**Doi**: 10.61186/jorar.16.3.148

# Structural and Functional Requirements of Emergency Operations Centers: A Comparative Study

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*Date of submission: 28 May. 2024* *Date of acceptance: 10 Jun. 2024*

**Original Article**

## Abstract

**INTRODUCTION:** Considering the important and sensitive position of Emergency Operations Centers (EOC) and little scientific research has been done on the subject, the purpose of this comparative study is to identify the structural and functional requirements of EOCs.

**METHODS:** In this comparative research, structural and functional requirements and considerations of modern EOCs were extracted to facilitate the process of managing operations and responding to disasters by studying the guidelines and standards for the design and construction of modern EOCs, as well as examining the experiences of different countries in using and operating these centers.

**FINDINGS:** By reviewing the studies, these components were extracted as the important structural and functional requirements of these centers including: common hazards in the region, the purpose of creating an EOC, the flexibility and multi-purpose nature of the EOC, audio and visual features of the operation control room, the number of administrative and operational positions, ergonomics and allocated space, required and technologies, the existence of a space for holding group meetings as well as people's rest, the amount of allocated budget and also the conditions of people's access to modern EOC.

**CONCLUSION:** Based on the findings, assessing the risks in the region and developing different possible scenarios, along with paying attention to the structural and functional requirements of modern EOCs based on the obtained criteria, can improve the disaster management process.

**Keywords:** Emergency operations center; Disaster management; Structure and function; Responding to disaster.

**How to cite this article:** Zamani E, Sadeghian A, Ganjehi S, Givehchi S. **Structural and Functional Requirements of Emergency Operations Centers: A Comparative Study**. Sci J Rescue Relief 2024; 16(3): 148-153.

## Introduction

The occurrence of all kinds of natural and man-made hazards have always been life-threatening, taken many lives, have caused many injuries and imposed heavy economic costs and losses to societies. Natural disasters have always occurred throughout human history and have caused various damages to people, their properties and the environment. According to the latest report published by the Center for Research on the Epidemiology of Disasters (CRED), 399 natural disasters occurred in the world, which killed 86,473 people in 2023. A total of 93 million people were affected by these disasters and more than 202 billion dollars of damages were caused to different communities. The occurrence of this number of natural disasters, which was more than the average of the last two decades, i.e. 369 cases, along with the challenges that the whole world experienced with the Coronavirus, as well as the occurrence of various technological accidents such as 2020 Beirut explosion, all emphasize and highlight the need for organizations involved in the disaster management process to be more prepared. (1) If measures are not taken to prevent disasters and reduce risks, by the year 2100, an average of 1.5 medium and large disasters will occur in the world every day, which is a significant threat to

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sustainable development. (2)

One of the most important measures to reduce the effect of disasters is the design, placement, improvement and optimization of EOCs in order to accelerate the process of disaster management and reduce the losses and casualties caused by them in emergency situations through facilitating information gathering, decision-making and directing operations.

EOCs act as command and communication headquarters to coordinate planning and decision-making during disasters or emergencies (3) and they are one of the key components of coordination activities during disaster planning as well as response to natural and man-made events and disasters.

Studying the history of EOCs shows that, like other areas of crisis management, these centers are constantly changing technologically and adopting new design methods derived from lessons learned in disaster management. Initially, these centers were called operations rooms and were considered as a space where key representatives of government and private agencies gathered to collect, evaluate and disseminate information. These multi-purpose spaces arose from the concept of civilian defense, which were almost similar in terms of layout and were usually created with the idea of a shelter because survival was of primary importance. (4)

While their main function was to provide a seemingly protected place for the responding agencies to maintain communication with the operational structures of the respective organization. They were also considered as a refuge for the ruling authorities and thereby ensured the continuity of the government. These centers were usually in the lower and basement levels of a municipal building or sometimes as independent underground facilities.

As the tensions of the Cold War eased, officials realized that the threat posed by natural disasters could also have important consequences on the functioning of governments as well as the standard of living and well-being of a large part of society. September 11 attacks shifted the focus of emergency management from an all-hazards approach to an approach biased toward homeland security and counterterrorism and created a new vision among community leaders that EOCs should not only ensure the survival of the government, but also facilitate the continuity of operations for the private sector by trying to recover and return to normal quickly. (5)

EOCs may be organized based on the major disciplines (for example firefighting, rescue& relief operations or emergency medical services), or by the emergency support function (e.g. transportation, communications, general works and engineering or resource support), or by geographic area (e.g. city, county, or region) or more likely a combination of all of them. However, the size, complexity, and types of EOCs vary by organization, while they all perform the same basic functions. (6)

The increase in the occurrence of hazards in recent years, especially disasters caused by climate change, along with the urban complexity, shows the need to pay more attention to the central role of EOCs in crisis management. Therefore, these centers should become complex communication centers to fulfill their mission during the crisis management cycle and not just be a command and control center during the disaster. A common misconception about EOC and its functions is that less attention is paid to its design and functional requirements. While as a physical place, this center has its own needs and in order to be effective, these needs must be met. The results of the studies show that the design has a significant effect on the effectiveness of the workplace and environmental comfort for both the physical and psychological needs of employees play an important role in reducing the destructive effect of high stress in critical situations. (7)

Functionally, EOCs act as command and communication headquarters for coordination, planning, and decision-making during disasters or emergencies. (3) The primary function of the EOC is to ensure that those responders working in the field have the resources they need to perform their duties. This allows decision makers to operate in one place to coordinate and communicate with support staff.

The review of studies related to the structural and functional requirements of EOCs shows that there have been limited studies on these requirements for EOCs. (8)

In some studies, the design and layout, and in some studies, the equipment and qualifications of the forces and personnel of these centers have been discussed.

Moore (1998) believes that one of the most important elements of the EOC is its organizational design and layout and states that the design of the EOC is affected by budget



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restrictions and space availability. (9)

Larson (2002) stated that each region should evaluate its needs and available resources and be creative in designing its EOC.

Gupta (2010) conducted research with the aim of sharing the experiences of EOC design in India and optimization methods to achieve the objectives considering the limited resources. Its findings showed that one of the requirements for the design of EOCs is to pay attention to support systems such as databases, telecommunications systems, communication systems and electricity systems. Considering the effects of accidents and disasters, these centers should be able to continue their activities during power outages or communication lines, also the equipment and structures of the centers should have sufficient structural strength against accidents. (11)

Shrader (2011) conducted an applied research to identify the best practices for creating and managing effective EOCs and named design and layout as one of the main elements of EOCs and considered these items essential in its management and design such as creating a standard organizational structure for the EOC based on the incident command system; attention to the limitations of available resources, existing needs; using technology and information management systems to improve information management; using equipment such as multiple displays, communication equipment, computer hardware and software program; considering arrangements for future technology upgrades of any hardware and software used in the center. (8)

Naseri et al. (2014) examined the role of the EOC in crisis management and the organizational structure of EOC in different parts of the world, its advantages and the role of this structure in the crisis management of Cheshmeh-Khosh Oil Field and presented the management structure of the EOC in the region. Based on the results of this research, the most important elements in the organizational-equipment model of the EOC are: proper location, proper access, human resources and equipment. Whenever the center has appropriate information, operational plans, sufficient space, trained groups, familiar staff, uninterrupted communication, advanced technical equipment and appropriate organizational chart can be useful in responding to crises and implementing the crisis cycle. In terms of management, the most suitable people for directing of the EOC and for membership and presence in the center of managers were suggested as the regional manager or the regional HSE manager, as well as the substitutes and regional HSE experts. (12)

Fagel et al. (2021) identified six configurations for operating room design including traditional multipurpose, cubicle cluster, horseshoe, stadium/theater, collaboration pods–theater style, and iris, each of which can be used at all levels of disaster response based on their advantages and disadvantages. (7)

Pollak et al. (2004) regarding the functional requirements of EOCs, proposed an operational analysis framework for preparedness training in operational centers, which focuses more on the management and preparedness of the center, and according to according to the analysis of the risks in the region and their simulation, operational scenarios should be prepared based on which the incident command system and the operation of the EOC and the existing procedures should be reviewed and revised. (13)

Peng et al. (2023) integrated short-term heavy rainfall forecasting technology into an EOC for rain and flood emergencies in Chinese Taipei by examining the existential importance of EOC and stated that this information enables the EOC to notify disaster management personnel in high-risk areas in advance of short-term heavy rainfall, thereby reducing the likelihood of danger. (14)

Arias-Hernandez & Fisher (2013) by examining digital technologies in three EOCs in Canada and two centers in the United States stated that the tunnel vision effect has a negative effect on joint work and joint situational awareness in EOC. (15)

Xun-yi et al. (2012) investigated access control strategies in EOC system based on VLAN while investigating security issues in access control in EOC system (16). Another concern in the design of an EOC that should be considered is the security of the site because the EOC must be able to control access to and from the site. (17)

No organizational structure of the EOC unit can meet the needs of the entire region or country, so its organizational structure should be formed based on the needs of the protection area and the available budget, also, this structure should facilitate the collection and management of information and decision-making. (18)

The first step in the development of EOC is planning, and in the planning process, things such as management of consequences, equipment



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needs, the ability of the government, the number of personnel and the space required for the presence and work of these people, the routine functions of EOC such as communication, inter-organizational coordination and in some cases, Operations Command should be considered and considered. (19) Therefore, considering the important and sensitive position of EOCs and relatively little scientific research on the structural and functional requirements of these centers, the purpose of this comparative study is to identify the structural and functional requirements of EOCs.

## Methods

In this research, which has been conducted in a comparative method, the structural and functional requirements and considerations of modern EOCs have been extracted to facilitate the process of managing operations and responding to disasters by studying the guidelines and standards for the design and construction of modern EOCs, as well as examining the experiences of different countries in using and operating these centers.

**Table 1**. Structural and functional components, planning and design of EOCs

| Criteria and components of structural and functional | Criteria and components of planning and design |
|---|---|
| Budget constraints | Multipurpose functions |
| Available space | Large and small size of the protection area |
| Needs and available resources | Frequency of disasters occurrence |
| Center security and accessibility considerations | Enough space for equipment and the presence and rest of personnel |
| Creativity | Command structure and community crisis management |
| Required information technology and telecommunication equipment and systems | Convenient access |
| The needs of protected area (operational) | Appropriate audio and visual features |
| Structural strength and stability of EOC | Support systems such as databases, telecommunication, communication & power systems |
| Facilitate the collection and management of information & decision-making | Dangers and risks in the region |
| The space required to manage ongoing operations | Available capacities and resources |
| Technology and information management systems | Attention to the limitations of available resources and existing needs |
| Number of people required to perform EOC functions | Suitable placement |
| Regional incident command system | Center activation processes |
| How to manage disasters | Identification of users and beneficiaries |
| Building layout requirements, development requirements and flexible use of space | Functions of the center and the equipment needed to do them |

## Findings

By examining the studies, these components were identified as important structural and functional requirements of EOC such as: common dangers of the region, the purpose of establishing an EOC, the flexibility and multipurpose nature of the EOC, audio and visual features of the operation control room, the number of administrative and operational positions, ergonomics and allocated space, required technologies, enough space for holding group meetings and also rest of personnel, the amount of budget allocated as well as the conditions of people's access to the modern EOC (Table 1).

## Discussion and Conclusion

The EOC is the center for collecting and disseminating information and analyzing disasters and the place where decisions and policies governing emergency response are planned and implemented. Maximizing use of available technology and human resources should be prioritized in the EOC because clear, concise and frequent communication is essential when responding to emergency situations. Each EOC has its own unique planning, design and functional requirements, as well as policies and operational procedures, according to its demographics and geographic area (6).

The components of an integrated design include ergonomics, environmental comfort, space allocation, circulation and access control, and communication with support spaces (7).

The space required for the EOC is determined based on the number of employees and a detailed examination of the requirements. The necessary space and equipment of the EOC depends on these items: the type, nature and severity of the incident or disaster, the population affected by the disaster, the number of organizations, teams and people present in response to the emergency situations, the extent of the affected area, and the level of ability and preparedness of urban relief

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centers (12).

The actual space required in various disasters may be different. The more the prediction of different scenarios of accidents is scientific and closer to reality; the ability to manage the operations of these centers will increase. Moreover, the limited budget and available space of the custodian organization can also be effective in choosing the actual space of these centers. Also, the planners and designers of EOCs should pay attention to the survival, security, sustainability, interoperability and flexibility of these centers. However, having a dual-purpose center is a very cost-effective way to run an EOC (20).

There are two debates regarding the functioning of modern EOCs: one is related to the policies and procedures and the other is related to the administrative and operational duties of these centers. There are usually two common management structures for EOCs. The first structure has an EOC commander who is usually the regional emergency manager, receives input from the EOC staff to develop emergency mitigation and recovery policies. In the second structure, a disaster management committee or advisory body separate from the center commander of EOC who manages emergency operations (21).

The EOC is closely related to the incident or disaster management system employed by the responding personnel (21). In most cases, the structure of EOCs will be similar to the incident command system. Setting up an EOC using the incident command system model has been shown to increase effectiveness and coherence even in the most devastating disasters (17).

The duties and responsibilities of EOC management and operations may vary depending on the geographic area or type of organization. However, there are a number of main duties that the designated person is required to perform. Some of them may be created before the EOC is activated, while others become active after the occurrence and related to the type of disasters. With the activation of EOC, directing, controlling and coordinating relief activities are among the activities that become more prominent (7).

Communication and its systems are important components of an EOC after personnel.

This system should provide a continuous pathway for both strategic orders and situational awareness to smoothly enter and exit the EOC without any issues (12).

In fact, effective communication plays a vital role in increasing preparedness, improving coordination, empowering people, facilitating logistics, reducing public anxiety, and limiting and reducing damage in general (22). Here, a point to consider is that there are inherent communication differences between organizations with different organizational cultures that must be coordinated during disasters response (23). Given the fundamental need for coordination and the fact that organizations often have to interact with new social actors, this challenge is exacerbated during a disaster.

The best-prepared command centers are those that have implemented an enterprise-wide information system specifically designed for incident management (24). However, Harris cautions that an overreliance on technology can have a negative impact on operations at the emergency center. Software systems often fail during disasters, and hard drives can also fail, rendering these technologies unusable.

In this study, by studying the guidelines and standards for the design and construction of modern EOCs, as well as examining the experiences of different countries in using and operating these centers, the structural and functional requirements and considerations of modern EOCs were expressed to facilitate the process of managing operations and responding to disasters. Any community, large or small, urban or rural, can improve its ability to centralize its information flow in an emergency by establishing a modern EOC. The existence of these centers will not only facilitate the process of disaster management, but by establishing communication between different organizations, it will be a basis for synergy between managers and consequently between operational forces. According to the findings of this study, design and functional requirements for establishing EOCs should be considered in addition to foresight and future studies about future disasters, assessment of hazards in the region and different possible scenarios based on the criteria stated in the research.

## Acknowledgments

None

## Conflict of Interests

The authors declare no conflict of interest.



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