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Modular Products
Futuristic Strategy for Designing Future Spaces

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Abstract

Today, along with the social and cultural changes which have led to the emergence of new needs, and regarding the new technological advancements, new products and methods have products in markets; one of these emerging phenomena is modular structure. The ability to choose and to diversify the range of desired products in the future is more after being supplied to the customer which allows the user in some cases to create the desired design at any moment in the future. In fact, consumers can get their desired products according to their tastes and requirements by applying functional properties. Most of the products, and some of them, are generally pre-designed and produced; however, it is possible to create various designs using some know-how and tricks. Such futuristic measures are taken at the design step and before production, i.e. they are within the framework of the action of futuristic designers. These new methods of designing building systems make it possible to provide certain flexibility. They provide usability for a longer time by making possible improvements. The benefits of this article are discussed. To provide flexibility in the space of architecture, it is essential that a smart planning system of futurism exists beside the pre-fabrication; modularity is one of them. This strategy will lead to increase the creativity and user-friendliness in the designs needed for daily life or products. This paper tries to explain the modular design strategy to provide an operational solution for the design of future human environments.

Keywords: *Modularity, Pre-fabricated, Architecture, Future Design, Design Strategy.*

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Introduction

After the industrial revolution and the transformation of the lifestyle and the creation of new needs, the previous methods of building were not responsive to the needs of man (Rezaeimanesh & Taghdiri, 2019). On the other hand, with the ever-increasing competition in the field of construction, manufacturers also moved to the implementation of advanced manufacturing techniques. These methods have long been used extensively in other countries, but in our country, they are significantly unknown and sometimes even abandoned (Sobuti & Ahmadi, 2015).

Therefore, it must be said that these new construction methods have been developed to meet the new needs, and this policy structure in the field of production will always lead to prospects of supply and demand. These efforts have always been aimed at specific goals, such as speeding up construction, lowering the cost of construction, and increasing the quality and ease of implementation, and these goals have formed new foundations for industrialization. Industrialization is the concept that belongs to the subcategory of advanced methods. Industrialization is a technique in which the components are made under the controlled conditions outside the site and are transported to the site and are installed in their own position, so at least the work is performed on the site (Rezaeimanesh & Taghdiri, 2019). On the other hand, in the current situation, mass production is also a necessity (Sadri, 2012). Mass production may be carried out using industrial, semi-industrial, prefabricated, or a combination of these methods (Beiranvand, Delfan & Moradi, 2014).

In fact, the term industrialization is used to describe and encompass the concepts of modulation, pre-fabrication, and assembly, and hence the cost of equipment, facilities and technology to increase output, reduce manual work and improve quality (Khezrian, Damavandi & Hosseini, 2016). Modular construction has been introduced as the first step in industrialization in order to equip the construction process which has the possibility of building robotics and acceleration within itself. In the pre-construction step, most of the elements in the factories and the places outside the building site are standardized and mass-produced, and then in order to be assembled they are transferred to the site. These elements are produced industrially in factories, so that they can make a large number of them at very low cost and time (Fig. 1) (Alaghemandan, Shayanpour, Khojostemehr & Khalilbeigi khameneh, 2016A). Therefore, it is inevitable that turning industrial designs into design and construction due to the inadequacy of conventional systems. It should be borne in mind that the incidence and durability of any modern method in modern societies depends on the flexibility of these methods with factors such as culture, national identity of societies, consistency with the canvas and climate, the environment and the economy of those regions (Beiranvand et al., 2014).

Modularization is a design approach that divides a system into smaller units (modules) (Fig. 2). Modules can be constructed independently and can be used in different systems (Alaghemandan, Shayanpur & Mirhafez, 2016B). In fact, they are entities that are structurally independent, but they interact and form a larger system which is modular (Behzadian & Baradaran-e Kazemzadeh, 2006).

On the other hand, it is necessary to consider future perspectives and future studies. The future is an indefinite period of time after now, when it is inevitable to access due to the time and laws of physics. The field of futures research, which is a complex, wide-ranging field of research, is the focus of future attention and focus in the future. Looking ahead means expanding our horizons and seeing behind the scenes of problems. Also, when a person is in the present, he thinks about possible future events by seeing the future and its outcome.

Research method

Different methods and mechanisms can be used to

Fig. 1. The Habitat 67, as a Canadian pavilion for the 1967 World Exposition (Designer: M.Safdie), is an empirical solution for high-quality housing in urban environments, and these modular units are prefabricated to reduce construction costs and are also type of new housing that can become a city or town. Source: Alaghemandan et al, 2016A.

Fig.2. The Zigizaghi project in the city of Favara, Italy. It is made of a horizontal surface (floor and chair) and a vertical surface (lighting and sound systems). Source: Alaghemandan et al., 2016B.

identify possible and probable consequences of an issue. The panel of experts is one of the most widely used methods in discovering the implications and future issues. In addition to the panel of experts, subjective mapping, dependability tree and future wheel are known as of the promising futures research methods in identifying and discovering probable and possible future outcomes (Glenn & Gordon, 2013).

Here, we have tried to focus on a subject, design, economic, technological, environmental, urban, etc. in a number of layers. To identify these consequences with this subject area, we need to organize and to use the experts from all required areas, which can be done in the form of a panel or interview. It is therefore carried out in a creatively-minded manner and with the help of mentality and the disclosure of hidden consequences which are often known in the mental meetings. One of the basics of panels is environmental scanning. An environmental scanning is conducted to monitor developments related to the subject of the study. Environmental scanning is very important in terms of enabling us to understand the symptoms and

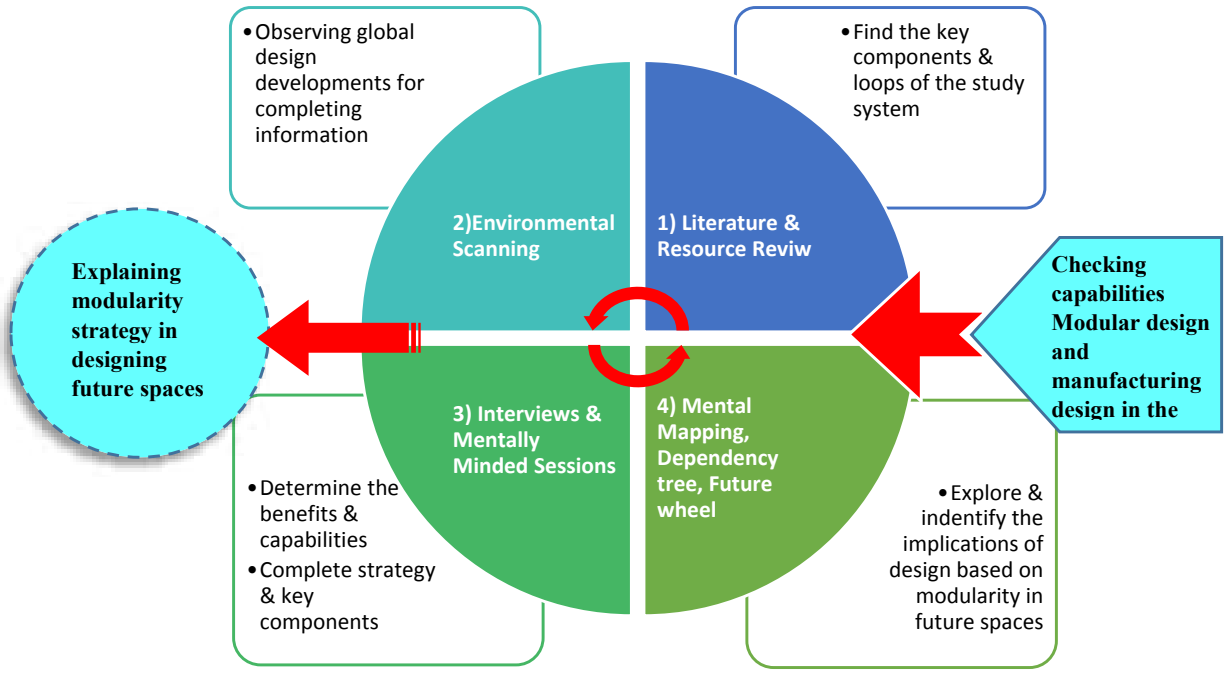

Fig.3. Steps to implement research methodology. Source: authors.

signs of weakness, it actually make us understand the symptoms of the change sooner than others. Also, environmental scanning is necessary to complete the predicted outcomes in order to observe the latest changes occurring in the studied area (Ibid).

According to Fig. 3, the first step begins with the review of resources which is attempted to identify and draw on the subject by reviewing relevant research topics, key components, prognosis, implications, and positive feedback loops of the studied system. The second step begins with the help of environmental scanning and simultaneously with the first step and continues until the end of the research. Surveying the environment with the aim of collecting the latest events, events, outcomes and feedback loops is a great deal of help in identifying the implications of space design which is due to the strategic changes of the modular design approach. For this purpose, you can use search engines, social networks, specialized groups, scientific circles, and field observations daily. The third step is interviewing with the experts. The interview was conducted in the format of extensive interviews with these individuals. The purpose of these interviews is to evaluate and to complete the findings from reviewing resources and environmental scanning. These experts are those who have a good understanding of the design and construction issues and the implications of using design approaches such as prefabrication and modularity. Because of the constant pursuit of this issue, they are able to provide more expert feedback. The fourth step is to hold memorable sessions. In many studies, steps four and five start at the same time. Meaningful meetings are combined with the drawing and completion of information from the panels. In mindless sessions, people without a position in a friendly and comfortable environment try to understand the developmental implications of the changing design approach. These sessions play a very important role in identifying changing layers, hidden implications and newer ideas.

In the final step, by scrambling and categorizing all the collected data from the previous steps, the vision of the strategic idea of the design would be completed. Namely, the subject is studied at

the center and outlines the different implications of the benefits and capabilities and potentials. Based on first-degree consequences, second-order consequences will be drawn and then the third and fourth-degree outcomes. To summarize the proposed strategy from a variety of perspectives and suggestions, it is generally possible to say that this approach is a combination of future wheel techniques, dependency trees, and mental maps (Malekifar, 2008).

We used the reputation and merit model to identify the experts. Based on this model, first, by referring to the treatises, articles, lectures, books and other scientific publications published in the field of industrial design and manufacturing, production of bonds and modularity, we came to the list of 21 researchers, and we asked them to introduce three most famous experts in this field. In the next step, we chose the names of those whose names were repeated more than three times and invited them to interview and attend panels and mentally minded sessions. The findings of this study are the result of an analysis of 15 experts on existing trends and possible events in the design and construction of future products.

Validity and reliability of information gathering tool

As most of the extracted concepts from the documents are basic principles and concepts, the probability of any changes in them was low and the reliability of these themes was high. To select the resources and studied documents, the experts in designing and manufacturing have been asked, who have been active as experts in this field for many years and currently have scientific degrees. During the course of studies, the updated documents and evidences have been used, which are the foundations of specialized work in the world and world design studios or are used as valid scientific and academic degrees in famous universities. They are highly valued.

Literature and theoretical foundations of research

• Geometry and proportions

The basis of the creation of nature and the whole being is based on proportions. Appropriateness is the relative and deductive relation between the various components of an element. In fact, measuring between the sizes of two things creates a ratio, and proportionality is said to be equal to these proportions. Geometry and proportions are mathematical concepts that in art and architecture refer to the relation between components in relation to the whole (Fallahnia & Zare, 2014). The use of symmetry and harmony in the design is one of the tasks that designers have been trying to achieve in the past (Mahdizadeh, 2015). In architecture, the proper design is created using appropriate dimensions and sizes for the application of forms and the creation of discipline and obtaining proper symmetries (Fallahnia & Zare, 2014). Proportional relations are often based on a module or unit. Different parts of a building or any other signature are also considered as its dimension or its multiple or fractions (Ibid). For example, Iranian architects created the Peymoun modular model with the help of geometry to create the best possible design. Also, matching systems

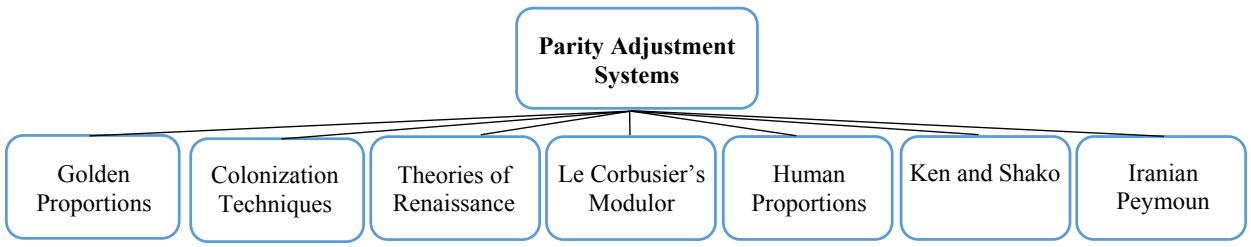

Fig.4. Different Types of Differential Settlement Systems (Fallahnia & Zare, 2014)

can eliminate the multiplicity of components in one architectural design by creating similar proportions and it can unite the design visually (Mahdizadeh, 2015). Fig.4 shows a variety of adjustment systems for different periods:

Modularity in the modern world, Ken in Japan, Peymoun in Iran etc, approve this claim that there has always been the concept of modular design in architecture, and the weakness have existed. The main purpose of all the theory of proportions is to create a sense of order and coordination between the visual elements of a building (Falahat & Mohammadi, 2011). In general, in all stages of the development of an architectural effect, the application of geometric parity in determining and controlling dimensions and sizes is the factor in achieving a desired result (Fallahnia & Zare, 2014). Consequently, modularity is based on the principles of geometry and proportions and proportional relationships between the components of the unit.

Research background

• Industrialization history

The Industrial Revolution transformed England into the world's first industrial power. Construction of the first iron bridge in 1779, the construction of the first railway network in 1825 are of its positive results. New inventions like steam machine make goods faster and cheaper than before. After World War II, the need for mass housing was the main reason for using industrial methods based on economic goals. In general, the history of industrialization is divided into three periods:

1. From the mid-19th century to the Second World War: A period in which theories and industrialization theories were created.
2. From World War II to 1960: A period that was the period of the implementation of the theories, and most of the economic objectives pursued, and the quality of architecture was not so important, so the buildings lacked harmony and variety.
3. Beginning in 1970, its goal was to improve the quality by using advanced technology in the design, production, and quality of the architecture with various systems (Rezaeimanesh & Taghdiri, 2019).

• The history of modularity and pre-fabrication

In ancient monuments such as the Pyramids of Egypt, the Roman and Greek temples, and the Sassanid and Achaemenid palaces, pre-fabricated pieces of stone are often used. Therefore, they can be named as pre-made and modular in terms of present definitions. But due to the lack of means of transportation, most of the components were being prepared and used at the building site (Safa & Fathiyeh, 2016).

Therefore, the use of a dimensional pattern has long been known by ancient civilizations of Rome and Greece (Farivar, 2013). The Greeks and the ancient Romans used the diameter of the column for the base size (modulus) (Falahat & Mohammadi, 2011). The Sri Lankan kings used large wooden prefabricated elements to build towers 2000 years ago, using special equipment they installed at the site (Alaghemandan et al., 2016A). In Renaissance architecture, proportions and modules are an integral part of the work of Renaissance architects such as Palladio (Falahat & Mohammadi, 2011). In traditional Iranian buildings, the observance of this discussion as Peymoun has been abundant (Mohsenin, 2007). Also in Japan, Ken was another type of Peymoun, whose networking was as tatami mat and gradually followed the structure of the building and the mouths (Falahat & Mohammadi, 2011).

In the late 19th century, in Europe, with the industrial revolution and the emergence of new building materials such as iron, concrete and other products, the idea of modulating buildings was formed (Farivar, 2013). In 1850s, the balloon frame building system revolutionized the speed with which new wooden houses were built. In the early twentieth century, construction companies in the United States provided their citizens with a residential catalog of their own, and the people chose the house of their choice, carrying out and assembling the house in several stages, and eventually the desired product,

residential building, was delivered to the customer (Alaghemandan et al., 2016A).

In 1909 Peter Behrens presented a plan for the "AEG" company. The motto of Behrens, "The Humanization of the Industrial World", was a brilliant crystallization in his electric kettle design. In this design, three types of electric kettles were built, with the door, the handle and the base of the same size, so it is possible to combine their parts and create new models. Also, to build the kettles from three types of different sheets (rice, nickel, copper) were used, and each of these sheets had a different texture (soft, hammer, wavy). By combining these elements more than 80 model kettles as a result of a wide range of choices were created (Pirbabaei & Amraei, 2009).

In 1936, Albert Bamies published a book entitled "The Reasonable Design" in which the 4-inch cube was designed as a design modulus. Ernest Nouffert, in terms of both human and simultaneous dimensions of Swedish scholars, achieved some minor differences (Mohsenin, 2007).

In the years 1942-1948, Le Corbusier developed a modular discovery at Alberti's lengthy work and other endeavors, and then, using this knowledge, advanced the appearance and efficiency of architecture. The system is based on body measurements, Fibonacci numbers and golden proportions (Mahdizadeh, 2015). It is also modular on the basis of mathematics and aesthetic dimensions as well as on the basis of the proportions of the human body (Falahat & Mohammadi, 2011). In such a way: one segment is divided into two parts, in which the proportion of the smaller piece to the larger piece is equal to the ratio of the larger part to the entire segment (Fallahnia & Zare, 2014).

In 1960, the designers of George Nelson Company had rejected the common old ideas in many normal houses of that time. This new method has benefited from the progress of the modern movement. Ideas focused on it were: 1. Effective performance 2. Mass production of materials 3. High flexibility 3. Removing the living space. Therefore, the characteristics of industrial houses in the year included: 1. fully small cubes for the development of units 2. Putting them together on the site 3. Matching components of these units easily and transferring them to another location (Sobuti & Ahmadi, 2015). From the late 1960s, both in volume and in production varied, in order to respond more effectively and quickly to demand changes in the market. Ford Motor Company

Fig.5. These glittering objects are modular lights that include a common unit and attachments for customizing the lamp. Source: Pirbabaei & Amraei, 2009.

is one of the great pioneers of this decade with Ford Mustang. In this regard, it is also possible to point out to electronics manufacturers like Sony and JVC as well as mobile phone companies (Pirbabaei & Amraei, 2009).

In the 1970s, the United States achieved the various construction methods that were used for example at the Hilton Hotel in San Antonio. This hotel has been in operation for 202 days and as of 2011 the tallest prefabricated welfare complex was known (Alaghemandan et al., 2016 A).

Discussion

• Modularity

In addition to the social and cultural changes that led to creation of new needs, as well as technological advances, new designs with modular approach are introduced in the markets (Pirbabaei & Amraei, 2009). Products that expand the scope of choice considerably and some allow the user to create their own design (Fig. 5). Products such as audio and video equipment, furniture, mobile phones, automobiles, etc., which can be obtained from a group with a variety of feminine and costly features (Pirbabaei & Amraei, 2009). In fact, modular design is a design approach that divides a system into smaller units (modules) (Alaghemandan et al, 2016A).

Module: The word derived from the Medus word in Latin and means the size; it is usually called as the predetermined thing having a standard (in terms of shape, size, etc.), which can be repeated. In the informal speech, it is a predetermined form, which is used to fill in the requested items (Safa & Fathiyeh, 2016). On the other hand, they are units in a bigger system which are structurally independent and work together (Behzadian & Baradaran-e Kazemzadeh, 2006).

A. Modular products: a group of products that are similar in technology, components, and compounds, and are used to obtain a unique end product using small pieces pieces (Khezrian et al, 2016). It can be said that the product is selected by the user from the production of the same cluster (Sadri, 2012). AS there are several alternatives in the production of clusters for each piece of product which can be selected by the user (at the time of purchase or afterwards).

B. Modular buildings: In 1983, basic technology was developed in America and Europe (Asadi & Behzadeh, 2015). Modular building systems are closed systems, whose components are prefabricated in the factory and independent of the specific building. In this case, the whole system is subdivided into sub-sets, which is a major expansion that is adaptable and independent (Sobuti & Ahmadi, 2015). It allows the possibility of pre-fabrication to run and create a quality building in terms of applied materials that are obtained in a factory manner, and this method prevents the reworks which make double charge; it even provides the flexibility in housing Asadi & Beigzadeh, 2015).

Modular housing construction transmits many operations to a controlled factory environment and complies with local building codes similar to those built in the site. Modular houses are composed of three parts that are usually completed after leaving the factory at around 95%, including completed floors, wall and ceiling paints, installed cabinets, finished roofing, and facades etc. The construction of these houses involves the use of similar materials to the houses built on the site, but is carried out in a controlled factory environment. When the house is completed at the factory, the completed parts are transferred to the construction site, then lifted up by the crane and placed on the foundation (Fig. 6) (Ashrafganjuie & Dehghani, 2016).

In sum, modular design is a construction method or process in which individual, independent or assembled models form together larger structures (Asadi & Beigzadeh, 2015). In all definitions the proposed modular concept refers to a component of a system, which is independent and complete, and does not require any other, and this component is in the proper connection with other components (Rezaeimanesh & Taghdiri, 2019). Modularity can

Fig.6. A Modular Wooden Village for the Beijing Gardening Fair, designed by Penda as a strategy for the renovation of rusty texture. Source: Ashrafganjuie & Dehghani, 2016.

be used in infinitely combinations and can unite the design with variety; and this means the miracle of numbers (Fallahnia & Zare, 2014).

• Modularity in Persia (Peymoun)

In Iran, beyond the same standard as the common module, it was called "Peymoun" (Mohsenin, 2007). They were certain dimensions that were repeated in the design. Its following removed any architect's concerns about intolerance and insensitivity (Falahat & Mohammadi, 2011). Iranian architects used Peymoun to make buildings very different. Although they were used by a pioneer (Fallahnia & Zare, 2014). In fact, implantation has implications such as flexibility and diversity. In other words, nowadays, with the industrialization of buildings, this concept has become different.

• Peymoun & Module Comparison

A. Similarities: Both signify proportions and impose a series of rules (Mahdizadeh, 2015). They are the basis for compliance (Fallahnia & Zare, 2014). Therefore, their application will result in the order and coordination in the plot. There is also a possibility of pre-fabrication in both systems (Mahdizadeh, 2015).

B. Differences: Among the differences we can cite, is that when the modulus is applied, the proportions are removed from the human state. Therefore, it does not apply to parts of the building where human fitness is needed and more modules can be used for areas that do not require human proportions, while Peymoun's system can be used in both cases (Fallahnia & Zare, 2014). In other words, since Persian architecture is intrinsic to architecture, Peymoun also implies this introversion, but the modularity is more concerned with extraversion. Also, the modulus of a mathematical pattern based on a discipline is numerical and linear, while Peyman meets the needs of design and construction in numerical and geometric terms (Mahdizadeh, 2015).

Research findings

• Modular product applications

Due to effect of the Internet and information technologies, customer relationship management and as a consequence, the receiver of their needs and desires can be achieved easily and quickly. By doing so, companies can order products tailored to their needs and needs by collecting, analyzing and anticipating the massive needs of customers. In this context, the paradigm of mass production of products, in accordance with the needs and demands of customers, replaces the traditional paradigm of mass production (Behzadian & Baradaran-e Kazemzadeh, 2006).

In fact, with the massive expansion of competition in markets, a phenomenon called the broad spectrum of consumerism was formed. In this approach, manufacturers have found that a product will only focus on a group of people in the community. This group, albeit numerous, represent only a fraction of society. So manufacturers have tried to provide products that allow the customer to select and order their product. This approach is called customer orientation. The goal of a customer-oriented approach is to make minor differences in standard forms for more tailored to the needs of the customer (Pirbabaei & Amraei, 2009).

When different groups of customers have different needs, the best idea is to separately provide each customer group with different products to their satisfaction. But this often seems impossible due to the various cost and time limitations. The solution to such a problem is a family-based product strategy based on modular architecture that addresses these needs by configuring, modifying the structure of the components and, in fact, modifying the modules (Behzadian & Baradaran-e Kazemzadeh, 2006).

It is worth mentioning that we should not assume the possibility of choosing with the personalization the same. Because personalization involves manipulating the user over the product s/he belongs to in order to create a more personalized relationship with the merchandise, which is often decorative and deals with a few items. But in the case of modular products, the creator of the scheme does not lose his authority, but only allows the user to choose. Creating a choice is a creative move from the creator of the design, and the possibility of user involvement is only within the framework of the choices that the designer has given It is noted above that paying attention to this matter can be a futuristic strategy in designing future products.

• Disadvantages and advantages of designing modular products

A. Disadvantages: Christopher Alexander criticizes the modulation: "These buildings are full of identical dry pieces, identical rooms, identical houses, and identical apartments in the same complex". In his critique, he continued to modulate with patterns in nature. "Nature is never modular, nature is full of similar units, but although all of them are in the same structural and general terms, but none of them are in the same details" (Asadi & Beigzadeh, 2015), he says. However, today, with the scientific advances and the use of human bionics, humans have realized the modularity of many natural phenomena and creatures. Therefore, Alexander's opinion today is not very accurate and can be ignored.

B. Benefits: At first, the benefits of advanced manufacturing techniques can be summarized as follows: 1. Proper use of materials and facilities; 2. Speed of performance; 3. Reduced price; 4. Better quality control; 5. High safety; 6. Additional shelf life and greater shelf life & 7. Better planning and control. 8. Energy storage (Sobuti & Ahmadi, 2015). Also, the positive points of the previous systems are: 1. the production of abundant and continuous product; 2. The working conditions of the space and the work environment of production and assembling; 3. The optimal use of resources and materials; 4. Speeding up the quantity of production in a unit time and eliminating the conditions and reasons for the waste of time; 5. It is possible to use the expertise and experience of skilled labor technicians and to continue to use

them & 6. Appropriate use of expensive equipment and elimination of waste of time (Farivar, 2013).
The potential benefits to modularity include: 1. Economic potential; 2. Increase of changing possibility of product/component; 3. Increase of product diversity; 4. Decrease of order waiting time; and 5.Connecting the design and production works. The very existence of upgrading, maintaining, repairing and fixing product defects (Behzadian & Baradaran-e Kazemzadeh, 2006). This design method has a distinct advantage for both the producer and consumer groups, and will be more satisfying with the customer as a result of the product's production, both for the benefit of the consumer and for the benefit of the manufacturer. Companies also step up their efforts to understand the demands of customers, and customers do not have the passive roles and teach the manufacturer what to do (Pirbabaei & Amraei, 2009).
Mark Lawson considers the benefits of prefabricated and modular systems in building:
1. Less time to build, resulting in lower management costs and a quick return on investment.
2. Economical benefit, especially for large buildings requiring modules to be replicated.
3. Thermal and sound insulation and high fire resistance due to the nature of the two shells of the modules
4. Lighter weight and reduced consumption of materials
5. Increase productivity due to industrialization of modules at the factory
6. Reducing neighborhoods and eliminating restrictions such as storing materials and preventing traffic
7. The ability to separate modules and use them elsewhere with other applications (Alaghemandan et al, source A, 2016).
It is also worth noting that modular homes are currently achieving a higher level of sustainability than other houses built on the site. Because less production is required due to less time to build and less time required to be present on the site, indicating that this method has less damage to the site and its surroundings (Ashrafganjuie & Dehghani, 2016).

The following are the benefits that can be made for modular designs:
1. Reduce performance time and improve quality
2. Selection of modular dimensions and its observance at all stages of design
3. Matching all materials, components and equipment with each other in such a way that it is not necessary to make adjustments to the construction site.
4. Adaptation of architectural and architectural design networks and adaptation of these networks to facilities, furniture and equipment
5. Polishing and grouping of components (Asadi & Beigzadeh, 2015)
6. Usability for longer time
7. Match the experience and user intervention
8. More economic and ecological sustainability
9. Easy access to the benefits of technological innovations
10. Reduce the assembly time and cost
11. Enabling mass customization (Khezrian et al, 2016)
12. Assurance of construction standards and their implementations
13. Reduce the wastes and increase recycling due to the construction of parts outside the site
14. Reduction of waste production at the site due to the construction of parts at the factory
15. The construction of components that require water is more controllable in the factory environment and has a higher potential for recycling at the plant.
16. Decrease of contamination due to the production at the factory. Therefore, they will have less effect on plant species.
17. Reducing disadvantages and defects after completion of work due to construction in the factory (Having the ability to predict the performance of the project, which means that it is possible to measure and estimate correctly with the least error, thus ensuring that the number of jobs is completed within a specified period) (Sobuti & Ahmadi, 2015).
18. Consumption of energy and materials

19. Precise control of the manufacturing process
20. Use of lighter, more durable structures, easier maintenance (Mohsenin, 2007).
21. Improvement of the construction process in terms of the environment (Asadi & Beigzadeh, 2015)
22. Achieving a new solution by adding another modality or removing it (Alaghemandan et al., 2016B)
23. Increased component flexibility and product change
24. Increasing product diversity
25. Eliminating risk
26. Effective development of customer needs
27. Introduction of new technologies
28. Ease of rework if incorrect assembly
29. Reduce of innovation costs
30. Flexibility in reactions and reactions
31. Facility in the production of complex products
32. Increasing the power of expertise for the company, meaning companies can focus on strengths. They have improved them and identified them with their weaknesses and overcome their rivals (Safa & Fathiyeh, 2016).
33. Creation of harmony (Fallahnia & Zare, 2014).
34. The user is faced with more choices during the purchase and can feel more friendly with the product by selecting different components and combining them together. User-centered discussion is displayed, especially in the features that are available to the user after purchase (Pirbabaei & Amraei, 2009).

The benefits of this approach have increased the opportunities of related industries and have led to think more about the use of modular construction method as a combination of environmental and economic benefits. Inside the modular construction industry, product lifecycle is due to its use in reducing energy production, implementation, maintenance, recycling and disposal. These benefits make the majority of designers and mass makers more inclined to this (Asadi & Beigzadeh, 2015).

• Overview of benefits

Perhaps, given the explanations below, the following can be considered as the most important benefits: increasing the creativity and consumer innovation, consumer participation in post-production design, adjustment and adaptation based on need or taste, increasing the shelf-life and product life in the usage cycle, variation, customization, cost reduction, increase of productivity, adjustment based on human ergonomic principles, reduce of production time as well as increase of product sales and etc (Fig. 7 & 8).

• Modular design principles

A modular design as a product which tries to interact more with its user, must be organized according to the user's desires, activities, and abilities, and it will organize them together. It must conform to the methodology that the user minds processes and decides to make, and provides full user control and state-of-the-art knowledge throughout the entire period of use (Asadi & Beigzadeh, 2015).

The basis of modular design is that the products are designed in such a way as to structure, standard parts and modules that can meet the needs of different groups of customers (Behzadian & Baradaran-e Kazemzadeh, 2006). Also in designing modular products, in addition to ergonomic topics, they also consider the mental needs of the user (Pirbabaei & Amraei, 2009). There is also a modular design based on thoughts, numbers, and logic whose dimensions, structure, and members are formed in laboratory conditions (Asadi & Beigzadeh, 2015). Therefore, a variety of sizes are obtained from the combination of a limited number of base sizes. These sizes can be used to design and manufacture buildings and their components, or to design spaces for buildings, appliances, and many more application (Sadri, 2012).

In order to achieve the benefits and modular product design, the following principles and principles are presented:

1. Customer orientation and expanding user groups
2. Increasing the choice of consumer choice by

Fig. 7. "Allied" modular interior architecture: office space segmentation with quick setup and adaptation to staff and interior design without changing the entire building. Source: www.designboom.com

Fig. 8. The "Tetris" table is packed with industrial design slides in different formats. Source: www.designboom.com

providing alternatives in selecting components

3. An application for mental health needs

4. Smart and innovative use of the principle of companion psychology and substitution in the design of a modular product (Pirbabaei & Amraei, 2009).

Since the base module is the basic unit of size in the modular coordination system, one of the following conditions is necessary for its determination:

1. The size of the module is large enough.

2. The size of the base module is small enough to match the size required.

3. The size of the base modulus must be so large that it can be obtained when subdivided into more subjective modules in design sizes.

4. To facilitate the use of modulated elements, their runners must always provide integer numbers.

5. In choosing the base module, the modules selected by other industrial countries should be carefully considered (Sadri, 2012).

It should be noted that the determination of the base module should be based on general conditions (size, design to fit the design, simple and complete, ability to adapt to international scale systems) and local conditions in different places (adaptation to cultural and social traditions, climatic conditions, and dimensions of locally produced materials) (Farivar, 2013).

It should be considered in the modular design, the production path in the production lines is uniform, so that all products pass through a clear path and uniformity and the production process is all the same. Only in the final assembly, according to the customers' tastes, the extra pieces are placed (Khezrian, et al., 2016; Asadi & Beigzadeh, 2015). Organizing and assembling is also done according to geometrical rules (Beiranvand et al, 2014; Asadi & Beigzadeh, 2015). The development of component replacement and standardization is a pivot for modular design (Sobuti & Ahmadi, 2015).

In the case of modular products, a very important point to note is that designing a modular product is different from the design of the product. The variation of a model and constant design, which has been achieved only through categories like variation in color or texture, is called a variety; for example, a heater in different colors. But this is the least possible choice that can be awarded to the customer. But the modular products consists of a collection of different which can combine and recombine. The differences of the components are visible, not only in some properties such as color or texture and even the price, but also in design, Gestalt and even the function (Fig. 9) (Pirbabaei & Amraei, 2009).

• Types of modular products

Modular products can generally be contracted in two types. The first type includes choices for composition and design at the time of purchase. In this kind of clustering scheme, the user chooses the components when buying a product and obtains the desired product. This mode, which the customer selects from his predefined elements, is called

a Collaborative customization. The second type includes options available to the user after the purchase, and the user can create combinations of his/her favorite (formally and in some cases functional) by combining standard modules (Fig. 10). This mode, in which the product can be changed after the purchase, is called Adoptive customization and the most creativity is seen in this section (Pirbabaei & Amraei, 2009).

Conclusion

Modular designs develop the scope of choice and some also allow users to create their own design. The consumer can get a good product from a group with a variety of fermented and costly features. In these products, it is possible to create a variety of designs by adopting measures. Such measures are taken prior to production and during design, that is, within the framework of the designers' actions. These new methods allow for a certain flexibility design. In addition, they provide the potential for improvement, usability for more time, user experience and user interactions, more economic and ecological sustainability, and the benefits of technological innovation. To provide flexibility in the space of architecture, it is essential that a smart planning system of futurism exists beside the pre-fabrication; modularity is one of them.

Architects and engineers can increase the creativity, innovative in design and color, easy and quick installation of needed daily life instruments or decorative elements by using a modular strategy in the design of prefabricated elements used in the future. They would satisfy every taste.

What has been gained from the findings of the research and the above studies can lead us to the important point, that the structure and principles of modularity in the present world and more importantly in the future world and future cities and our future life is one of the key strategies in designing and production to provide services or products. Therefore, modularity can lead to the creativity and innovation of the consumer, so it can create every time the artistic, economic and industrial products using the principles of modularity depending on its needs or environmental conditions with the fundamental units that it possesses. So modularity is one of the key principles in designing the future products.

Fig. 9. Open Motors startup in China focuses on designing modular vehicles and maintenance of other companies. Source: Pirbabaei & Amraei, 2009.

Fig. 10. Open architecture and development of a six-sided rebuilding construction system by the modularity strategy in Guangzhou, China. Source: Pirbabaei & Amraei, 2009.

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