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Optimizing the Risk of Building Environments Using Multi-Criteria Decision Making

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Abstract

Construction industry is known as one of the most dangerous industries in the field of air pollution which causes damage to environment and endangers human health. Therefore, in order to reduce and control risks by construction industry, planning is done. The method which is used to discuss the risks is MCDM. Some criterion is used to risks, in this study, the insights and suggestions are used which are risk comprehension, risk evaluation, safety risk and safety performance. Weight of four main scales was performed by Super Decision software. Paired comparison of main scales is performed in terms of 9 hourly quantitatively scale and is same as AHP process. According to the research, the more weight was pertinent to risk comprehension and the less weight is pertaining to safety insight. The results show that in order to control risks, risk comprehension has high priority in building environments.

Keywords: MCDM; Risk evaluation; Building environments

Introduction

Construction industry plays important role in development of economy. Since there are many complexities in the industry, it is regarded as most dangerous and rate of damages and compensation to workers [1]. In this industry, the damages are resulted to death, serious occupational damages and time lost as for its nature [1]. Constructional workshops are recognized in terms of many incredible factors like continued repair, frequent circulation, unsuitable working situation, expose to different weather, high unskilled workers and temporary workers which cause many accidents [2].

Today, development of industry and technology causes constructional factories and environments play important role in production and economic cycle and the workers are regarded as human factor use superior technology and valuable capital, thus, it is important to use and promote bodily and mental force as producer forces for substantial development. In fact, human force is regarded as one of the most important factor in production and service and is treated by many factors. Civil projects are converted constructional industry into one of the most dangerous industry because of dangers in administrative and constructional environments. In one side, regardless other industries, constructional industry are dispersed in different parts of world by physically and it is challenged to supervise on it as safety and health. In 2005, average 12.2 deadly accidents and 7.1 accidents result to injury for each 100000 workers were registered. In Iran, statistical report reported by Ministry of Labor and Social Welfare show that nearly 35% of accidents (one third of working mode) were pertinent to construction and civil which are resulted to death and severe injuries. Also, according to nonofficial statistics published in 2012, 46% of occupational accidents in Iran were on constructional section and more victims were construction workers [3], thus, in order to obtain health aims to protect working force, it is necessary to discuss risks due to workshops and constructional workers. In order to make decision on controlling and protect workers, it is necessary to evaluate risks exclusively. One of the main solutions to evaluate occupational and environmental risks among constructional workers is to optimization process in multifaceted decision environment. Optimization of health risk by MCDM determines workshop risks and is enable to suitable decisions to protect workers. MCDM is to select the best options based on incompatible aims relatively. In fact, MCDM models are applied to design [4].

In research as analyze physical risks of Balaroud Khuzestan dam in constructional environment by MCDM, they identified activities and environmental process as for severity of probable and probable outcomes and then human, equipment and identify and classify risks in the form of Delphi method and after prioritization factors by TOPSIS, AHP, by using integration by extraction and embankment, explosion and excavation are regarded as most important environmental risks for Balaroud dam [5].

It was their study as ranking HSE performance of Gas companies by using MCDM, performed field visiting different units of Iranian National Gas Company and then identified and classified parameters involved in safety, health and environment. The results show that province gas, development and engineering, transmission and refine gas have points 0.74, 0.55, 0.40 and 0.19. Also, they presented MCDM and using TOPSIS fuzzy as most efficient to identify, rank and optimize risk from HSE point of view [6].

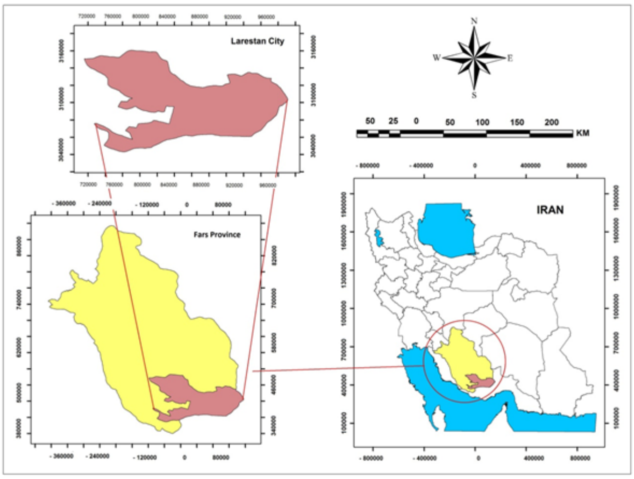

Figure 1: Geographical situation of Larestan.

Results of Hashemi [6] by discussing effect of application of MCDM in water electricity projects and use of MODM to optimize algorithm crowd to look for optimized solution and restore decoration system in water electricity project and the aim of present study is to discuss and plan constructional environment of Larestan city by MCDM method [7].

Materials and Methods

Geographical situation of region under study Larestan city is one of the southern cities of Fars province and geographical situation is shown in **Figure 1**.

Decision process

In majority cases, decision is suitable when it is based on some criterions, in MCDM method, instead of risk scale, some criterions are used, from the method point of view, AHP method is suitable method to model qualitative scales and its vast applications to select, evaluate, plan and decision are so high [8]. Multifaceted model is considered for some decisions and in linear planning, it is supposed that decision makers have a one single aim. Consideration of one aim causes problems, thus, it is necessary to use multifaceted models.

Mathematical form of MCDM

In MCDM models, instead of linear planning (which has one single aim) we confront with some aims. Generally, multifaceted model with k aims as.

Which Xj is decision variable of j and n is number of decision variable, gi (xi) is m limitation, m is number of limitations and bi is nonnegative and fixed value.

AHP process is started to recognize and prioritize them, the elements including different methods and priority estimators. In first step, each of data has been weights and the estimators are located in matrix and estimated as single and weight of them is evident, the, by using normalized method, all estimators are estimated, in third step, by consideration of weight of estimators and alternative points, points of alternatives is obtained and they leveled and final step is to determine their compatibility [9].

In modeling step, problem and decision aim are recognized as hierarchy. Decision elements are decision index, decision options. Hierarchical process needs to break a problem with some indicators and high level shows main aim of decision. Second level shows main and sub-indicators which connect to sub and partial indicators. The last level offers decision options [10]. Hierarchical decision is in **Figure 2**.

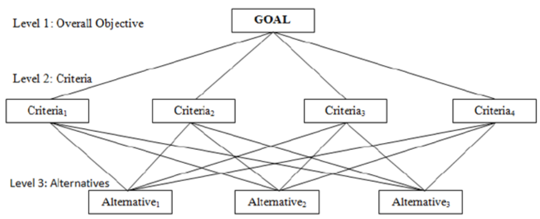

Figure 2: Hierarchical analysis process.

In pair judgment step, after designing hierarchical decision, the comparisons are performed among different options in terms of index and judgment. It is done by pair comparison between decision elements (pair comparison) and by numerical points which show prioritization between two decisions. In order to do, options comparisons by m index are devoted to it and in **Table 1**, manner of valuing is shown [11].

Importance Degree	Relative importance to another scale in paired comparison
1	Equal importance
3	Average preferable
5	Strong preferable
7	More strong preferable
9	Severe preferable
2,4,6,8	Medium preferable for numbers

Table 1: Paired comparison.

Findings

According to hierarchical process which was selected by expert society, safety performance, safety insight, risk comprehension and risk evaluation are considered in **Table 2**

Scales	Safety insight	Safety performanc e	Risk comprehen sion	Risk evaluation
Safety insight		ü	ü	ü
Safety performanc e	ü		ü	ü
Risk comprehens ion	ü	ü		ü

Risk evaluation	ü	ü	ü	

Table 2: Internal dependency of main criterions each other.

Paired comparison of main scales

Paired comparison of main scales is performed in terms of 9 hourly quantitatively scale and is same as AHP process. The result of paired comparison and harmony vector that is offered in **Table 3**. In order to obtain suitable result, paired judgment is used and geometrical average is obtained [12].

Scales	Risk comprehension	Safety performance	Risk evaluation	Safety insight	Normal
Risk comprehension	1				0.31
Safety performance	0.2	1			0.23
Risk evaluation	0.5	0.2	1		0.2
Safety insight	0.33	0.5	0.2	1	0.16

Table 3: Paired comparison for main scales.

Paired comparison for internal dependency of main scales

In order to understand interactive dependencies between main scales, paired comparison was performed to obtain matrix in terms of 9 hourly quantitative scales. To calculate importance coefficient, each of main scales (as for interactive dependency) and paired comparison (by control first scale) is offered in **Table 4**. The results are offered in **Table 4** as for or their internal dependency [13].

Scales	Safety performance	Risk performance	Risk evaluation	Safety insight
Safety performance	1			0.35
Risk evaluation	0.5	1		0.29
Safety insight	0.33	0.5	1	0.22

Table 4: Paired comparison as for their internal dependency by control risk comprehension.

Discussion and Conclusion

Application of MCDM methods is considered as one of the main element in framework of risk evaluation in order to help decision and reduce and minimize negative outcomes. In management of constructional projects, evaluation of safety risk is regarded as important step to identify dangers and value damages. In this study, four insights are offered to discuss situation of Larestan construction workshop which are risk comprehension, safety insight, safety performance and risk evaluation. After interview with experts who were 15 people, the weights of scales were discussed and more weight was pertinent to risk comprehension (0.31) and less weight was for safety insight (0.16) and the remaining were safety performance (0.23) and risk evaluation (0.2) which show risk comprehension is applied to control workshop risk more. Evaluation of danger was performed for health and occupational safety by AHP and done this study, risk evaluation suitable with PFPRA which is combination of Fine Kinney hierarchical method and fuzzy inferential system were suggested for excavation dangers. Integrated method was valued by experts. Discussed necessity of risk evaluation in Turkey in constructional projects. In this study, for first scale, three sub scales are considered, and importance of worker; knowledge (0.3) worker' skill (0.16), worker' experience (0.08) were prioritized. Second scale (safety performance) had three sub scales which were management knowledge (0.47), management skill (0.28), and management experience (0.16). For third scale, three sub scales are considered which are logistics managers (0.28), logistics facilities (0.19) and logistics workers (0.07). The last scale is safety insight which has less weight and has four sub scales including modern equipment (0.36), modern technology (0.32), modern repair system (0.1) and modern navigation (0.06). As for discussion which is used to control health risk, we can use prioritization to select and reduce cost, increase control and health of environment for people domiciled and its environment.

Conflict of Interest

The authors declare no conflict of interests.

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