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Hazard Assessment Matrix; Results of a Delphi Study

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Background: Identification of hazards is one of the most important parts of industries' strategies. This can be done using a hazard matrix as an applicable tool which can also rank hazards properly.
Methods: In this study, the Delphi method was used to select best alternatives for a hazard matrix. All possible items were gathered and passed Delphi rounds, in which mean, median and standard deviation were used to evaluate decisions. Moreover, Kendall's coefficient of concordance was used to reach consensus between panel members.
Results: The panel members found 42 items in five categories, of which 29 items benefited a mean and median more than 5. Moreover, Kendall's coefficient of concordance reached 0.66, which indicated a statistically meaningful agreement for the number of experts.
Conclusion: This study introduced a hazard matrix, in which different consequences were accounted based on a well-known decision making method. The matrix is developed for hospital application with respect to panel members' knowledge and can be used suitably in this field of industry.

1. Introduction

Hazard is a kind of danger which can occur in any period of time [1]. Identification of hazards is one of the most important parts of industries' strategies, in which all possible hazards are identified and ranked based on a hazard matrix [2, 3]. This matrix is used to classify hazards like occupational ones and is a helpful tool to promote industries' health, safety and environment purposes and evaluate risk of organizations [4-6]. A hazard matrix is applied widely to rank different risks based on their importance in industries, which is made using frequency and severity rates [7]. To achieve this important object, there are different kinds of hazards required to be considered: hazards to people like hazards associated with occupational diseases, property damages or environmental loses. Actually, any incidents related to health, safety and environment are considered in a hazard matrix [5].

To rank hazards properly, decision makers face inadequate documented information or sometimes there will be untrusted information which needs methods to reach consensus. Two relevant methods in health care services to reach this aim are the Delphi tool and Nominal group technique which have been used in health care decision making issues [8]. The Delphi method is used widely to organize options and problem solving. It concludes all experts' viewpoints in an accurate way and can be used properly to reach a hazard matrix [9].

Not only healthcare workers are exposed to different hazards, but also there are environmental hazards in the health care industry which put public health at risk [10]. In addition, reputation aspects that play the special role in the hospital decision making process, in which many professionals are working in a complex industry with many stakeholders and challenges [11].

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In this sector, assets and financial consideration have prominent effect on all divisions of activities [12]. Thus, it is important to evaluate and rank all these issues to better make decisions in every activity. The purpose of this study was to introduce a Hazard Assessment Matrix based on Delphi Method.

2. Materials and Methods

This descriptive study was conducted between June and September 2017 based on preparing a questionnaire. In this study, the Delphi method was used; Delphi method was advanced by Dalkey and Helmer (1963) [13] and has been widely used in management issues, e.g. planning, policy and decision making and even in quality management studies [14]. Delphi is a structural tool of carrying out a consulting process which allows individuals to express their opinions as a whole [15]. This process uses continuous questioning from panel members based on controlled feedback [16]. The Delphi process was used because there were no previous research as a validated measure to reach our purpose and a generalized structure was needed [17]. Moreover, this technique leads to saved time and money and there is no need for direct interactions between contributors; moreover, certain domination of individuals in responses is removed [18]. Reid stated that Delphi has prominent importance in health care domains, in which there are powerful hierarchies and helps to reach consensus among group of experts [18, 19]. One of the most important issues in the Delphi process is selecting panel members [20]. Dalkey et al. (1970) stated that accuracy is achieved when panel members increase to 11 [21]. Moreover, Somerville (2008) mentioned that 5 to 10 panel members are sufficient [22]. In order to identify experts, the snowball technique was used; in this way, two occupational educated experts with at least five years of professional experience in the field of hospital health and safety were found and the aim of the study was explained to them. Afterwards, the experts introduced four other experts who were educated and had the same experience. Three more experts were added with the same process, and the last expert was similarly added before the beginning of the process. All the members were willing to contribute in the study. In this study, a seven-point Likert scale is a famous bipolar response which arranges (least to most) list of responses containing approval or disapproval about defined categories was selected to increase the scale's reliability by adding "very" to the bottom and Top of the five point scale Table1 [23].

Table1 : Likert scale response categories [23]

Scale	
1	Very unimportant
2	Not important at all
3	Unimportant
4	Neutral
5	Important
6	Most important
7	Very important

2.1. Delphi Process Follows These Steps

1- The panel of experts selected based on the field of study
2- Selection of ratio scale to rank priority of opinions
3- The group of anonymity experts participating in the study via mail questionnaire or interviews
4- The iterative process (more than two rounds based on statistical agreements)
5- Sending and controlling feedback to respondents in each round
6- Complete aggregation of respondents' answers in the final round (8)

To investigate consensus, statistical mean, median and mean standard deviation can be used to establish existence of agreement in the study [24]. Moreover, Kendall's coefficient of concordance, was used to measure consensus between all the responses in every alternative process and is a measure of validity of questionnaire; it ranged between 0 and 1, with the value closer to 1 indicating a good match between judgments and closer to 0 showing disagreement between the respondents [25]. In addition, to measure reliability, Cronbach's alpha coefficient of the questionnaire was used.

Based on the literature review, incident reports, near misses, previous risk assessment documents and interviews with personal and management of hospitals, all criteria involved in Hazard assessment matrix was obtained. Then, 42 structured questions (open-ended) mailed to the panel members to achieve feedback (they were asked to give their new additional idea in the end of letter), In the next step, all the answers were gathered and analyzed by SPSS-22 software, in which options with mean and median less than 5 did not meet agreement by the panel members (based on the seven-point Likert scale). In the second round, the questions with feedback were re-mailed to the members until the fourth round, in which Kendall's coefficient of concordance reached an acceptable level of consensus [26].

For example, Table 2 shows some results of health consequences of hospital, in which alternatives were evaluated: In the first row, all the panel members were asked about the importance of "incidents without any injuries" as options to consider in the final matrix and they ranked it with respect to the Likert scale, in which in the fourth round, it benefited mean, SD, and median as 5.80, 0.422 and 6.00, respectively. Due to these results, it was agreed by the panel members. In contrast to the first row, in the second row where "the effect of individual performance and result in occupational diseases" were evaluated, the result of the final round depicted the mean and median less than 5 and illustrated disagreement of experts; moreover, SD was high (0.675), which represented difference of opinions about it and consequently was rejected by the panel members.

Table 2: Results of the Delphi process in the category of health consequences

NO	Alternatives	First Round			Second Round			Third Round			Fourth Round			Final result
		Mean	S.D*	Median	Mean	S.D*	Median	Mean	S.D*	Median	Mean	S.D*	Median	Consensus
1	Incident Without any injuries	5.60	0.966	6	5.90	0.568	6	5.80	0.422	6	5.80	0.422	6	Accepted
2	Effect on individual performance and result in occupational disease	4.40	0.516	4	4.40	0.516	4	4.30	0.675	4	4.30	0.675	4	Rejected

*Std. Deviation

3. Results and Discussion

In this study, 42 items were evaluated and based on the control feedback of the responses, 29 items were left in the last round of Delphi. All the 29 items demonstrated mean and median more than 5, which were acceptable. Kendall's coefficient of concordance reached 0.66, which was statistically meaningful agreement among the panel members. Moreover, between the rounds 3 and 4, there was a 0.07 decrease of Kendall's coefficient of concordance, which showed few disagreements between two consecutive rounds. The mean standard deviation that was another measure of disagreement in the last round decreased from 0.65 to 0.48, which was enough to accept the results [27]. All the 29 alternatives revealed mean and median more than 5 (13 items were omitted) and these items were located in their order to build up the final matrix.

The final result of the Delphi process is shown in Table 3, in which the severity section yielded four categorizes of health, environment, asset and reputation consequences. Further, in the likelihood section, 5 levels were agreed which comprised of incident that often occurs in the investigated department of hospital during a year (level A), or in hospital (level B), at least one time in this hospital (level C), the same incident has happened at least in hospitals (level D) and it has not seen in any hospitals before (level E).

In this matrix, the most critical alternative in Health consequences was when it showed results in more than one fatality. Moreover, the most unfavorable aspect was extreme effect on environment of area in the environment category. Property damages were ranged from no damages to destruction which included stopping all activities in hospital more than one day. Finally, national or international effect and disassociation with stakeholders were agreed as the most important issue for hospital reputation.

Due to result of SPSS software, in the health consequences category, the forth level in the matrix "more than three days absence from work" had the least consensus among the panel members, in which mean and median were 5.10 and 5 respectively. Also three items had most consensuses with 5.80 and 6 as mean and median. In the in category of environment the same result occurred, in which "the effect on all stakeholders and more than one complaint" had the least consensus and three items had most agreement among the experts. Moreover, in the asset section, two items had least accordance among professionals, in which the mean and median were 5.20 and 5 and two had the most ranks with 5.90 and 6 as the mean and median. Finally, in the reputation section, there were the most consensuses on the first level (no effect was observed), in which the mean and median were 6 and three items had the least agreements by 5.10 and 5 as the mean and median.

Healthcare workers are exposed to a large number of hazards [28]. In addition to their health aspects, there are different issues like asset damages, environment and reputation aspects which have to be considered in hospitals. In this study, it was attempted to include all hazards mentioned by introducing a hazard matrix for assessing risk of them.

A hazard matrix is a risk assessment tool which can be applied to rank health, safety and environment (HSE) hazards with respect to their importance [29]. In this matrix, all parts of the industry like workers and departments were interconnected and hazards of different agents were analyzed and predicted [5].

In this study, a hazard matrix was introduced, in which different consequences were considered. First level of consequences in the matrix was comprised of two states of "no effect" and "without" which interfered near misses in accidents. In the category of health hazards, all health and safety problems that could result in consequence were considered. In this category, fatality and permanent disability due to their long continuous effect on individual life or his family selected as last levels of health hazards. Reputation consequence differs in every society, but in this study, with the help of the panel experts, various kinds of reputation aspects with respect to our society were proposed that showed its adequacy to assess hazards in this one. Furthermore, in this study, in reputation consequences, stakeholders' values were considered as an important part of decision making. Similar to the present study, a hazard matrix was built with respect to health, safety and environment hazards by the help of the selected board to recognize and prioritize risks in industries by Haddad et al. (2012) [29].

Table 3: The hazard assessment matrix; the result of the Delphi process

	Severity of consequence				Likelihood				
	Health	**Environment**	**Asset**	**Reputation**	A	B	C	D	E
0	Without any injuries	No effect was seen	Without damages	No effect was seen	L	L	L	L	L
1	Minor injury to individual	Minor effect on environment neighborhood	Minor damages	Local effect	M	L	L	L	L
2	Less than three days absence from work	Specified effect on environment	Halt in one department for less than two hours	Media effect and at least one complaint	M	M	L	L	L
3	More than three days absence from work	Major effect on environment neighborhood	Halt in one department and disturbance in other ones	Effect on all stakeholders and more than one complaint	H	M	M	L	L
4	Permanent disability or Death	Sever effect on local environment	Stop all activities in one department	National effect and raise in civil liability insurance	VH	H	M	M	L
5	More than one fatality	Extreme effect on environment of area	Stop all activities in hospital more than one day	National or international effect and disassociation with stakeholders	VH	VH	H	M	M

However, the aim of this study was to achieve an applicable hazard matrix to rank and evaluate hazards in hospital. Donoghue also designed a hazard assessment matrix for ranking occupational health risks in the mining industry, in which only one category was investigated [7]. In some studies, a job hazard matrix was introduced [4]. In the present study, four categories of hazards including health, environment, asset and reputation were analyzed. Unlike other studies which concluded HSE aspects, in this study, all possible aspects like HSE, asset and reputation were considered [5].

4. Conclusion

According to results, Hazard Identification based on Delphi method benefited inclusive items required to carry out hazard identification process. Although this available study was built up for Hazard Identification of hospital, its complete performance can be obtained from its adequacy for its end-users which require to delineate it for different practices and achieve feedback from them [30].

Authors' Contributions

M.B., conducted the field work and wrote the manuscript; N.M. and A.A., conducted the study and wrote the manuscript; M.B., analyzed the data and wrote the manuscript; M.B., revised and approved the final manuscript.

Conflict of Interest

The authors report no conflict of interest.

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