Journal of Human Environment and Health Promotion
Print ISSN: 2476-5481 Online ISSN: 2476-549X

Designing an HSE Management of Change Model: A Case Study of Civil Engineering Projects Based on the Delphi Method

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ARTICLE INFO

Article type:
Original article

Article history:
Received: 26 MARCH 2022
Revised: 27 APRIL 2022
Accepted: 24 MAY 2022

DOI: 10.52547/jhehp.8.2.104

Keywords:

Management of change model
health
security
environment
Delphi method

ABSTRACT

Background: Organizational environments are constantly changing; hence organizations must adapt to such changes. Therefore, this study aimed to design an HSE management change model for civil engineering projects.
Method: This cross-sectional study was conducted in 2019 based on the Delphi method. The participants were 39 HSE experts working on Iran's large civil engineering project. The instrument of the study was a questionnaire consisting of 40 necessary measures based on the Penfold's change model. The Delphi method employed in this study comprised three rounds and was carried out based on the 5-stage Penfold's change model (current situation, analysis, understanding, planning, execution, and keeping changes).
Results: The results of the Delphi study showed that from 60 items after the three rounds, 57 proposals were approved by the specialists. Also, 10 out of 15 recommendations were taken by experts in the change management model.
Conclusion: The final change management model in this study included 38 items for the five stages of change management (based on the integration of 67 items). Results indicated that this model can be used to reduce the consequences of changes affecting occupational safety, health, and the environment.

1. Introduction

As dynamic social structures, organizations are continually changing, affecting, and being affected by the environment. All organizations must adapt to such changes. Therefore, dramatic changes can pose serious challenges to employees regarding how they can improve their ability to deal with the new nature of occupations and acquire new methods to perform novel occupational tasks[1]. In order to bring about effective changes, organizations need to manage, plan and design the upcoming changes-a process, also referred to as management of change (MOC). Management of change is considered one of the key factors in dealing with new changes and seeks to change the status quo to reach a desirable state [2]. According to official statistics, 46% of all work-related accidents occur in construction projects, 70% leading to worker deaths. So, civil engineering projects and construction businesses are among Iran's most unsafe and accident-prone sections. The development of the domain of

How to cite: Soltanzadeh A, Mohammadfam I, Ghorbani A, Mahdinia M. Designing an HSE Management of Change Model: A Case Study of Civil Engineering Projects Based on the Delphi Method. *J Hum Environ Health Promot.* 2022; 8(2): 104-9.

such projects has underlined the significance of issues related to health, security, and environment (HSE). Civil engineering projects are susceptible to accidents because of using various groups of workers, occupational variety, and lack of familiarity with the working environment. Thus, dealing with HSE issues has attracted attention among researchers and construction management [3, 4]. Therefore, the HSE department is regarded as one of the most important departments in any civil engineering project. Paying due attention to small and large changes and their effects can be essential in managing change in the HSE of civil engineering projects and cause positive socioeconomic and humanistic results for these projects. Moreover, each project consists of a welter of potential risk factors resulting from various types of changes which can cause serious challenges for the projects or even put an organization out of the competitive market [5, 6]. Hence, project and senior managers need to use change management models to survive in a competitive market. Accordingly, given the issues mentioned above, this study was conducted based on needs analysis in one of the largest active civil engineering organizations to identify and analyze factors affecting HSE management of change and to design an HSE management of change model for civil engineering projects. Researchers have proposed different change management models. However, according to the objectives of the study, Penfold's change management model has been used in this research. The selection of this model is due to the alignment of its steps, which includes reviewing the current situation, analyzing and recognizing, planning, implementing change, and maintaining the achievements of the change with the objectives of the study and presenting a change management model in the field of health, safety, and environment.

2. Materials and Methods

This qualitative study was carried out in 2019 based on the Delphi method in one of the largest organizations working on significant civil engineering projects in Iran. The expert panel of this project was 39 HSE experts working for the above-mentioned organization. Also, all people in this study were health, safety, and environment managers in construction projects. The participants' means of age and working experience were 28.6±8.19 and 5.2±6.82, respectively. Of 39 expert participants, 54% had a bachelor's degree, 41% had a master's degree, and 5% had a Ph.D. in the HSE field. This Delphi-based study was conducted in three rounds via a questionnaire consisting of 40 items based on the Penfold's management of change model [7]. In addition to three rounds of Delphi, the validity of this model was assessed using the content validity ratio (CVR) and content validity index (CVI). Further, its reliability was evaluated using Cronbach's alpha. CVR and CVI in this study were 0.8 and 0.9, respectively. Furthermore, Cronbach's alpha coefficient for this model was measured at 0.84 .

2.1 Penfold's Management of Change Model

This model includes the following five stages [8, 9]:
1st stage: Analyzing the current situation: Determining what is being done now.
2nd stage: Analyzing and understanding: Understanding change components.
3rd stage: Planning: Explaining what should be provided, what can be achieved and how to achieve them.
4th stage: Change components: Explaining how changes should be realized.
5th stage: Keeping change benefits: Identifying ways to stabilize changes and evaluate their effects.

2. 2 The Delphi Method

Group decision-making is an appropriate way to deal with complex issues and problems. In the decision-making process group, the field experts can arrive at a consensus on a relevant topic. The Delphi method is a qualitative research method used by field experts to come to an agreement. Indeed, this method is used to synthesize experts' ideas in an organized way to reach a final agreement about an issue [10, 11]. This study used a 3-rounds Delphi method.

2. 3 Procedure

following the aims of the study. Consequently, a total of 39 HSE experts cooperating with one of the largest civil engineering organizations in Iran were invited as the study participants. Although different numbers were suggested for the appropriate number of experts in the Delphi method, it was argued that a minimum of 10 experts suffices in a homogenous study [10, 13]. The Delphi change model of the study was designed based on the Penfold's management of change model, and the data were gathered via a questionnaire. After evaluating various studies and models, 40 items of change were introduced in the first round. The level of consensus in Delphi studies is considered higher than 50%. In this study, the consensus level was 55% (of all the participants) [14]. The study procedure is shown in Figure 1.

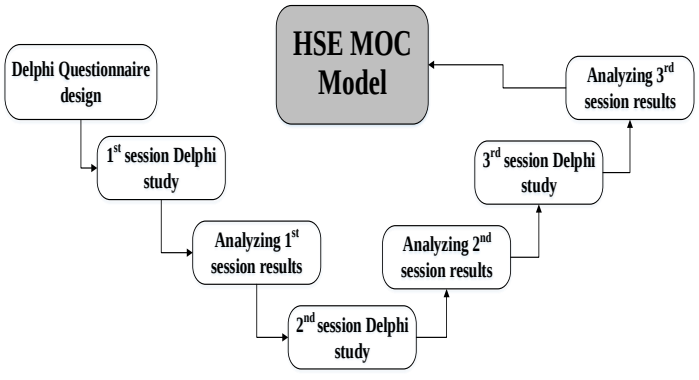

Figure 1: the procedure of the study

3. Results and Discussion

In the first round of the Delphi model, the research team designed a questionnaire consisting of 40 items based on the Penfold's management of change model and a comprehensive literature review and distributed to 39 participants. Eight items were suggested for each of the five stages in the Penfold's management of change model. Moreover, the expert panel was asked to suggest their recommendations regarding necessary changes in the HSE department at the end of the questionnaire. The number of completed questionnaires was 36 in the first round (92% response rate). Based on the assigned consensus level (55%), items below the required level were removed in this round. The results of the first round demonstrated that six items were removed, and 34 items remained. Additionally, 15 items were suggested by the expert panel for the HSE management of the change model (Table 1). The questionnaire with 34 items and 15 suggested items in the first round was given to 36 experts to perform the second round of the Delphi model. Likewise, the experts of the Delphi panel were asked to choose the appropriate stage for each of the suggested items in the first round. The expert panel confirmed all 34 items. Besides, they specified the required stages for each of the 15 items and decided that 10 items were in accordance with the stages specified in the management of change model; however, five items were inconsistent with the model (55% consensus level) (Table 1). After analyzing the results of the second round, the items suggested by the experts for each stage were added to the relevant stage. Similarly, to present the model and limit the results, 10 suggested items and 34 items that were confirmed by the panel were combined. Finally, 23 items for the five stages of the management of change model were finally introduced. As for the third round, the modified questionnaire, including 23 items was given to the experts. In this round, the expert panel confirmed all 23 items for the five stages of change management (Table 2). After analyzing the results, the final HSE management of change model was presented. Based on this model, change starts from understanding and analyzing the current situation and, after passing through the planning and execution of changes stages, ends up in the final stage of keeping the change (Figure 2). In this study, the HSE management of change model comprising 23 items was designed based on a 5-stage procedure and a 3-round Delphi model for large civil engineering projects. The first stage (current situation) included four items: analyzing the long-term strategies and plans for the HSE of an organization, identifying and analyzing the employees of the HSE department, identifying important factors and resources in line with HSE goals, and analyzing strengths, weaknesses, opportunities and threats (SWOT). The findings of this study agree with the findings of some previous studies [8, 15]. For example, the item 'analyzing long-term strategies and planning of an HSE organization' is in line with the reports of a study conducted by Cummings and Worley (2005) [15]. The items of 'SWOT' and 'identifying important factors and sources in line with HSE goals' have also been confirmed by other scholars [8]. Furthermore, the item of 'identifying and analyzing the characteristics of human recourses working in the HSE department' has been confirmed. The second stage (analyzing and understanding) consisted of four items: understanding the work environment and employees of the organization, identifying and evaluating tentative costs for changes, identifying positive and negative points of changes for organizations and beneficiaries, and constantly evaluating HSE needs. The results of previous studies also show that the items of 'understanding work environment and employees of the organization' and 'identifying positive and negative points of changes for organizations and beneficiaries' are very significant in managing change models [16]. These two items, together with the items of 'evaluating tentative costs for changes' and 'evaluating HSE needs,' emphasize that the economic justification of changes in organizations plays a crucial role in the advancement of organizational goals and plans [17]. The third stage (planning) comprised six items: forming strong teams to plan and execute changes, allocating sufficient budgets for required changes in the HSE department, causing changes accompanied by appropriate training and culturalization, employing qualified expert personnel, analyzing the cost-benefit of changes for senior managers and using problem-solving strategies to item based on standards. The presented items in this stage showed that predicting appropriate financial resources and budgets for changes and planning for more consultation can help execute HSE changes. Another important item is analyzing cost-benefit; such an analysis can ease the cost estimation process and help decision-makers reach informed decisions [18].In the fourth stage, the results of the planning were executed. This stage consists of the following five items: removing obstacles hindering changes, implementing change management procedures with appropriate training, establishing necessary connections between managers and employees and using reward mechanisms, providing appropriate educational and training courses using successful change experiences and finally, executing changes based on the planning process. These items are taken to achieve an appropriate condition [11]. In the executing stage, it is necessary to provide the managers and employees of an organization with appropriate education and help them use successful change experiences and execute measures in an organized fashion. Also, removing personal, structural, systemic, and skill-based obstacles is essential for changes so that such items can be presented via appropriate educational courses [19, 20]. Besides, changes can start from smaller sections of organizations and be generalized later to the whole organizational system [21]. The fifth and last stage was keeping changes. This stage consisted of the following items: building a team to evaluate the effectiveness of changes and analyze the effects of changes, constantly monitoring the process of the execution of changes and informing about such changes, constantly assessing the degree of satisfaction

Table 1; The suggested items and stages in the first and second rounds of the Delphi model

	suggested items	stages of Penfold's MOC model					The highest percentage (%) (maximum votes/all participants)*100
		1st	2nd	3rd	4th	5th	
		Current situation	Analysis and cognition	Planning	change Implement	Keep changing	
1	Preparing a report of the change process	4	0	2	6	24	66.67
2	Performing activities according to standards and instructions	0	2	4	25	5	69.4
3	Use of appropriate space for the HSE unit	1	1	22	10	2	61.1
4	Not using relationships in recruiting	3	3	13	12	5	36.1
5	Using skilled and qualified personnel	3	0	24	5	4	66.67
6	Personnel reinforcing in the HSE unit	25	2	1	5	3	69.4
7	Attract the support of senior executives about the need for change	2	0	4	9	21	58.3
8	Justify the cost of change for managers	0	28	5	2	1	77.8
9	Explaining the benefits of making a change	2	1	1	3	29	80.5
10	Creating change along with creating culture	3	5	20	5	3	55.6
11	Allocating financial resources to make changes	3	3	20	6	2	55.6
12	Efforts to approve changes for implementation	2	6	17	8	3	47.2
13	Suitable selection system for hiring skilled personnel	14	7	10	3	2	38.9
14	More authority to the HSE unit	7	6	9	8	6	25.0
15	Update of equipment and use new technology	10	8	11	3	4	30.6

Table 2: The results of the study after the third round of the Delphi model

	1st Stage: Investigate the current situation
1	Review the organization's long-term HSE strategies and programs
2	Identify and analyze the characteristics of the human resources in the HSE unit
3	Identify important factors and resources to achieve HSE goals
4	Analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT)
	2nd Stage: analyzing and recognition
5	Understanding the environment and employees of the organization
6	Identify and evaluate potential costs of changes for the organization
7	Recognize the positive and negative consequences of change for the organization and stakeholders
8	Continuous assessment of the organization's HSE requirements
	3rd Stage: Planning
9	Creating strong teams for planning and implementation of change
10	Allocate financial resources for changes and appropriate space for the HSE unit
11	Make changes along with education and culture
12	Using of skilled and qualified personnel
13	Cost-benefit analysis for senior managers
14	Use problem-solving methods and perform activities according to the standard
	4th Stage: Make a change
15	Remove barriers to change
16	Continuous implementation of change management program along with proper training of change functions
17	The relationship between managers and employees in the process of change and the use of incentive mechanisms
18	Appropriate practical training using the successful experience of change
19	Implementation of changes based on planned stages
	5th Stage: Keeping changes
20	Forming an evaluation team to evaluate the effectiveness of the changes and analyze the effects of the changes implemented
21	Continual monitoring of the implementation of changes and informing the process of changes
22	Continual measurement of employee satisfaction
23	Predicting the change of senior managers and justifying them about maintaining change

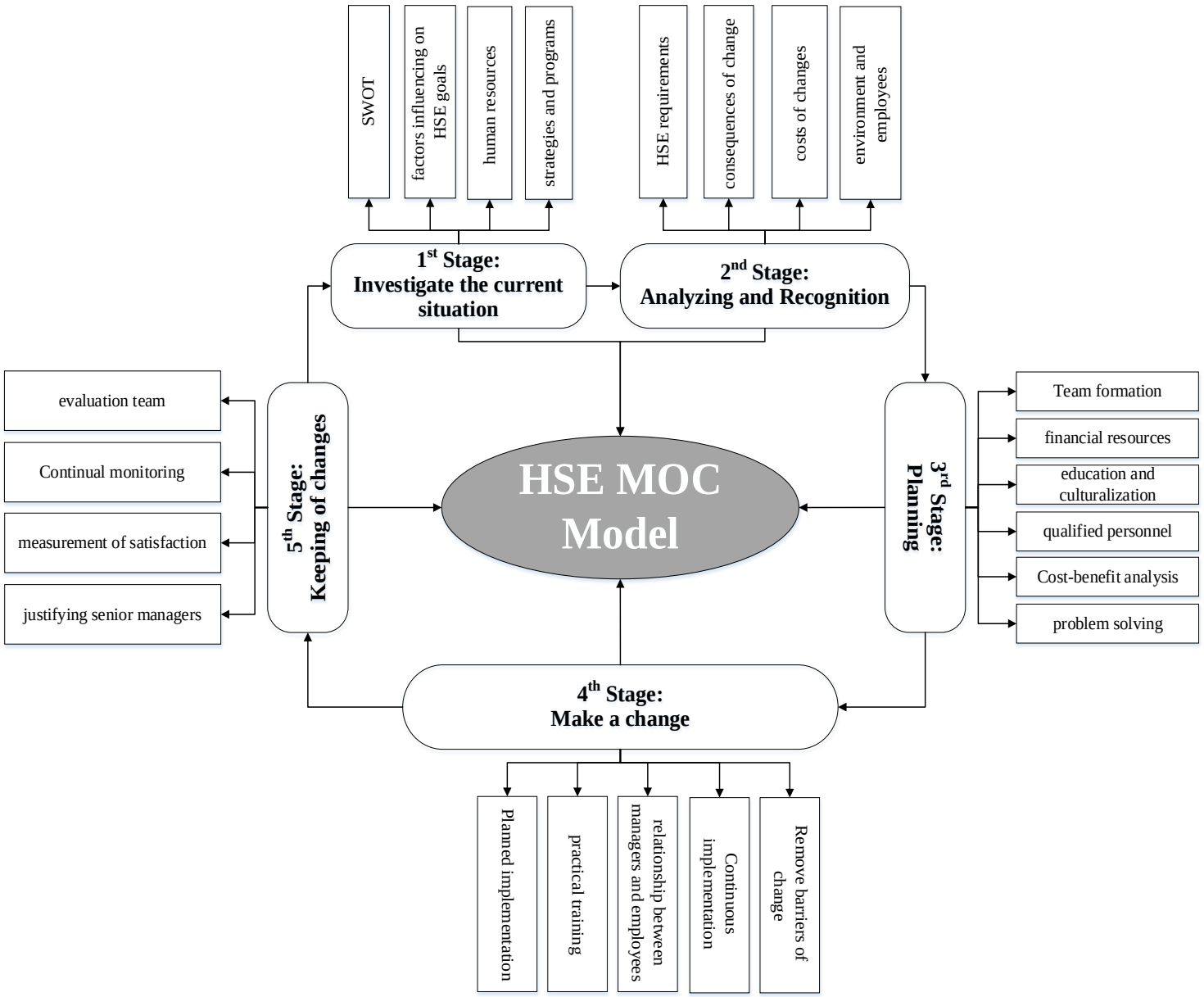

Figure 2: The HSE management of change model based on the results of the study

among employees and predicting changes in senior managers and justifying them to keep the trend of changes. Constant monitoring of the process of changes and publishing the relevant results, and forming a particular team for evaluating changes and their effect can play a key role in keeping changes. Another important item to keep changes was informing employees regarding changes and their relevant results [7, 22]. The other two essential items were educational courses about changes and the justification of employees and senior managers [23].

4. Conclusion

Although this study was the first of its kind conducted on HSE in Iran, the results may improve the efficiency of HSE departments by reducing the risk of accidents and occupational hazards. Though this model was designed for civil engineering organizations, it can also be used for many production and service-providing organizations because it was designed based on the comprehensive Penfold's management of change model.

Authors' Contributions

Ahmad Soltanzadeh: Concept of study; Responsible for design; development of the data analysis; Responsible for data interpretation; article revision; Writing an article; Responsible

for data collection. Iraj Mohammadfam: Concept of study; Responsible for design; development of the data analysis; Responsible for data interpretation; article revision. Ahmad Ghorbani: Responsible for data collection. Mohsen Mahdinia: Concept of study; Responsible for design; development of the data analysis; Responsible for data interpretation; article revision; Writing an article.

Conflicts of Interest

The authors mention that there is no conflict of interest in this study.

Acknowledgements

The authors would like to express their gratitude to the management and study subjects of the large civil engineering project for their cooperation. (This article is a part of the research project No. 981084 and ethical code IR.MUQ.REC.1399.069 approved by the Vice-Chancellor for Research and Technology of Qom University of Medical Sciences and Health Services) .

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