Cumhuriyet Üniversitesi Fen Fakültesi
Fen Bilimleri Dergisi (CFD), Cilt:36, No: 6 Ozel Sayı (2015)
ISSN: 1300-1949

Cumhuriyet University Faculty of Science
Science Journal (CSJ), Vol. 36, No: 6 Special Issue (2015)
ISSN: 1300-1949

"Designing Smart Homes" Economic Requirement or Environmental Necessity in Northern Cities of Iran

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Received: 01.02.2015; Accepted: 06.06.2015

Abstract. The overall goals of building energy management system is providing the comfort of residents along with reducing energy consumption during the operation of construction operations. Due to the elimination of energy carriers subsidies in recent years and the increase of its staggering price particularly in the residential sector that has the highest consumption of energy, the need for energy management system for efficient consumption in building can be felt more than ever. This study aims to assess the need for smart design of buildings and impact of factors of "comfort, energy subsidies elimination, modern life and safety and security" which were analyzed by using descriptive-analytical method and binominal tests of research variables. Statistical population of this research is engineers of Engineering Society of Northern Cities of Iran through which 432 samples were questioned directly by simple random sampling method. After collecting field data via questionnaire, the ties between variables of research have been tested by SPSS software. The results of binominal test show that 76% of respondents consider the necessity of smarting residential units in high and very high level. Respondents consider the factors of "building high security against accidents such as fire, theft, etc. in smart buildings" with more impact than other factors. This shows the non-awareness of engineers toward performance and main objectives of smart building.

Keywords: Smart Homes, Building, Energy Subsides, Northern Cities

1. INTRODUCTION

Generally, home automation refers to the use of computer-based control systems for monitoring and controlling the physical environment, security access or fire alarm systems in a building. Smart building management system is applied with the goal of keeping temperature and air quality in a specific area, lighting control, monitoring the performance of all systems, sending warning messages for maintenance and facilities personnel when any error or malfunction occurs. Temperature control, ventilation, and air condition (HVAC), lighting control, control of hot water, electric control, access control, security and fire control are considered as common applications for a building automation system (BAC) (Doonis & Carayzos-2009). The overall goal of building energy management system is providing the comfort needs of residents along with reducing energy consumption during the operation of the building operations. The results of commercial use assessment in California show that over 85% of energy use in commercial buildings is by heating, cooling, lighting, ventilation and administrative equipment (Aytron & et al-2006). Control strategy for initial triple systems (heating, cooling, lighting and ventilation) is very essential for health and life quality of residents. Thermal, visual and indoor air quality comfort will be considered as the main three factors which affect the quality of life for residents in the building environment. Nevertheless, improvement of indoor comfort usually requires more energy. Therefore, not only the goal of building control system is to improve these main three factors of comfort related to the environmental quality of life factors of users, but also to reduce the consumption in building's operations (Roy Yung & Ling Fang Vang-2012) Due to the fact that main use of building management system is serving users, providing their needs is always essential and has great impact on designing control systems. Building energy

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Special Issue: The Second National Conference on Applied Research in Science and Technology

management system must have flexibility and be capable of status changing for determining the priorities of users. To design an effective building control system, engineers often divide all control issues into a series of basic questions to be resolved and to solve any basic issue consider specific and separate control (Pipatanasamporn & et al-2009).

To assess the energy management status in Iran, the most important macro indicators of this area in the country can be compared with its universal and favorable values. Although the primary energy consumption in our country is lower than Japan and some other countries, due to higher energy intensity in our country than the rest, it can be found that: energy consumption in the non-productive sector (household) is more than the productive sector (industry). This is due to some matters: 1) Industry doesn't develop much. 2) Energy consumption in the household sector is higher than standard. 3) Principles of energy consumption in the industrial and domestic sectors of the country are not respected.

Although many countries are planning to reduce "energy consumption growth", "energy consumption growth" of our country is increasing. In our country, energy consumption growth was about 4.7% in 2005 which reached to 10.3% in two years and given the current consumption status, this number will unlikely reduce in the near future. If the above number fixed about 10.3%, future of state energy will be catastrophic (Alireza Peymanpak & et al-Pages 26, 27, 2010)

This issue has been long considered by European and using smart buildings, pursued optimizing in energy efficiency in buildings with the following objectives: A) The time we actually need to use energy. B) Use merely that amount of energy which is required. C) Request for applying energy that has the highest efficiency. (ABB AG Company-2009)

Advances in technology, data collection and powerful analysis added intelligence to existing building infrastructure for flexibility and methods change so that companies use energy in its real place. Especially, building engineers can apply productivity in more goals. Receiving data direct them and improves the productivity automation. This shows a significant savings with helping the companies, with the aim of reducing fuel with relatively low investment. Most importantly, the basic technology is already widely available and easier to implement (Accenture (2011))

By assessing the studies, internal factors of country and concerns of designers, some factors can be introduced for necessity of smart design of buildings as influential factors. These are: elimination of energy subsides, modernizing life and appropriate change of residence pattern, building high security against accidents such as fire, theft, etc. timely response to living needs of residences.

2. BACKGROUND OF RESEARCH

Maddadi and et al (2011) in an article entitled "Advantage of using Computer Systems in Smart Homes" have expressed that combination of technology with art and science of architecture in recent years has led to designs and smart residential structures which can give comfort to human in near future and remove the need to do any activity in home. Smart homes in the world are known as Smart Home or Intelligent House. A house that due to having artificial intelligence can react as to its environmental condition and also commands of landlord. Also, this artificial intelligence can automatically do some of the chores. In a modern smart home, all the technology capabilities are designed for increasing safety, security and comfort of human. Systems that turn an ordinary home to a smart one has special place in construction industry and it's the time to increase the standard level of implementing projects and their quality by using these systems. Advantages of building management for manufacturers and building owners

include decreasing executive costs, decreasing maintenance costs, increasing production capability and adaptability.

In an article entitled "Intelligence Consumption of Energy in Smart Homes", Hashemi Parinchi and et al (2010) have expressed that many useful measures have been obtained in optimization of energy consumption in our country. However, there is still vast potential for optimizing the energy consumption in the country. More than one-third of the energy used in building is wasted; it means more than two billion dollars annually?! Meanwhile, by using new and smart technologies in buildings, energy savings can be significantly saved.

In an article entitled "The Role of Modern Internet Technology of Objects in Energy Consumption Area of Smart Homes", Gheysari and et al (2013) make relationship between objects and internet through measurement equipment to provide smart identification and management. The entire equipment is connected to internet for control and remote management. Mahdavinezhad and et al (2011) in an article entitled "Intelligent Recognition in the Spatial Organization of Traditional Houses" have stated that Iranian architecture is formed as a broad and deep encyclopedia during the time and provided a rich source for the promotion of architecture of now and future; source to meet the existing challenges of contemporary architecture. Based on the theoretical framework, smart architecture research could be explained based on two structural principles: 1) Reaction Rate: Performing reaction in the limited and desirable period of time so that the requested quality provided in the required time. 2) Reversibility: Changes have the ability to return to its previous state by the time of resolving and removing environmental factors. The research will analyze smart applications by studying spatial organization of Iranian houses. The studies show that essential subject in Iranian houses is their spatial organization; the same subject that prepared the efficient operation situation from Iranian houses. When this spatial organization meet the operation pattern, manifestation of intelligence will be created in Iranian houses; type of intelligence that maximize the qualitative efficiency of using architectural spaces without using multimedia technologies.

Tavakoli (2010) in the study entitled “Smart Homes and Its Role in Energy Efficiency” has stated that Iran has a lot of energy resources but due to the dense population and high energy consumption and in fact, the energy loss in the different seasons of the year, we are faced with a lack of energy. For instance, electricity and water shortages in summer as in winter gas shortages. However, if a system is designed to automatically regulate the use of energy resources and prevent waste of energy, it can play an important role in energy storage.

Anooshe Pour (2011) in an essay entitled “Recognition of Smart Home and Evaluation of Their Role in Electronic Cities” stated that smart homes can provide desirable electronic services for citizens of these towns. In addition, the benefits of smart home as optimization and energy saving is completely match with aspirations of the electronic cities.

Theoretical Foundations

Home automation is emerging and expanding technology[1] that in its lowest level, it refers to all the services and products that can be operated or messages that can be displayed in the house environment without any interference from the landlord. According to this definition, an alarm clock or smoke detectors are examples of home automation devices. [2]

Remote controlling of home accessories is also a part of home automation. Home automation devices may be applied for on or off furniture or settings to change the function of the device

[1] Nicolle and Abascal, Inclusive Design Guidelines for Hci, 212.
[2] Riley, Programming Your Home: Automate With Arduino, Android, and Your Computer, 3

based on predetermined time. These devices may also be adjusted so that they can adjust the performance of the equipment as per the in the ongoing changes in home environment. Homes that are benefited from such techniques are sometimes called smart home or intelligent building. These techniques may include the use of broadband communications. Home automation may be implemented using programmable and centralized or decentralized approach with separate sensors and controls. In this system, advanced electronic controllers may be used for lighting, heating, cooling and entertainment devices. This system may have a special wired or wireless LAN system to communicate with several separate systems (such as light sensors that control the light). One of the important aspects of home automation is its potential for reducing energy consumption. Since the system consume energy for its application, they are only useful for your home, only if their reduced energy consumption resulting from their adoption will be more than their consumed energy. If the purpose is cost savings, priority must be to design an efficient home with high efficiency equipment and energy saving. Home automation systems reduces the performance time of devices and limits the time that they are turned on, or reduce the need to use the device so it will cause energy saving[3].

The main idea in home automation is that all of the electronic and electric systems and the home equipment will be connected to each other in a same network in such a way that all of them may be controlled by same controller. For example, if you were watching a movie on your home TV, the lights automatically be faint and the calls automatically be referred to the answering machine so you can watch the movie in peace. Home Automation Association (HAA) defined home automation as follows: "a process or system (with different equipment or techniques) that provides lifestyle improvement and turn home to a safer, more efficient and more comfortable place". However, home automation technologies are already available, but due to costs, as well as consumers perspectives that thinks to it as complex solutions to simple problems, prevented its spread. But it is hoped that in the future the standards for home automation will be fixed and we will have integration in various technologies and the services providers, so that these obstacles will be overcome. Nowadays, the building construction standards are in progress. In addition, the old wiring methods are not sufficient for modern homes needs and their modern equipment and power and communications are required all over the place. Using home automation has several advantages compared to free wired and disconnected methods and if it will be implemented properly, it can help to the comfort and simplicity of the lives. Home automation can provide the immediate access to the amenities of home and the place can be personalized according to desires of the users (personalized means that the different persons may have different experiences in same room and they can change the settings as per their wishes). These systems will able use to perform active repair and maintenance and even before occurrence of any actual defect. For example, if the central heating system will broke, the system will automatically sent an email to the repairman and the repairman will check the owner's calendar to set a proper visit date. Security and communications are important in this regard. One of the advantages of the homes that are built on automation platforms is the fact that they are easy to install and add new tools (without the need for special configuration or refer to a specialist). In the future means any device (such as DVD Player) will require one wire to connect and most of the connections are wireless telecommunications.[4]

One of the initial and simplest home automation devices is remote control of lights and home devices. In fact, even the TV remote control is one of the home automation devices. A common home automation system has a server as the core of system and some devices that are connected to the server. The operator may connect to the server through internet and control any devices that are connected to the server. In order to connect to this server, having a PC is not necessarily required. Most of these systems are designed in such a way that they can be controlled by a

[3] Alam, Siddiqui and Seeja, Recent Developments in Computing and Its Applications, 577
[4] Amor, Internet Future Strategies: How Pervasive Computing Will Change the World, 100 and 101.

simple handy device such as a cell phone or generally, any other devices with ability to connect to the internet and run a web browser[5].

The home automation is a method to assist the senior and disable people. Using this technology, these people may stay home safely and easily and remain independent. In this way, there will be no need to transfer these people to clinics. [6] The projects that are introduced in this regard are some of the most challenging projects in the field of home automation and they are also true for all of the issues raised in the distance care, such as constant monitoring, non-invasive and maintain patient mobility. Home automation helps the better interpretation of the physiological data. For example, you can remotely monitor a patient's blood pressure that the need to synchronize the patient's status (in terms of being asleep or awake); a certain blood pressure in physical activity may be perfectly normal, but the same in sleep mode can be indicative of a serious health condition. Besides these care, other facilities such as outreach services, information services and communication services may also be offered.[7]

Smart homes are dynamic environments that respond to the changing needs of their residents. Using the technology in building will cause a meaningful and huge capital turnover. However, experience shows that the best or most advanced technology will be removed if they are not financially viable. Induction of green and intelligent products and technologies in new and existing buildings may lead to proper use of energy in these buildings and it will deduct the operational costs and finally, it will be lead to less of general costs and the environment will be greener. Finally, implementation of smart technology will deduct the costs compared to traditional methods. Because, in the operational term of these technologies, their expenses will be deducted a lot and the workforce costs will be deducted as well. The idea of green smart technology is entitled “Bright Green Building” (Frost and Sullivan, 2008, Page 103).

A newly common method is to merge computer and information technology as a new technology named BEMS[8]. This central and well managed system may monitor and control many of activities and services related to the buildings. Sustainable energy management of the daily operations of buildings is done to maintain comfortable conditions for building occupants and to minimize energy consumption and costs. The central monitoring system of buildings enables this system to translate the energy knowledge of building to different rules and finally, turn it to electronic orders that will be sent to actuator devices. Specifically, the system may request the specifications of a proper energy. Using expert knowledge, the wrong decisions can be detected and removed. Through intelligent monitoring, performance optimization of HVAC and lighting occurs. (Haris Doukas et al, 2006).

Building Systems engineering by a smart room controllers network for lighting, sun protection, heating, ventilation and air conditioning and other building systems are supported and has a major role in conservative energy use based on needs. Required investment in intelligent control structure is generally low in comparison to structural changes in the building and by spending reasonable capital and calculating ratio of profits and convincing costs, this system can be implemented.

[5] Milutinović and Patricelli, Ebusiness and Echallenges, 212 and 213
[6] Omatu et al., Distributed Computing, Artificial Intelligence, Bioinformatics, Soft Computing, and Ambient Assisted Living: 10th International Work-Conference on Artificial Neural Networks, IWANN 2009 Workshops, Salamanca, Spain, June 10-12, 2009. Proceedings, 675
[7] Schumacher, Helin and Heiko, Cascom: Intelligent Service Coordination in the Semantic Web, 131.
[8] Building Energy Management System

3. MATERIALS AND METHODS

In this study, based on the nature some subjects and the purposes are predicted from descriptive - analytical and applied research method. Since this study used questionnaires and interviews to gather the information needed, thus, from the other side, this study can be considered as a survey research.

In order to answer the research question and test hypothesis, some variables are applied such as: the impact of removing subsidies on energy products, modern life and changed in the pattern of residence, high building security and timely response to the living needs of residents. All of the required information was gathered in 2 ways:

a- Research literature that was provided with reference to the books, articles and archives of related authorities.
b- Field method with respect to the objectives and research questions using tools such as objective observation, interviews and questionnaires was applied to collect information. The population of this research included all members of the Engineers of northern cities of Iran who were member of CEO. And using Cochran formula 432 samples were questioned directly based on systematic random method. Collected data has been analyzed using SPSS, and nonparametric binomial statistical test.

Hypothesis Testing and Analysis of Findings

This research was performed by reviewing the population including 432 samples of whom 276 were male and 156 were female and all of these samples had job experiences and were experts in construction field. The main research variable was non-parametric and of ratings type, therefore the Kolmogorov - Smirnov test was applied to check the normality of data distribution and to select the proper test for investigation of research variables.

Evaluation of Normality of Variables:

Table 1 . Results of Kolmogorov - Smirnov Test to Evaluate Normality of Data Distribution One-Sample Kolmogorov-Smirnov Test

		Need to Design Smart Home in the Northern Cities of Iran
N		432
Normal Parameters[a]	Mean	4.0000
	Std. Deviation	1.21476
Most Extreme Differences	Absolute	.264
	Positive	.205
	Negative	-.264
Kolmogorov-Smirnov Z		5.485
Asymp. Sig. (2-tailed)		.000

a. Test distribution is Normal.

As it can be seen in Table 1, the value of z in Kolmogorov - Smirnov test for variables related to the research hypothesis, the z value is below the mentioned value in table 1and it significantly exceeds the authorized error (0.05); thus, the difference of distributions of the collected data with normal distribution was significant and the data distribution cannot be assumed normal. Therefore, in this study, a nonparametric binomial distribution was used in this study.

Evaluation of Research Hypothesis

- The main hypothesis of the research:
- It seems that smart design is not necessary for homes in northern cities of Iran. H_0
- It seems that smart design is necessary for homes in northern cities of Iran. H_1

Table 2. The Tests Results of Binomial Test to Compare the Frequency of Below Average Responses and Above Average Responses about the Necessity of Designing Smart Homes in Iran's Northern Cities.

Binomial Test

		Category	N	Observed Prop.	Test Prop.	Asymp. Sig. (2-tailed)
Construction of Smart Residential Unites	Group 1	<= 3	102	.24	.50	.000[a]
	Group 2	> 3	330	.76		
	Total		432	1.00		

a. Based on Z Approximation.

The main assumption of the data distribution was not normal; therefore, a binomial nonparametric distribution was used for to test the hypothesis. The results of table 2 indicated that the frequency of more than an average responses were 330 cases (76%) and the frequency of below average responses were 102 (24 percent). Given the level of significance that was less than 0.05, the difference in frequency of responses between the two groups was 99%. Therefore, the null hypothesis that the smart home design in northern Iran is not necessary was rejected and the opposite hypothesis is accepted.

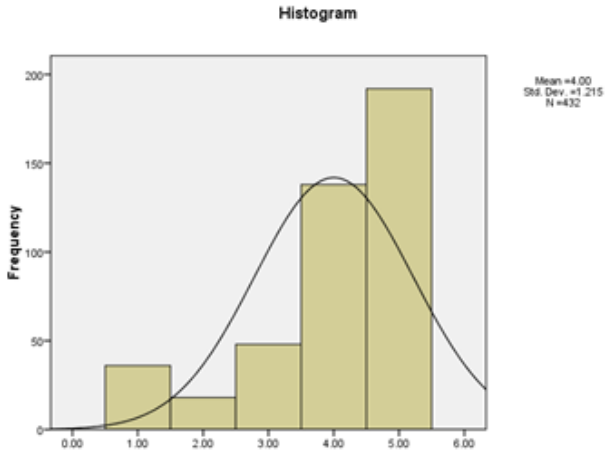

Figure 1. The Necessity of Designing Smart Homes in the Northern Cities of Iran

Using the gathered data through questionnaires and after analyzing them by SPSS, the results of binomial nonparametric test indicated that among factors such as "elimination of energy carriers subsides, modernizing the life and appropriate changes to residence patterns, building high security against accidents such as fire, theft and so on and timely response to the living needs of residents in the building", the factor "building high security against accidents such as fire, theft and so on" had more effect compared to the other factors.

Table 3-
One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Elimination of Energy Carriers Subside	432	3.7917	1.46360	.07042
Modernizing the Life and Appropriate Changes to Residence Patterns	432	4.3472	.86959	.04184
Building High Security against Accidents such as Fire, Theft and so on	432	4.6250	.61166	.02943
Timely Response to the Living Needs of Residents in the Building	432	4.0000	1.09417	.05264

In such a way that 93.1% of the engineers evaluated the effectiveness of these factors as much and so much. The factor "modernizing the life and appropriate changes to residence patterns" won the 2nd place and "timely response to the living needs of residents in the building" was the 3rd important factor; finally, "elimination of energy carriers subside" was the least important factor, in 4th place.

Table 4 . Frequency Distribution of the Number and Percentage of the Responses of Samples to the Question of Affecting Factors on the Necessity of Smart Home Design in the Northern Cities of Iran

Tourism Beds	Responses Options	Very low	low	average	high	Very High
Elimination of Energy Carriers Subsides	F	72	12	48	102	198
	%	72	2.8	11.1	23.6	45.8
Modernizing the Life and Appropriate Changes to Residence Patterns	F	0	24	42	126	240
	%	0	5.6	9.7	29.2	55.6
Building High Security against Accidents such as Fire, Theft and so on	F	0	0	30	102	300
	%	0	0	609	23.6	69.4
Timely Response to the Living Needs of Residents in the Building	F	18	24	78	132	180
	%	4.2	5.6	18.1	30.6	41.7

4. DISCUSSION

Combining the modern technology with art and science of architecture during recent years has led to design and structures of smart homes that have come with the comfort of its inhabitants. In Iran, architects seek to institutionalize energy management in the country and to supply comfort of living for the people of the country. In all of the performed studies, and executive and executive plans, the general objective of building energy management system (smart buildings), is to provide the needs and peace for residences of the building together with reducing energy consumption. But in the taken survey, the engineers mostly selected the factor of "building high security against accidents such as fire, theft and so on" as their main objective. This is different with the main objectives of Madadi et al. (2011), Hashemi Princhi et al. (2010), Gheisari et al. (2013), Mahdavinejad et al. (2011), Tavakoli (2010), Anoosheh Pour (2011) Roy Yang and Ling Feng Wang (2002), Shaoulin Wang et al. (2011), Accenture (2011), Donis and Karaizos (2009), ABB AG Company (2009), Pipatanasampourn et al. (2009), Frost and Sullivan (2008), Aitron et al. (2006) that was providing thermal comfort, visual comfort (lighting), enhance indoor air quality, reduce energy consumption; that ware determined as the 4 main factors that affect the quality of lives of the residences of building in the residential

environments. Of course, it should be kept in mind that “building high security against accidents such as fire, theft and so on” factor is considered in all of the studies as secondary objective. On the other hand, this indicates the lack of knowledge among engineers about the performance of the main objectives of smart buildings. This can be one of the major factors in the failure of employers to use the system. Considering the abovementioned description, the hypothesis of ‘the effectively of elimination of energy subsidies than the other factors to design smart home in the northern cities of Iran’ is rejected. Therefore, the below mentioned strategies are provided to promote and develop smart home design among engineers and residents in the northern cities of Iran.

5. SUGGESTIONS

1- Improve the culture through visual media in form of commercial teasers in a variety of national and local TV networks
2- Application of smart construction methods in public buildings, offices and places with a lot of visitors.
3- Introduction and use of these systems in schools and universities to be seen by the students and have indirect influence on their families.
4- Preparation of promotional brochures and placing it in a municipality documents and CEO files.
5- Providing banking facilities to clients who are planning to use the technology
6- Supporting the knowledge base companies and localization of equipments and reducing the costs of making smart buildings

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