices are similar in Singapore, New York, San Francisco and many places in Europe. The high prices of housing in Hong Kong lead to appearance of any kind of innovations in small urban homes and place it at the top of the list of the most unaffordable cities. In response to these problems, intensity is observed in the intentions of governments and city municipalities to solve them. There are many quick decisions for legislative changes for construction of small affordable units. Government funding and subsidies are provided. For example, in Singapore over 80% are government funded homes.

1.3 ECOLOGICAL PROBLEMS

Recent years, our planet has faced serious environmental problems such as overpopulation and urban sprawl, air pollution and climate changes, deforestation, extinction of animal and plant species, soil erosion, industrial and municipal waste, changes in ozone, water pollution, noise, odor, light, etc., which all affect every living creature and our future. The striving to understand the problems is growing and attempts are being made to manage them. There is an increasing awareness of the importance and responsibility of humanity to protect the environment. Priority is given to the reuse, recycling and use of environmentally friendly materials to create a sustainable design. These intentions are leading in the research and design of new architectural forms and interior design.

2. EXAMPLES OF CONTEMPORARY ARCHITECTURAL FORMS AND PARTICULARITY OF THEIR INTERIOR ENVIRONMENT. ANALYSIS

2.1. CARMEL PLACE, NY

Since 1970 in the United States, there is a 61% increase in the number of single and two person households. Only 38% of households in the country consist of three or more people. This explosion of single households is extremely evident in cities. In San Francisco, the statistics are over 38%, in Seattle over 40%, in New York over 53%. In response to these changes in 2012 New York Mayor Michael Bloomberg has announced the winner of the *adAPT NYC* competition for design of an innovative micro apartment building which has to meet the housing needs of 21st century. The competition is indented as a way to deal with the need of apartments for one or two people in the context of the constantly growing single households and the shortage of small homes in New York, which

continues to grow with a staggering rate. In an attempt to resolve this imbalance, the winner in competition – *nArchitects* issued experimental project of a modular nine storey building on urban land on *East 27th Str., Kips Bay, Manhattan, NY*. For this and subsequent projects and in support of the creation of more affordable housing, the municipality has eased regulations and restrictions on density and minimum areas from 1987, according to which all new apartments must be larger than 400 f² (approx. 37 m²). The *Carmel place* project, also known as *My MicroNY*, is attracting international interest as a new prototype of a residential building due to its innovation. For the time it was built (2013–2016), this was the first building with micro apartments and the tallest modular building in Manhattan. Its construction consists of prefabrication, transportation and installation of 65 individual self-supporting steel framed modules. The foundation and ground floor of the building were erected on site; the finished modules were added to them, followed by some finishing works including decorating the facade in different shades of brickwork (fig. 2.1.1). Transporting and installing the modules took two weeks. Preliminary preparation of the elements and modularization contributed to a more efficient construction process. This reduces time, construction noise, construction waste and site operation, which by itself is a major step forward in environmental protection thinking and marks new environmental standards.

The project aims to test the viability of decreasing the minimum size of apartments from 400 f² (approx. 37 m²) to 300 f² (approx. 27 m²) while balancing the need for more space. The building consists of 55 residential units with an area between 260–360 f² (approx. 24–33m²), which are completed by 10 modules with common areas located throughout the building such as lobby, gym, common laundry room, bicycle storage, roof terrace on the eighth floor, which provides space for outdoor events and activities and other multifunctional areas that promote social interaction between residents for the benefit of their mental and physical welfare. The interior of the apartments offers almost 10-foot ceilings (approx. 3m) and Juliet type balconies, which provide plenty of light, fresh air and significant storage space. Through the skillfully considered interior design, new possibilities for micro living are demonstrated, which do not sacrifice the quality of life. The cooperation with *Resource Furniture* provides an opportunity to install transformable furniture that performs various functions and saves space (fig. 2.1.2).

Figure 2.1.1: Carmel Place, Manhattan, NY

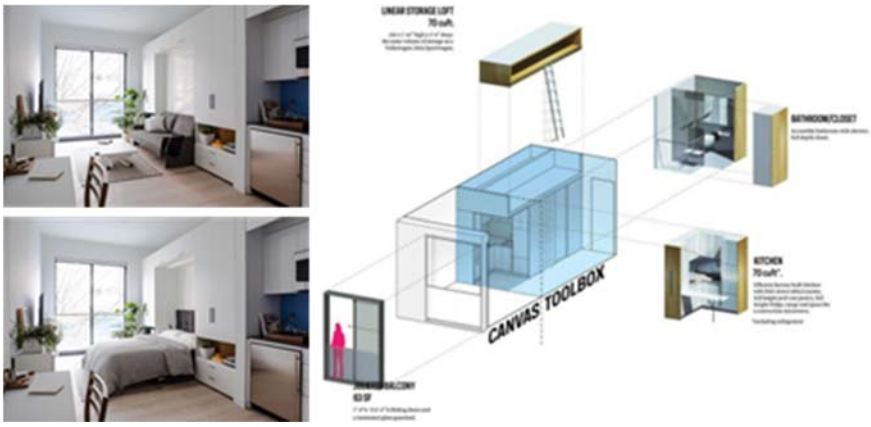

Figure 2.1.2: Carmel Place- interior

The project was developed with the support of the Department of Housing Protection and Development in New York. With the construction of *Carmel place*, the city has revised the Zoning Code to encourage modular construction and diversify housing options, offering micro units as well. It is assumed that this is the beginning of dealing with the housing crisis and the growing single households, and that modular construction is becoming an innovative and desired approach with a number of environmental benefits.

2.2. O POD TUBE HOUSE

Asia is the largest and most populated continent on Earth. It occupies 30% of the land and has a population of over 4.5 billion. The average density is 148 people/km². Among the most densely populated countries in Asia are Singapore and Hong Kong with a remarkably high levels of density, respectively 8 292 people/km² and 7 082 people/km². The urban population in Asia is over 51%. Among the most affected housing markets today is Hong Kong, which is ranked as the most unaffordable market in the world (13th Annual Demographia International Housing Affordability Survey). The housing shortage faced by the younger generation is so severe in Hong Kong that so- called "living in a cage" appears (extremely small housing, in the form of bunk beds built into a structure to provide personal living space). They are known with their poor living conditions. In response to these problems and the research for an improved living environment in 2017 Hong Kong based architectural studio *James Law Cybertecture* is developing a prototype of a low cost micro housing unit out of concrete pipes, which is offered as a solution to ease housing problems in Hong Kong. The micro home is designed by two consecutively arranged water pipes with a diameter of 2.5 m and an area of approx. 10 m² (fig. 2.2.1). In one pipe the living room is furnished, in the other the bathroom and kitchen. The choice of material is determined by its low price, availability and strength. Named *O pod tube house*, this experimental micro home is purposed for one or two people. It is fully equipped with a small bathroom, kitchen, shelves and a sofa that converts into a bed. Space saving furniture maximizes the space inside. The access to each home is developed in a smart direction and is realized through smart locks, online through a smart phone. Today, an *O pod tube house* could be purchased for 15 000 USD.

Figure 2.2.1: O pod tube house

O Pod Tube house is designed to have a flexible application. The modules can be easily moved and installed in a short time in different places. They can be used as separate housing units or stacked on top of each other or they can compact different urban areas of land or water (fig. 2.2.2).

Figure 2.2.2: O pod tube house- application

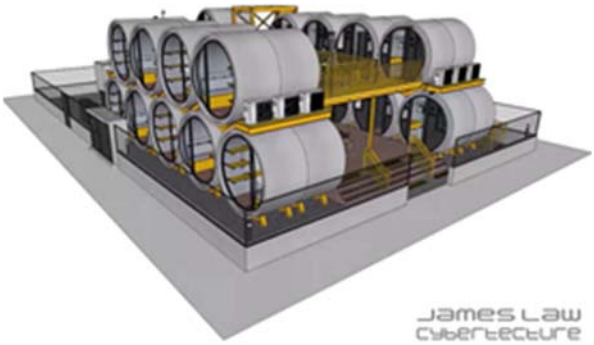

Figure 2.2.3: OPod Housing No.1

In a similar way the *O Pod Housing No.1* is engineered (fig. 2.2.3) – a social housing project providing accommodation to Hong Kong citizens who cannot afford conventional home. Consisting of 21 units, arranged on two levels, the *O Pod Housing No.1* project is deployed on an unused urban plot in the *Kwa Wan* district of Hong Kong and it should be put into operation in 2021. Each house is made of *O Pod tube house* pipes and has a separate toilet and shower, cooking area and living room with transformable sofa- bed, supplemented by common social spaces. The homes are developed in smart and eco directions, equipped with Wi-Fi and home automatisation for better resource management.

2.3. ALPOD

Recently, as a result of the cooperation between three companies *AluHouse*, *James Law Cybertecture* and *ARUP* a new mobile city home *AlPod* was created as a solution to the rising real estate prices in Hong Kong. Designed as a high- tech house with the idea of creating a "next generation home", it has

an area of 42 m² and is an excellent alternative to small urban dwelling, which can be installed in most limited places. Made from aluminum, the *AlPod* is strong, light enough to be moved from one place to another, easily adaptable to different climatic conditions and environments, isolated from heat and resistant to corrosion and fire. In addition, aluminum is recyclable, which makes the *AlPod* a modern environmentally friendly minimalist living unit (fig. 2.3.1).

The used monocoque structure creates an open interior space without additional internal columns and partitions. Large sliding windows and doors allow harmonious interweaving of interior and exterior, providing natural light and air. The interior of the *AlPod* is brilliantly designed, including everything necessary for a household. It is equipped with a separate kitchen and bathroom, living room- bedroom and dining room, air condition, power sources and lighting, which are preinstalled and makes it essentially a "plug-and-play" home. The floor is wooden laminate and the walls and ceiling have a matte metal finish, emphasizing the modern design of the house (fig. 2.3.2).

Figure 2.3.1: *AlPod*

Figure 2.3.2: AlPod – interior

The project designers believe that mobile *AlPods* could become the building bricks of the smart cities of the future. Designed to be the next generation of housing typology *AlPod* suggests that housing modules can be situated not only as independent units, but also to be arranged in specially designed multi structures in height, revolutionizing and redefining our ideas of what architecture should look like and how urban landscape will develop in future.

2.4. MICRO COMPACT HOME (MCH) is a project created in response to the growing demand for urban housing for the migrant population in need of temporary accommodation. In Europe, the increase of international students marks growth. In 2015, they were about 4.6 million and are expected

to reach 8 million by 2025. For the ninth consecutive year, foreign students in Germany exceed 3 million. In this connection 10 000 new small homes are expected to be built in the next few years, mainly in Berlin, Frankfurt and Munich.

The *Micro Compact Home* project started as a collaboration between the Technical University of Munich and the Tokyo Institute of Technology, inspired by Japanese tea house architecture and using modern European and Japanese prefabrication methods and concepts. In 2001 a team of researchers and designers based in London and the Technical University of Munich are developing a project for micro compact dwelling unit and named it *Micro compact home* (fig. 2.4.1). *M- ch* has a timber frame structure with anodized or polyester powder coated aluminum external surface, isolated with polyurethane foam and drainage layer. The windows are made of aluminum frame and double glazed glass, the door has a double security lock, construction of walls, floor and roof is composed from six layers of material. *M- ch* has dimensions of 266 x 266 x 266 cm and a cube shape. The interior features a fully equipped kitchen, two compact double beds, storage space, sliding table for dining or work, living room, shower and toilet, air conditioning, water heating, fire alarm and smoke detectors (fig. 2.4 .2.). Electricity, water and sewerage are required to install the *M- ch*. In cold months, it uses no more than 348kWh of energy, in summer, using air conditioning approximately 123kWh. Due to its small volume, respectively rapid heating and cooling, the use of *M- ch* is considered highly energy efficient. A "*low.e- home*" version with low energy values and potentially zero CO2 emissions is available. Solar cells power it and a small vertical axis wind generator mounted on the roof. *M- ch* is completely recyclable. The aluminum is very efficiently recycled with only 0.3% wastage in the process and with only 11% of the energy required to make it. With these characteristics, *M- ch* corresponds to the contemporary criteria for ecological and intelligent home. Its price with equipment included, but without delivery and installation is approx. 38 000 euro. It weighs 2.3 tons. Manufactured in *Uttendorf, Austria* for a period of 8–10 weeks. It is delivered by truck or helicopter. The *M-ch* elements can be modified with a second door at the end of the kitchen and a connection to another *M- ch* unit. This would provide accommodation for a short stay of more than two people. The main idea of the micro unit is "less is more".

In 2005 *M- ch* student village was opened in Munich. It was commissioned by *Studentenwerk Muenchen* and funded by telecommunications company *O2* Germany. For the design of the first *M- ch* housing units, *Horden Cherry Lee Architects London* and *Haack Hoepfner Architekten Munich* collaborated. The village is named *O2 student village*, it consists of 7 living units and is installed in the Technical University Munich (fig. 2.4.3).

Figure 2.4.1: M- ch

Figure 2.4.2: M- ch- interior

Figure 2.4.3: O2 student village

2.5. WILKINSON EYRE (MODULAR UNDERGRADUATE VILLAGE FOR DYSON INSTITUTE OF ENGINEERING AND TECHNOLOGY MALMESBURY, UK) created a modular student village of 67 separate living units for accommodation of undergraduate students and visiting staff at the Dyson institute as well as an additional building "round house" provided for social activities. It has a light steel structure and has a cafe, bar, lecture hall and study space inside. The student village also includes other common areas, such as kitchens, laundry rooms, a reception desk, all located in the heart of the Malmsbury campus of *Dyson Institute of Engineering and Technology in Wiltshire, England.* To create the housing units the design team of *Wilkinson Eyre* explored various materials and modular construction options, but ultimately focusing on creating a structure of cross laminated timber (*CLT*) panels, which are used also for interior design including kitchens and bathrooms. The structure outside is covered with waterproof anodized aluminum panel. The modular type of construction is preferred by designers in order to go beyond the existing architectural typology, and *CLT* material is chosen for their project because of its stable natural structural qualities and high stability. Each living unit of 32 m² is manufactured in Scotland and delivered furnished and ready for installation. On campus, units are installed in combination with up to five other pods in a staggered arrangement. Each composition includes a shared kitchen and laundry room, along with a reception and storage area, while each individual module has a bedroom, working and storage area, shower and toilet, separate entrance and large windows that *Wilkinson Eyre* designs at an angle to maximize natural light and campus views (fig. 2.5.1). The modular living pods are engineered to be energy efficient, using the thermal mass of *CLT* and natural ventilation.

Figure 2.5.1: Student modular village of Dyson institute of engineering and technology Malmesbury, UK

2.6. SHELTER WITH DIGNITY is a project aiming to improve the lifestyle of homeless population of New York. It is important to note that according to the UN, more than 100 million people worldwide are homeless. After the acceptance of changes in housing legislation in New York in 1955 in connection with the ban on the reconstruction or construction of new *single room occupancy units* (*SRO*), the number of the homeless population is constantly increasing, and since 2012 its increase exceeds 40%.

The innovation project was created by Framlab studio situated in Bergen and New York. The ideas of its founder *Andreas Tjeldflaat* are inspired by the possibility of creating space ensuring a better life for certain society groups, aiming to improve social and environmental sustainability through design. The project is based on the possibility of using the "abundant" quantity of unused "vertical lots" in metropolitan cities, for which *Framlab* created its *Homed* system. The innovation of the project consists in the construction of hexagonal housing pods, which are connected together to a scaffolding attached to the empty vertical walls of existing buildings. By this way, up to 95 residential units can be built on a typical wall with approximate dimensions of 15 x 21 m. (fig. 2.6.1).

Each housing unit is designed to provide all year- round home for its resident. The module exterior construction is made of steel and oxidized aluminum, and the interior is composed of organic shapes of 3D printed recycled polycarbonate (fig. 2.6.2). The windows of the modules are made of PMMA (*Poly methyl methacrylate*) smart glass. Moreover, to offering the necessary transparency and confidentiality, they can also be used to display advertisements or works of art. This opens the possibility for housing units to generate income and to support themselves. Each housing unit is designed to be energy efficient and self-sufficient by collecting solar energy and recycling rainwater for drinking and toilet needs. Every module is proposed for a single person. Access is via a staircase built into the scaffolding. 3D modules are prefabricated and can be installed and dismantled quickly and smoothly. *Shelter with dignity* provides practical use of free vertical space in New York.

Figure 2.6.1: Homed, Shelter with dignity

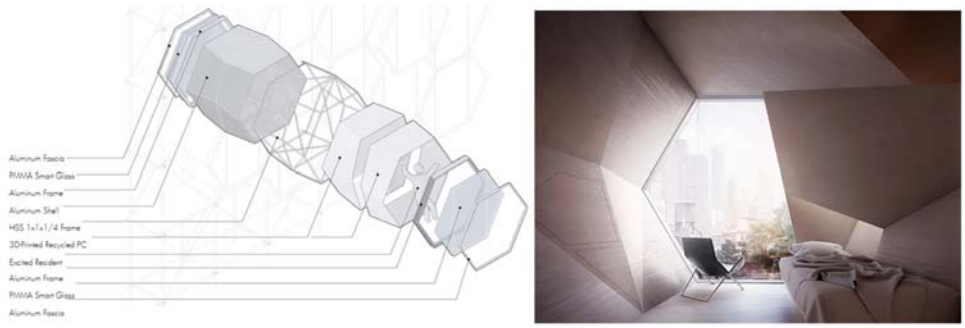

Figure 2.6.2: System Homed. Interior

RESULTS AND DISCUSSION

In the report, the features of the architectural form and interior of contemporary minimalist living units are analyzed in response to global demographic, social, economic and environmental problems. From the stated facts, it is evident that the housing concept acquires new dimensions influenced by the actual requirements of the society. The considered innovative examples illustrate the connection between the housing unit and the particularities of the target group. The affordability is clearly identified as a key factor in the change and development of residential architecture today. The researched projects are distinguished into three main user groups. *Carmel Place, O pod tube house* and *AlPod* are proposed as a solution to get along with necessity of apartments for one or two people in the context of constantly growing single households. In addition, *O pod tube house* and *AlPod* are designed for flexible application; they can be moved easily and installed in a short time in different places, can exist independently or built into horizontal or vertical multi structures. *M- ch* and *Dyson institute student village* are an example of a contemporary minimalist living unit designed for temporary accommodation of students. *FRAMLAB* is a project aimed to improve the lifestyle of homeless population. Through their *Homed* system, the designers demonstrate an innovative approach of using the free vertical parts of existing buildings in metropolitan cities. Regardless of the consumer differences of the analyzed examples, the connection between them is obvious. They all are modular units. Prefabrication of elements and modularization contribute to a more efficient construction process. The time for construction is reduced, the noise, the construction waste and the work of the site as well, this appears to be a serious progress in the thinking for environmental protection. Furthermore, an innovation in the modern construction approach is the choice of lightweight and recyclable materials such as aluminum. Energy efficiency and self-sufficiency of the micro housing unit is developed using intelligent control systems and materials, by this way very low energy values and potentially zero CO_2 emissions can be achieved. By means of responsible choice of interior materials such as *CLT, 3D recyclable polycarbonate and PMMA smart glass* in addition to minimalist interior approaches, in practice the analyzed housing units are an example of creating a sustainable design.

CONCLUSION

Based on the examples analyzed in the report, it can be concluded that the choice of recyclable and environmentally friendly materials used in the construction of small urban dwellings in the context of a minimalist housing unit, the conscious attitude of more and more people to live with less and minimize their environmental footprint, the application of technological progress and the intelligent

environment - all of them could contribute to a better future.

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