Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env.Pharmacol. Life Sci., Vol 4 [Spl issue 1] 2015: 291-299

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804

FULL LENGTH ARTICLE **OPEN ACCESS**

A survey on the possibility of enhancing the incident command system through intelligent building management systems

Soheil Mahmoodi[1], Neda Saadat[2]
1-Reconstruction Research Department, School of Architecture and Urban Planning, Shahid Beheshti University , Tehran, Iran.
2-Reconstruction Research Department, School of Architecture and Urban Planning, Shahid Beheshti University , Tehran, Iran.
Email: soheil.mahmoodi88@Gamil.com

ABSTRACT
In this paper, it is trying to assess the possibility of applying intelligent building management systems (IBM) to enhance buildings Incident Command System (ICS) in the event of natural and unnatural disasters. The goal of this review is to find a more precise and effective way to control the crisis in buildings by help of intelligent systems. The use of this system, in the control of crisis in all settlements from the least scale, such as a house to highest scale, such as a town and habitat and help us to achieve an efficient and integrated intelligent system in critical situations in order to reduce any risk of both natural and man-made disasters. The research method is through specialized literature and library document and global experiences review. In general, it seems that in the world, the use of intelligent building systems has not been just related to optimize energy consumption and is also used to help crisis management.
Keywords: Incident Command System, crisis management, intelligent building management, risk reduction, Intelligent Anti- Earthquake System

INTRODUCTION

The events of the last demonstrate that despite the availability of a widerselection of building materials and technologies,in both rural and urban parts of developing countries, small dwelling continues to be vulnerable to disasters. [1] As we know, the optimal management and originally crisis management areone of the main issues to overcome difficulties arising from the crisis. The management should be applied in a way that has maximum effectiveness in the golden time of 72 hours after the accident. [2]Incident command system (ICS) , one of the structures with more than 30 years history in many world organizations, and it will be briefly described as follows: an effective coordination mechanism for confronting operations in unusual circumstances. [2] In this paper, after a brief introduction of this management system and its strengths, the capabilities of building intelligent systems have been discussed and introduced. Then, according to the capabilities of intelligent systems, the paper will try to improve quality levels (ICS) and speed in responding to the crisis by this system.

Incident Command System

Iran's locationat Alps – Himalaya seismic belt and its climate and weather conditions caused that the country is exposed to various natural disasters which responding to these disasters is done through DisasterMitigation and Management Organization. On the other hand, the structure of crisis management in the country in terms of planning and software is well-developed, but in practice, implementation, and training and maneuver at national level, it faces with weaknesses and lack of hardware facilities, infrastructure and support services for crisis management. The important characteristic of the disaster management system includes: [3]

- The sectorial management from the executive branch of the national sovereignty
- Participation of organizations (as expertise committees) in the preparation stage
- Cross-sectorial coordination in the implementation of crisis management
- Management of preparing stage of crisis management apart from the other three stages
- The community-oriented risk management

- Increased national preparedness against natural disasters
- Managing the prevention and reduction of the effects
- Incident Command System to manage the response and recovery

As can be seen, the Incident Command System ICS is one of the important features of this structure regarding to risk management. The system has 36 basic posts which is determined for the five major missionsof commanding, planning, operations, support and administrative-financial affairs. [4]

In 1970, Incident Command System by alabor called "Firefighting Resources of Southern California Organized for Potential Emergencies" which in partnership with local, state and federal resource came to fight large fires. Before the creation of this system, respond to incidents had many weaknesses which some of them are mentioned below:

• Inadequate communication due to conflicting terms
• Inefficient or improper use of technology
• Lack of standardized management structure
• Lack of accountability and lack of responsibility
• Lack of pre-determined methods and as a result waste of time in the early hours of the incident [2]

Incident Command System is one of the fundamental elements of disaster management and anexecutive management system, which designed for enabling effective and efficient incident management through data collection,facilities,equipment, personnel or procedures and communications and works through a common organizational structure. [5] This system is currently the most common accidents management system in the world.

Incident Command System principles are:

1. The common language that causes all accountable organizations use the standard and fixed information.
2. The common and similar structure which provides a standard structure for all organizations responsible for dealing with the crisis and also facilitates inter-organizational communication.
3. Organizing by a specific pattern, which in needed cases, allows the structure of the Incident Command System to be able to develop by a determined model
4. Integrated communication system which creates a common communications plan, standard operation, regular communication texts, common frequencies and common language.
5. Informationsystems, which in fact are the most important source of information, analysis and strategic solutions, when dealing with crises have a crucial role in the prediction, prevention and containment of the risks and crises. [7]

This system is applied in the two fields of human and physical which each has its own impact, but interacting with each other to control the crisis. In the human sector, education, preparation and knowledge of the crisis response are more salient.But in physical sector, vulnerability and Risks threatening Building are discussed.

On one hand, in the midst of the crisis, a proper management of human resources leads to proper use of resources, centralized monitoring, reduction of people's communication load, increase the safety and reliability of the system and reducing the blind and single -centered works, which are among main and effective factors to deal with the crisis arisen[6]. On the other hand, the buildings themselves are highly vulnerable, according to the characteristics such asfloors and residents multiplicity. [8] In sum, it can be pointed out that often due to lack of knowledge and awareness of residents and staff about risk management and mitigation and also building'sage and their high non-structural vulnerability in the event of a disaster, in these structures, many lives will be at risk [8] and this can cause a crisis inside another crisis and intensify the need for an integrated management system.

The components of the Incident Command System

As mentioned above, the system consists of five main sections that each have their own specific subcategories and responsibilities. ICS organization often isn't dependent to the administrative structure of the building and location and the organization chart is dedicated to the event. In Figure 1 the chart is shown. The objective of its implementing is reducing roles, titles and confusion created at the time of the incident and in three overall levels of managerial, information and administrative can be investigated. The duties of each section are given in Appendix 1. [2]

Chart 1: organizational chart of crisis (reference: the author)

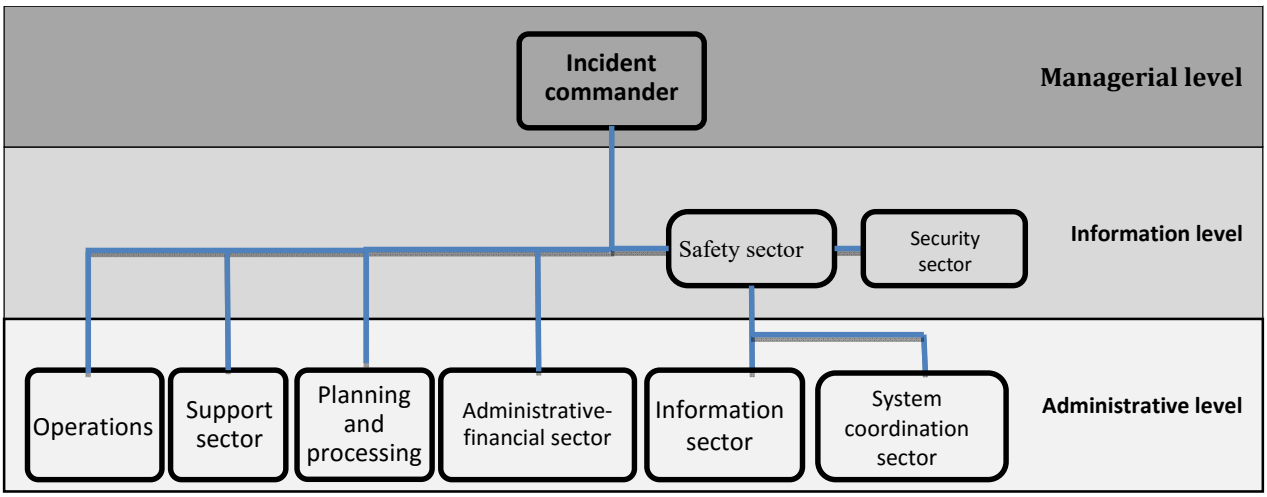
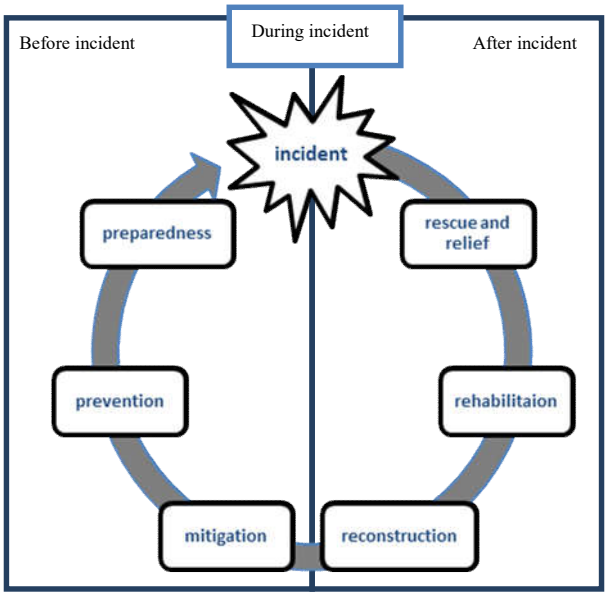


Chart 2: the cycle of crisis management [9]



In order to better understand the optimal management of crisis situation, it is necessary to remark the cycle of crisis management. (Chart2) with respect to this shape, the cycle consists of three stages of before, when and after the incident. Prior to the occurrence of any accident, vulnerability reduction, prevention and readiness are the main objective of any crisis management. In this course, it is needed to understand the current situation of both the physical and human contexts which the Incident Command System is in its bed.

To implement this system,a safe building structure in times of crisis is needed. For example, consider if you have the best and most efficient crisis management team in a building with upper-middle vulnerability, what will happen at the time of the accident?Probably, the most ofthe authorities are injured or placed in a situation that reduces their effectiveness. Thus, recognition of the vulnerability and risk of buildings, must be a step ahead of the crisis. For more preparedness during the incident, the need to complete awareness about exit routes and ensuring the safety before the incident, exist. So that after the incident, a more accurate planning or decision to be taken. On the other hand, the key data collection and classification, play an important role in this decision making.

In each building,it is possible that many weaknesses occur in the design and implementation steps which make it vulnerable to accidents and injuries that always all these physical problems are surmountable through spending micro and macro costs and updated technologies. Coordinating organizational chart of buildings with the chart of Incident Command System, construction escape stairs in front of the building, strengthening of non-structural components, and providing maps for emergency exit, maneuver and promoting the culture of safety, widening entrance are among proposed measures [8]. Research and innovation in the design of intelligent sustainable building, has recently attracted much attention. [10]
This resulted that scholars are welcoming to new technologies and modern management methods to solve problems. One of the methods for optimal management of buildings refers to a collection of hardware and software for monitoring and integrated managing of the building's crucial parts. This method is called Intelligent Building Management (IBM). [11] One of the advantages of this system is that in any situation where the control logic changes, without the least physical change (I.e. Without changing the wiring) and only by the changes in planning, a new logic can be implemented. [12] This allows us that in proportion to our needs, plan the system and connect it to other areas of management. Thus, due to the low and valuable time and the need for precision and speed in crisis, the application of intelligent systems can saliently help it. So, due to the capabilities of intelligent building management systems, we can imagine that they are useful in critical condition and in various fields. The following are brief descriptions of these intelligent systems.

What is Intelligent Building System?
Intelligent Building management system (IBMS) refers to a collection of hardware and software which are installed for monitoring and integrated managing of the crucial parts of the building. [12] The original plan of building management systems was introduced in the early 1970s. University of Michigan, United States of America began the first intelligent building and the building of the University of Arizona in 1995 was implemented it as well. [13] According to the Continental Automate Building Association (CABA), there is a difference between smart buildings and smart homes. But in general, it can be said that an intelligent building is a construction which includes dynamic and affordable environment by integrating the four main elements, namely, thesystems, structure, management and the relationship between them. [13] This system is making possible the management and control of the building through the automatic system of lighting control, access control (entry and exit), controlling heating and cooling, alarm and fire control, machinery room and logical connection of these systems. [12]

Objectives of Intelligent Building Management System
The following objectives are usually perused Through BMS performance in buildings:
- Permanent monitoring of all building components
- Optimization and energy savings
- Create a favorable environment for building residents
- Management of the building in the event of accidents
- Proper use of equipment and raise their useful life
- Reducing the costs related to maintenance
- Accurate statisticalreporting on the performance of building components
- In order to optimize the consumption and performance and accurate recording
- Exploiting the different parts of the building
- Intelligent prioritizing of expenditure during an emergency. [12]

Advantages of Intelligent Building Management (BMS)
Generally, for facilities managers, monitoring and remote monitoring capabilities are provided with a higher precision and we can summarize the benefits for directors as follows: low operating costs, high efficiency of installed equipment, reduce in repair and maintenance costs, the rapid and accurate announcing about defect and needed to revision components. [12]
In Figure1,the controlled components (BMS) with details and how to communicate with a central monitoring system and the central control can be seen. The following briefly describes some of them.

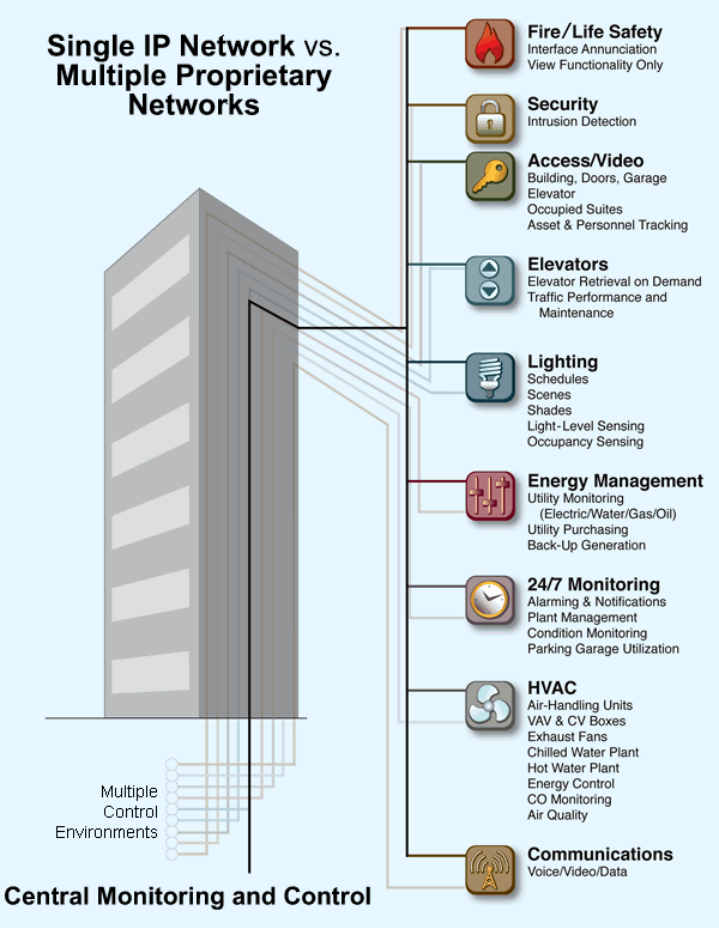


Figure 1: The relationship between the components of intelligent buildings [14]

Fire detection and alarming systems: smoke and heat sensors are set with the electrical systems in buildings to activate the alarm system. Sound and no sound alarms are included in this system.No sound alarming systems by phone warn the guard, emergency services, such as emergency, fire-fighting or local police if the damage is salient. [12]

Security System: security control system manages all signals related to the security instruments and regulates the warning signals. If doors or windows are opened by force,the security system is activated and detects the presence of unauthorized persons and notice it.

Access Control System: When the doors and windows are closed or opened all connections will be checked. In case of incomplete closure, the warning notice. Also, control person's traffic to prevent the entry of strangers into the building.

Elevator control system: the system's ability is to maintain the security of the elevator to in the time of the lack of electricity or other accidents, to automatically or manually control the elevator.

Lighting system: this system provides the possibility to control the electrical power and adequate lighting. The control logic is defined based on the needed and relevant light intensity to suit any space. [12]

Energy Management System: using this function and with the primary data from internal and external environment such as temperature and air quality, it is possible to minimize heating and cooling equipment's'usage time and in this way savings a considerable extent in the consumption of electricity and fuel.

Timing system: this system, can control each sectorby timing and independent from itsprimary regulator, based on a defined schedule and proportional with the user's need.

Heating, ventilation, Air Conditioning (HVAC): The system controlsinstallations of heating, cooling and ventilation and ensuring the satisfactory conditions of the building.

Communication systems: provide the ability to communicate with internal and external parts through wireless communication systems for users and administrators. This system can usevarious communication protocols and are adjustable for any requirements. [12]

How the Intelligent Management System works

Each of these sections when the monitoring sensors are activated, start the restore and process the input data and proportional with the scenario that are intended for them, make changes to the site. An example is given in Figure 2 for a better understanding of how they work.

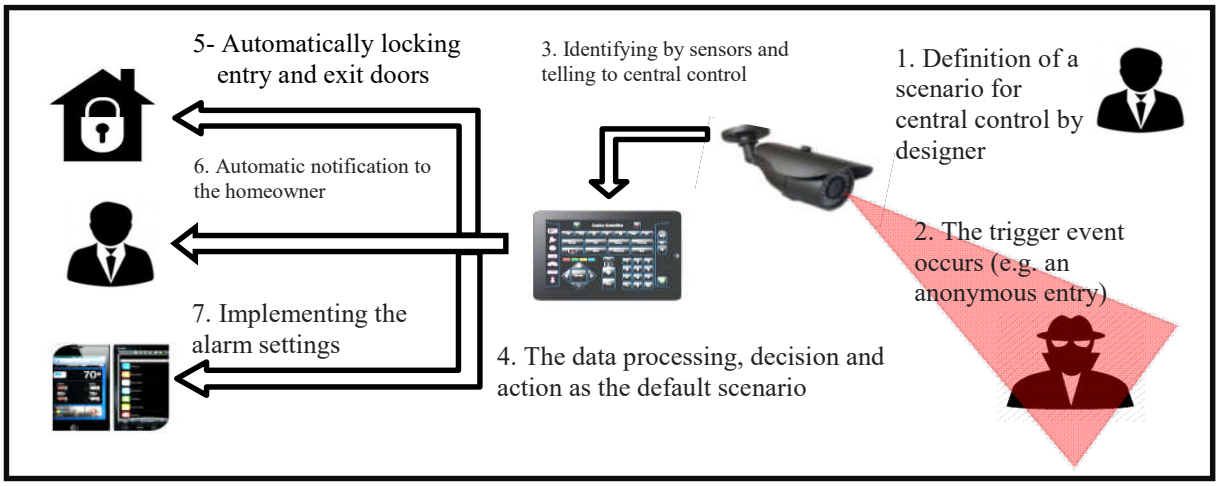


Figure 2: simple example for how IBMS works*(reference: the author)*

Accommodation points the Incident Command System and Building Management System

Disaster warning systems are widely used to protect peoples' lives, while don't have the ability to communicate with the storage systems and controllers which are installed in the building. This leads to a lack of time to prepare and emergency evacuation in face with disaster,especially events like the earthquake. On the other hand, warning systems are not able to collect information for individuals and rescue teams. [15] Active Disaster Response System (ADRS) which by default and throughasample is designed and in following it will be explained and its important role besides the rescue teams to reduce causalities, will be briefly discussed.

According to Appendix Table A which includes the main responsibilities of the Incident Command System, every person needs a series of classified data about the condition when the incident which leading to a series of operations. These people have also subordinates who take responsibility in previous days, during and after a disaster.

The active corresponding disaster system (ACDR)

This system has the ability to reduce the operation time to 15 seconds. The enough time needed to save your lives by running up to 100 meters or crawling under a safe shelter safe during an earthquake. The system is designed in Taiwan. The distance from Taichungcity which is located in central Taiwan in Taipei City in the north is about 150 kilometers, for receiving seismic waves from one city to another just 30 seconds is enough. This system can provide 15 seconds of time for people at risk to get to a safe place. [15]

The method of the system is in a way that at the time of the incident first, the information is sent to the processor in the building. Then automatically do security tasks like opening doors and windows, closure of electricity and gas lines, etc. and activates the general earthquake warning alarm. After the earthquake, according to the rate of deaths and injuries, creates a connection way and makes a connection with services related to the rescue and provides for them the necessary information. The Process can be seen in Figure 6.

As a result, the system could dramatically limit the amount of damage and loss of life and by establishing a temporary communication link with greater accuracy and speed could inform the rescue teams about the building condition and the data obtained. [15]

This system shows that the use of intelligent systems for pre- and post- crisis periods can accelerate the process of crisis management and disaster and prevent further losses.

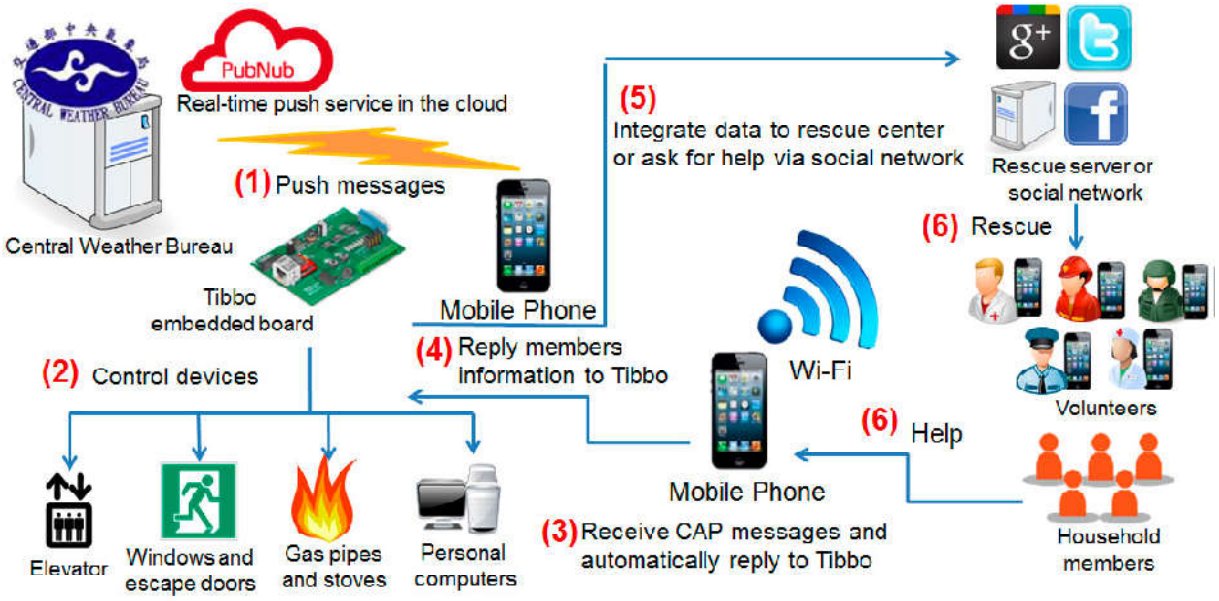


Figure 3: Active disaster response system flow chart.[15] (ACDR)

CONCLUSIONS

Finally, it can be concluded that the intelligent management systems can be useful to accelerate the process of crisis management through the Incident Command System and reduce information requirements and help to save the people's life in the building.

In general, it seems that the tasks which in the Incident Command System in the disaster management cycle can be assigned to intelligent building management system, are as follows:

Before the earthquake: All parts of warehouse of support group should be monitored and supervised and the responsible of the sector be informed about the usage date and time of maintenance and checking of items. Preliminary data about the structure as default be available which in emergency and in the likely absence of the administrator or his assistant, the date be accessible for the deputy. A list of all emergency numbers be saved in the phone which upon the occurrence of an earthquake, the emergency and fire-fighting be informed about the damage and losses through phone, fax, wireless etc.

During the earthquake: when the earthquake occurs, earth internal wave can be divided into two categories. The P non-destructive wave that moves faster than the S wave.Due to the high speed of the P-wave than S-wave, with respect to theproportion of the desired distance from the epicenter location, P-wave arrived to the scene a few seconds earlier and sensors and devices with audio alerts, inform people about earthquake and simultaneously order to cut water, electricity and gas.All original data are classified andcollected for authorities and sends them to their mobile phone.

Harmful and hazardous locations such as heating room are controlled by continuous monitoring and alarms when a problem occurs.

After the earthquake: also, due to the seismic sensors and microprocessors which for this purpose in all parts of the installation are located, it is possible to receive data about physical or software damaged in each part and estimate the cost of the damage that occurred in all these parts. Also, controlling entrances and exits is useful for early discharge and the proportion of emergency evacuation plans, people through early warning systems that are on the way,are directed to the outside. Holds the elevator at the nearest floor and in the event of fire, activates the Automatic extinguishing system only in the same area in a controlled way.

In general, this system first, through the data collected by sensors, classifies more than half of the minor and major responsibilities of Incident Command System depending on conditions and issues them to the authorities. Whichaccording to the needs of the buildings and also features of flexibility and steering of intelligent systems, it is adjustable and changeable and can help to reduce the damage during the incident.

Appendix (A) the duties and authorities of the Incident Command System

Managerial level	Incident commander's responsibilities	Major incident command and control
		Decisions in order to protect the health and safety of workers, the public and the environment
		Decisions in order to ensure the safety of reactors in the incident
		Having detailed information about the internal and external components' details
		Maintains coordination and communication with other institutions and organizations
Information level	Responsibilities and duties of the Director of Public Information	Receiving and collecting information from all internal and external levels
		The reference of all information
		Provide advice to the incident commander on the dissemination of information and media relations.
		coordination of active staff of public information
		Receive and obtain information from the planning department
	Responsibilities and duties of the Director of Safety	Ensure the safety of responders
		Giving adviceto the commander for safety policies
		Reducing the threatening risks of employees
	Responsibilities and duties of the Director of Coordination	Gathering information about supporting institutions
		Coordination with the relevant institutions and organizations outside the organization
		Management of public relations inside and outside of the complex
	Responsibilities and duties of the Director of Security	Ensuring the security of personnel and other individuals involved in the crisis.
		Following the restrictions and security circles for non-responsible people
		Controlling and protecting the location of crisis managers, special equipment and special occasions
Administrative level	The role of the Director of Planning and Information Processing	Work very closely with the incident commander and senior staff
		Collecting and analyzing data
		Preparing , development and interpretation of the incident action plan
		Management of technicians activities
		Management of planning process
	The role of the Director of Operations	Management and development of operations
		Developer and executer of strategies and tactics
		Work very closely with other members of the general and administrative level
	The role of the Director of support sector	Provider of resources and services to support the event
		Compiling contracts and facilitating for receiving goods and services in order to equip the operation
		Work very closely with other members of the administrative and financial executive level
	The role of the Director of Finance and Administration	Negotiation about contracts with the support sector
		The organization management during normal and no crisis times
		Documentation and analysis of the demands
		Training in a non- crisis times

REFERENCES

1. Aysan , Y., Davis, I. 2013, *Disaster and the small dwelling, perspective for UN IDNDR.*National center of Earthquake engineering research, p1
2. Yavar, B, Incident Command System, Journal of the harbor and sea, ports safety, No. 6, Spring 2007, pp. 106-109

3. Ebrahimi, M. Describing and evaluating the crisis management systems in Iran, Second Conference on Scientific Research, Management And Rescue, Tehran , 2005
4. Soleimanzadeh, S , Mahdaviieh , M; Fallahi , A , development of Incident Command System of Shahid Beheshti university, the Second National Disaster Management Conference, Tehran, 2012
5. Farzad Behtash, MR - Keinejad, MA; Pirbabaei , MT; Aghababaei , MT, Promoting resiliency in Tabriz Metropolitan through implementing Incident command and control system, the Fifth International Conference on Natural Disaster Management, Tehran, Permanent Secretariat of Crisis Management Conference, 2013
6. Rajablu, A, Crisis Management and Incident Command System , Third International Conference on Health and Crisis Management in Disaster, Tehran, 2006
7. Husseini, B, Jazaieri, A, Elements and components of crisis command and control using new technologies, the Second National Disaster Management Conference, Tehran, 2012
8. Bashiri, M; Khajeii, S; Shomali, Earthquake vulnerability reduction in student residences, Case Study: the dormitory of Keshavarz Blvd, Shahid Beheshti University, Tehran University, Crisis Management and HSE National Conference on Lifeline,Industry and Urban Management, Tehran, 2013.
9. PAHO. (Pan American health organization), *Natural Disasters Protecting the Public's Health*, Scientific Publication No. 575, p12
10. Huang, Q., Cox, R., Shaurette, M., and Wang, J. (2012) Intelligent Building Hazard Detection Using Wireless Sensor Network and Machine Learning Techniques. Computing in Civil Engineering .pp. 485-492.
11. Fariborzi, E, Tavsolian, G, The role of information and communication technologies in intelligent buildings, the Eighth Symposium on Advances in science and technology, Mashhad, 2013
12. Janbozorgi, A, Ghanad, Z, Intelligent Building System, Kayson Journal, No. 43, winter2010, Pp 1-4
13. Jafari, V; Tavassoli, H; Zeinali, I, Energy efficiency in smart buildings, the First Conference On Climate , Building and Energy Efficiency, the Energy Efficiency Organization of Iran, 2011
14. *Madsen, J. J.,* 2008,*The Realization of Intelligent Buildings,* Buildings magazine, source: bpg properties ltd*, www.Buildings.com*
15. Yen Lin C, T.-H Chu E., Ku L.W., Liu W. S,.2014, *Active Disaster Response System for a Smart Building,* International Symposium on Computer, Consumer and Control (IS3C 2014), Taichung, pp490 - 493