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Investigating and Analyzing the Indicators Affecting Smart Housing in Baghdad city

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Abstract: Providing suitable housing in terms of safety, comfort, and energy efficiency has been considered as the most important human demands, and in this regard, the intelligent building system creates ideal conditions in buildings by using the latest technologies. In this regard, the purpose of this study is to investigate the position of urban planning indicators affecting smart housing in Baghdad.The method of the present study is descriptive-analytical in nature and applied in terms of purpose. Data collection has been done in two ways: library and field. The statistical population of the study was experts and experts in the field of housing in Baghdad, and 86 experts were selected as the sample size using the Delphi sampling method. To analyze the information, structural equations and operating system analysis have been used. The findings of the research show that the information technology index with a value of 22.78 and the index of intelligent systems with a value of 15.79 had the highest and lowest level of intelligence of residential buildings. Also, the results of structural equations show that in the physical component between the criteria of the information technology index, the existence of a digital building map with a figure of 0.307 and in the environmental component between the criteria of the energy consumption index, the use of new methods of energy dissipation with a figure of 0.411 and in the physical component and the index of smart systems, the criterion of controlling equipment with mobile applications and tablets, have the most effect on the intelligence of residential buildings in Baghdad. In general, the residential buildings of Baghdad are not in a good condition in terms of intelligence, and due to the needs of the city as well as the old and worn-out texture, in order to improve the quality of life of the residents, save energy consumption, and prevent accidents, the need for urban managers to pay attention to smart technology is essential.

Keywords: *Smart Housing, Information Technology, Energy Consumption Control, Smart Systems, Baghdad City.*

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Introduction

Today, buildings account for more than 20,% of the world's total energy consumption, of which about 60% of this energy is spent on ventilation, cooling, and heating of buildings (Sazigheh & Saadatjoo, 2020). Therefore, it is necessary to address the main indicators affecting the reduction of energy consumption in the general design of buildings and to determine the basic climate patterns for different types of buildings. With the entry of superior technologies into the construction industry and the need to respond to the new needs of the people of the society, smart housing has been in the spotlight as an emerging but highly attractive phenomenon. Among the most important factors and capabilities welcomed by consumers, we can mention security and safety, convenience and comfort, facilitating management and saving energy consumption, and helping to promote health and hygiene (Mashayekhi, 2019). With the advent of smart grids and the emergence of issues such as advanced communication and information infrastructures, two-way communication, advanced metering infrastructures, energy storage systems, and local area networks, they have revolutionized patterns of electricity consumption and energy saving. Smart buildings using artificial intelligence and the use of sensors can reduce energy consumption through better control and promise to enter a new era of energy efficiency (Farzaneh, et al., 2021). The concept of smart buildings has been introduced by the Energy Performance Directive with the aim of promoting energy flexibility, renewable energy generation, and user interaction (Dakheel, Del Pero, Aste & Leonforte, 2020).

Smart residential buildings include smart lighting, curtains and canopies, elevators and escalators, electrical and installation equipment, traffic control system, burglar alarm system, surveillance cameras, and fire alarm and extinguishing systems (Arabi and Nia Ravanshad, 2016). Therefore, building smartening can create a great change in the system of urban stability and stability. Smart building is an integrated set of multiple systems for effective resource management, increased technical capability, investment cost savings, operationally, and flexibility (Quchani, et el, 2019).

Nowadays, energy saving and building safety is one of the important discussions in many cities, including Baghdad. The city of Baghdad is located in a hot area with limited energy resources, and it also has large and modern buildings, which due to the lack of distance between them and the use of sunlight and shading, a lot of energy is wasted in these buildings every year, and these buildings face risks such as fire. On the other hand, the city of Baghdad has numerous historical buildings and worn-out textures, which by renovating and equipping them with smart technology, an important step towards improving the quality of life of residents and creating sustainability and saving energy consumption, increasing safety and security requires attention to smart buildings. Therefore, a smart building in Baghdad can create stability in the urban space so that it guarantees security, safety, optimal energy consumption, and resilience against hazards. Therefore, the purpose of this study is to investigate the position of smart building indicators in Baghdad. The research question is expressed as follows:

1. How much do the buildings in Baghdad observe the smart indicators?
2. What is the most important factor affecting the smart buildings of Baghdad?

Background and Theoretical Foundations

Today, with the further development of new technologies in the field of the construction industry, the use of smart technologies has expanded more rapidly, so that in European countries, the use of smart technologies in commercial buildings after 2018 and also residential buildings after 2020 has become mandatory (Brangança & Koukkari , 2011).The American Planning Association has dealt with technical issues and urban planning and design in order to achieve a development model based on energy efficiency. This model proposes sustainable use of energy resources, community ecological form and function, community-based resource management, land use optimization, social equality, and economic vitality as the five basic principles of achieving energy efficiency solutions in all cities. The energy consumption of heating and lighting is used as criteria for evaluating energy efficiency (Nasrollahi , 2013). In a study titled "Data-Driven Measurement and Control for Smart Buildings and Smart City Systems points out that wireless sensor networks, machine algorithms for extracting information from data, and IT infrastructures play an effective role in supporting data flow in smart buildings and smart city systems (Grigore, et al, 2018).

The results of the research on the effect of building smartening on the profitability of the hospital of the Social Security Organization of Alborz province showed that smartening has a significant and strong effect on cost reduction with cost savings, staff welfare, and patient welfare. Reducing the cost by saving has a positive and strong effect on reducing the cost of room lighting and reducing the cost of room temperature, and reducing the cost of room lighting, reducing the cost of room temperature, patient welfare, and employee welfare has a significant and strong effect on profitability (Berliani, et al., 2018). According to the research of Ghadiri Moghaddam et al. in 2019, it can be found that among the various options for energy reduction, the use of a trump wall and the greenhouse phenomenon, the installation of a trump wall and a shade with appropriate windows in the southern wall of the building, is the best performance in providing energy (Ghadiri Moghaddam et al., 2019). In 2008, Hamza investigated the effect of using a ventilated double-shell façade with simple, colored and reflective glass in different facades of a seven-story office building located in the hot and dry area of "Cairo" (Hamza, 2008). A study in 2014 considered the characteristics of the outer shell as the determining factor in the amount of energy consumption and considered it necessary to pay special attention to the design process of the building and in particular, to the design of the outer shell of the building(Cicelsky & Meir, 2014). Another study in 2015 found that several factors affect energy consumption in tall buildings. The degree of importance of these factors varies between different buildings and is generally categorized into architectural, human, technological, and natural parameters. Architectural factors that are related to the design of the building and its components include the functions of the building, spatial relations, the shape of the building, the height and the external shell of the building (Elotefy, et al, 2015). Yang's research in 2018 investigated the energy performance of building shells in China's climatic regions by comparing the energy consumption of high-rise buildings with the existing standards in China and provided solutions in this regard (Yang, 2018). In 2019, Hafezi et al. analyzed energy in the early stages of designing high-rise office buildings in Tehran and concluded that the percentage of windows, type of glass and building form, the most influential indicators, and mass and thermal insulation have the least impact on energy consumption (Hafezi et al., 2019). The simulation findings of Khodakarami and Ghobadi's research in 2018 showed that by doing proper planning in the field of energy consumption and management in smart office buildings, it is possible to reduce more than 91 to 40 percent of annual energy consumption and the highest amount of savings is in the cooling and lighting sectors (Khodakarami, Ghobadi, 2018). In a smart building, equipment plays a significant role, which can be mentioned as follows:

Smart materials: These are materials that have the ability to react quickly and appropriately to environmental stimuli. The basis of the concept of intelligence is to receive the desired reaction from materials and to respond quickly and unquestioningly to specific and unstable stimuli (Mofidi, 2013).

Smart Materials: Smart materials are often described as adaptable or intelligent materials. While most of the smart materials that are known today may be described as applicable materials due to their properties for self-modification. Sometimes different products or materials may be combined with intelligent properties to create complex behaviors (Zafarmandi et al., 2021).

Sensors: With the support of active sensor networks consisting of sensor and actuator components, the building energy management system can integrate various physical sensor information and control various household devices (Han & Lim, 2010). A review of the background and theoretical foundations related to the subject shows that smart home through four components of physical, environmental, economic and psychological can improve the quality of life of the residents, and the indicators related to each of these components have been examined from the perspective of different researchers and presented in the form of Table 1.

Method

The method of this research is applied in terms of purpose and descriptive-analytical in nature. Data collection has been done in library (books, articles, documents, etc.) and field (questionnaires) using the Delphi technique. The statistical population of the study includes experts and experts in the field of construction, civil engineering, urban planning, environment and energy, information technology, geography and urban planning, and crisis management. To determine the sample size, the Delphi method was used, and 86 people were selected as the sample size. For analysis, structural equation modeling and operating system in the form of LISREL software have been used.

Discussion and presentation of findings

According to Table 1, the components and dimensions of intelligence in buildings, especially residential, are very extensive and complex. According to the purpose of the research, these components and dimensions of intelligence have been investigated and evaluated in three more general sections, namely information technology, control of energy consumption and optimization in buildings, and intelligent systems in buildings, each of which has been investigated with the details of the criterion (Table 2) in the city of Baghdad.

The value of t-statistic in the research model for evaluating the components affecting smart residential buildings (Table 3) shows that information technology with a t-value of 22.78 is in the first place, energy consumption control with a t-value of 22.63 is in the second place, and finally smart systems with a t-value of 15.79 is in the third place. In general, the statistical value of the components affecting smart residential buildings in Baghdad is 21.69, which is not in a good condition. Among the studied components, the information technology component with a figure of 3.15 and intelligent systems with a figure of 2.98 had the highest and lowest level of intelligence, respectively.

As can be seen in Table 3, with a probability of 95% of the components affecting smart residential buildings in Baghdad, it has a significant level of (0.000). As a result, there is a significant difference between the base limit (3) and the obtained value of 2.89. Due to the fact that the obtained value is less than the base level, the components affecting the smart residential buildings of the city are not in a good condition.

In order to investigate more accurately between the indicators and fundamental components of smart residential buildings, structural equation was performed in LISREL. Among the cri-

Table 1: Components of Effective Intelligence in Improving the Quality of Life of Residents

Component	Index	Source
Anatomical	Comfort and convenience Fire Safety Air conditioning	(Nemati, Hassanzadeh, M., & Maleki, M., 2018) (Rezaei & Moradi, 2021) (Kazemi Pouran Badr et al., 2020), (Rostami, Hatami & Hosseini, 2020) Dehnad, A. and Shakouri G. H, 2013)) (a. Rifat Boynuegri. et al 2013) (Dehnad, A. and Shakouri G. H, 2013) (a. Rifat Boynuegri. et al ,2013)
Economic	The cost of using new technologies and methods, appropriate energy exchange in the entire area, ease of design of energy distribution facilities, return of the cost of smartening, power and gas power cut-off in times of danger, management of building energy consumption based on supply and demand, intelligent control of the cooling system, heating according to the ambient temperature. Reducing the cost of repair and maintenance	(Ghazi, Naderi, 2011), (Honarvar & Haghighi, 2021), (Omidvar, Tabrizian & Shahmirzad, 2021), (Alizadeh, Jafari Nokandi & Soltan Moradi, 2019) (a. Rifat Boynuegri. et al 2013) (Rostami et al., 2020) (Aboutaleb, 2016)
Environmental	Energy Consumption Optimization Reducing greenhouse gas emissions No use of fossil fuels Reducing the emission of environmental pollutants	(Ghadiri Moghaddam, et al., 2019) (Honarvar & Haghighi, 2021), Omidvar et al., 2021, Rezaei & Moradi, 2021, Tortabian & Haghparast, 2021, Gorji Mahlabani & Haj Aboutalebi, 2009) (Rostami et al., 2020) (Zafarmandi, Amirjamshidi, Sanei, 2021) (Farzaneh, H.et al 2021) (Kazemi Pouran Badr et al., 1399) (Mohammad Tayebi, 2020)
Psychic	Security	(Abu Taleb, 2016) (Bagheri Ziari et al., 2016)

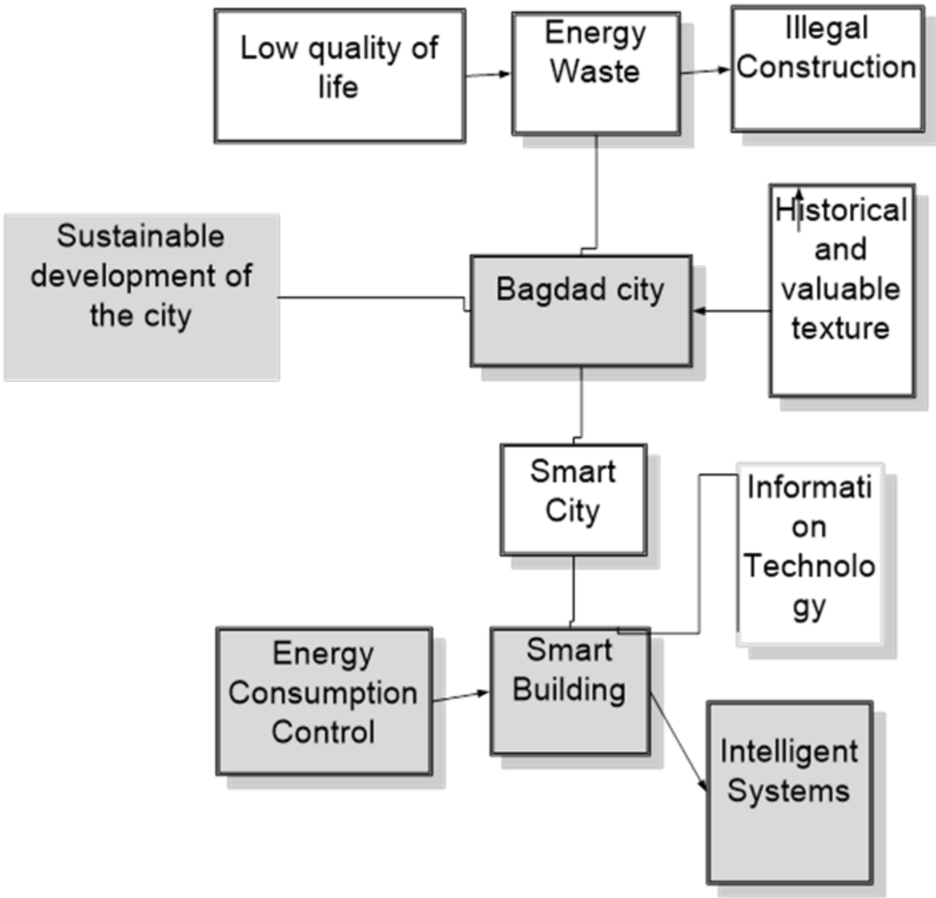

Fig 1: Conceptual Model of Research

Component	**Environmental**	**Economic**	**Physical**
Index	Control Information Technology	Energy Consumption	Intelligent Systems in Building
Criteria	- The use of new technologies and methods -Proper energy exchange across the entire area, - Ease of design of energy distribution facilities -Intelligent control of cooling system, heating according to ambient temperature - Managing the building's energy consumption based on supply and demand	- Data related to building repairs - Ability to report data and information of all parts of the building -Digital building drawing, - Monitoring and controlling information	- Existence of a comprehensive computer network in the building, - Monitoring and control of building equipment (air conditioning and fire extinguishing) - Control the equipment with the mobile phone or tablet app - Use sensors and actuators, - Adaptability of equipment to changes in building uses

Table 2 Components and Indicators of Smartening (Source: Authors with Interpretation of the Literature on the Subject)

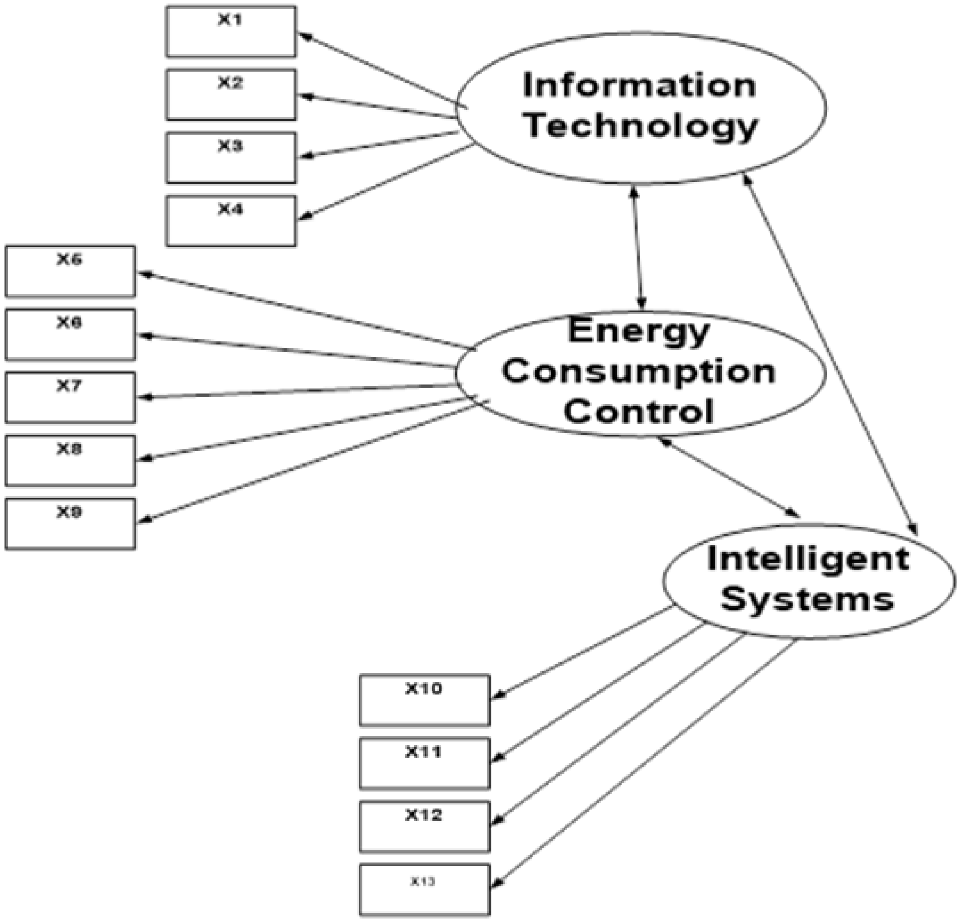

Fig2, Source: Software Output

Row	Components	Upper Limit	Lower Limit	Degree of Freedom Significance	T Value	Deviation	Average deviation	Average
1	Components Affecting Smart Buildings	1.18	0/923	00 /0000		21.69	0.921	2.89
2	Information Technology	1.08	0.877	00 /0000	86	22.78	0.985	3.15
3	Energy Consumption and Optimization	1.18	0.985	00 /0000	86	22.63	0.992	3.05
4	Intelligent Systems in the Building	0.78	0.63	00 /0000	86	15.79	1.02	2.98

Table 3 The Position of Information Technology Indicators of Smart Residential Buildings

teria of the technology and data index in the smart building, the possibility of reporting data and information of all parts of the building with a coefficient of 0.185, the existence of a digital building map with a coefficient of 0.371, the speed of extracting data related to building repairs with a coefficient of 0.329, monitoring and controlling the information of all details of the building with a coefficient of 0.307 can be effective in controlling and optimal energy consumption. The field of energy consumption control with the index of using technology and new methods of energy dissipation with a coefficient of 0.411, ease of design of energy distribution facilities with a coefficient of 0.398, management of building energy consumption based on supply and demand with a coefficient of 0.375, and intelligent control of cooling and heating system with a coefficient of 0.354 have had the most effect, respectively. And finally, the index of intelligent systems in the building from the physical component with the index Existence of a comprehensive computer network in the building with a coefficient of 0.366, monitoring and control of building equipment (air conditioning and fire extinguishing) with a coefficient of 0.376, control of equipment with a mobile phone application or tablet with a coefficient of 0.399, Using sensors and operators with a coefficient of 0.329, And the adaptability of the equipment to changes in the building's uses with a mobile phone or tablet with a coefficient of 0.310 was investigated and analyzed. The results of the study of the criteria of the smart systems index show that the index of equipment control with mobile phone or tablet application has the most effect. And in general, data technology with a coefficient of 0.485, control of energy consumption with a coefficient of 4.78, and control of intelligent systems with a coefficient of 3.67 are effective in the realization of smart city building. The results of the structural analysis are presented in the form of Figure 3.

Conclusions

A smart building is a building that includes a dynamic and cost-effective environment by integrating the four fundamental elements of systems, structure, services, management, and the relationship between them in times of emergency. The intelligent building system uses the latest technologies to create ideal conditions in buildings, so this point becomes more important when the issue of energy is raised. The study of multivariate structural equation analysis showed that the indicators of information technology, energy consumption and control, as well as the index of intelligent systems in the city of Baghdad are not appropriate. Also, the results of structural analysis of the components affecting smart residential buildings show that among the studied components, the information technology index with a figure of 3.15 and the index of smart systems with a figure of 2.98 had the highest and lowest level of intelligence in the city, respectively. This indicates that smart systems are due to factors such as: lack of a comprehensive computer network in the building, lack of monitoring and control of equipment (air conditioning and fire extinguishing) in the building, lack of control of building equipment with a mobile phone application or tablet, , the lack of use of sensors and actuators, as well as the inability of the equipment to adapt to changes in the building's uses, so it is necessary to apply the necessary feasibility study in these matters in the city. The inadequacy of the smart components of residential buildings in Baghdad indicates that the smart infrastructure in the city has not yet been provided, and a large part of the city's residential units are old and worn, and a significant number of residential units have been formed in marginal and informal neighborhoods. Therefore, in order to solve this situation, the following suggestions are presented:

- Allocating facilities for volunteer owners to build housing using smart indicators.
- The use of flexible and adaptable materials in the building in the city according to the climate and culture of the region.

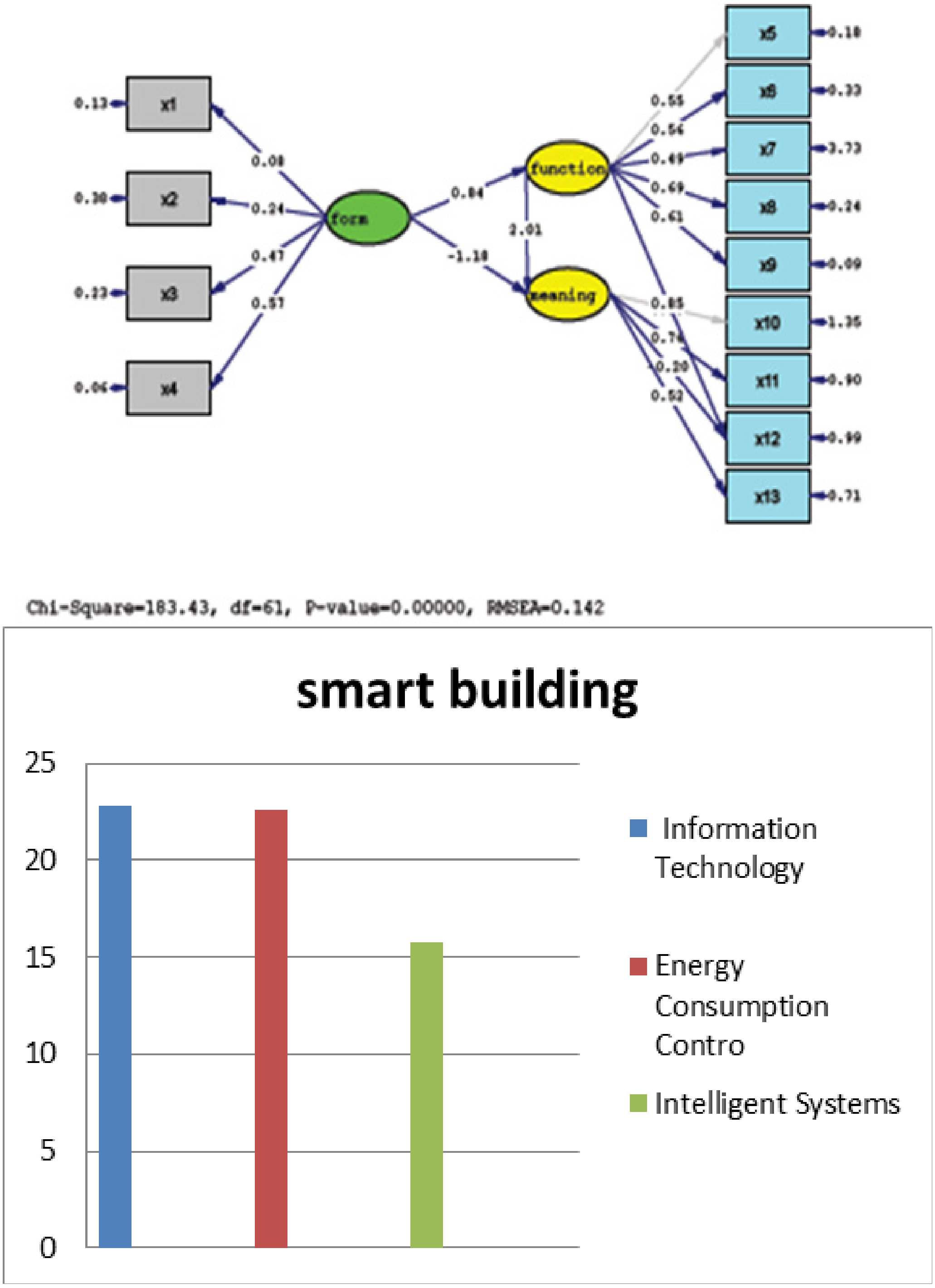

Fig: 3 Intelligent Housing Model

- Installation and commissioning of electrical and electronic equipment in buildings.
- Formulation of criteria and principles for the use of intelligent systems in residential buildings.
- Using smart systems to manage energy consumption and accurately monitor the amount of consumption in buildings.

Conflict of Interest: The authors declare that they agreed to participate in the present paper and there is no competing interests.

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