Designing a Questionnaire to Assess Crisis Management Based on a Resilience Engineering Approach

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Abstract

Introduction: Awareness and preparedness for prevention of crisis plays an important role in minimizing its impacts and fatalities. This study suggests how to enhance the efficiency of crisis management through applying a Resilience Engineering (RE) approach .The aim of this study was to design a questionnaire to assess crisis management based on RE approach.

Methods and Materials: In this descriptive survey, four principles of Resilience Engineering including top management commitment, flexibility, learning and awareness were assessed using a self-designed questionnaire. This research was conducted in seven public hospitals in Iran in the year 2013, and 113 nurses completed the questionnaires. Data were analyzed using SPSS software. Reliability was assessed by internal consistency (Cronbach's alpha), and intraclass correlation coefficient analyses. Furthermore, content, and face validity were assessed and the factor structure of the questionnaire was extracted by performing exploratory factor analysis.

Results: The mean age of participants was 32.7 (SD=7.18) years. Reliability evaluation showed high internal consistency and good reliability. The Cronbach's alpha coefficient was 0.951 ($p<0.001$) and Intraclass Correlation Coefficient (ICC) was 0.95. The mean scores for the content validity index (CVI) and the content validity ratio (CVR) were 0.85 and 0.75, respectively. The results of exploratory factor analysis (EFA) indicated four factors for the questionnaire that jointly explained 69.9% of variance observed.

Conclusions: The findings of this study suggest that assessing crisis management applying a Resilience Engineering approach-based questionnaire is beneficial and advantageous in assessing crisis management in hospitals.

Keywords: Crisis management, Resilience Engineering, hospital, safety.

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Introduction

The worldwide natural and man-made disasters are significantly raised in the recent years (1), and the average extreme weather events have increased from 1900 to 2010 (2), to substantially affect people and organizations (3, 4). Natural disasters such as floods, earthquakes, volcanoes, wildfires, dust storms and excessive heat or cold as well as unnatural man-made disasters such as nuclear or biological incidents and accidents in nuclear power plants and the widespread car, airplane, train and ship crashes and wars occur around the world every day (5). As M. Orencio et al. stated in 2013 (6), "Droughts, floods and tropical storms accounted for roughly 100000 fatalities and caused 250 billion USD in 2005" (3, 4). Global economic crisis caused approximately 200 billion USD loss in 2012 and total losses were only slightly above the ten-year mean of 187 billion USD. Human fatalities caused by natural disasters was nearly 8,800 below the ten-year mean of 100,000 fatalities (7). These results imply that the plans and programs for decreasing effects of disasters in fatalities and economic were not adequate and effective.

Disaster is defined as a sudden extraordinary event that makes great damage, loss, destruction and affects great number of people and their environment (8, 9). Disasters are huge, uncontrollable (10) and can produce large-scale disruption of societal infrastructure and the normal healthcare system, presents immediate threat to public health (9) and result in an interruption in normal healthcare delivery, and the ability to respond to disaster victims (11). Since hospitals are the final point in the rescue chain (12), their preparedness and alertness should radically increase. A successful disaster response can be enhanced through disaster management preparedness (11) and applying new approaches such as Resilience Engineering. Disaster management preparedness is used in disaster management plans to define a formal plan of action to enable the hospital staff respond to the disasters and their aftermath effectively (9).

In recent years, Resilience Engineering approach has come to be regarded as an important field among safety and management approaches (13). Resilience can be defined as an ability to survive and cope with a disaster with minimum disturbance and damage (14). It is also the ability of systems to respond suitably to unforeseen demands and situations to return to the status which was existed before the disturbance and continue normal operations (15), also to advance the state through learning and adaptation (14). There are four principles considered for Resilience Engineering: top management commitment, flexibility, learning and awareness (16).

The aim of this study was to design a questionnaire to assess crisis management based on RE approach. We survey top management commitment, flexibility, learning and awareness of nurses toward RE in hospitals. The first hospital caregivers are emergency physicians and nurses. It is imperative that they possess adequate knowledge and skill about safety and crisis (17).

Resilience and Resilience Engineering

The origins of resilience concept come out of the ability to bounce back or (18) coping with complexity because of the result in many unknown situations. Resilience develops failure strategies, awareness toward ways to avoid failures, adopting ways and methods and learning about the potential paths. In addition, Carmeli et al. in 2013 on the principles of resilience stated, "failures are breakdowns in the normal adaptive processes needed to cope with the complexity of the real world, and that

success relates to organizations, groups and individuals who produce resilient systems that recognize and adapt to variations, changes and surprises" (19).

There are many ways to define resilience. One way is "the intrinsic ability of a system to adjust its operation before or following changes and disturbances, so it can maintain operations after an accident"(13). R Resilient systems or organizations must have the following four qualities and abilities: 1) reply to regular and irregular threats in a robust and flexible way, 2) monitor what is going on, including its own performance, 3) anticipate risks and opportunities and notice combine and affect events on each other, and 4) learn from experience (13, 20). Another definition for resilience is the ability of individuals, groups, or organizations to absorb strain (19), disturbance, undergo change (21), and ability of an organization to keep or recover quickly to a resistant state. So resilience includes the property to avoid failures and losses, and the property to reply effectively after these have occurred (21, 22). In hazards research, resilience is defined as "the ability to survive and cope with a disaster with minimum impact and damage" (14).

RE emerged from the principles of organizational reliability (23, 24) and studies based on how people and organizations try to anticipate paths that may lead to failure (25) and how learn, adapt, and create safety in an environment with hazards and crisis (26, 27). RE can be considered an alternative to conventional risk management approaches because these are inadequate for present-day systems (13). Based on various studies, Costella et al., 2009 (16) represented four principles for RE that included:

a) Top management commitment: this shows demonstrating a devotion to health and safety or to the same scope as the other objectives in organization (16) and represent commitment towards addressing human performance concerns (28).

b) Flexibility: because of individual and organizational pressures, human errors are unavoidable (16, 29, 30), therefore work system design must be flexible and should support the natural human strategies for coping with hazards (31). Flexibility is the ability of organization to adapt with problems in ways that maximize capacity to solve problems (28). Meanwhile, flexibility can be defined as an ability in people in making significant decisions without having to wait for management instructions and guidance's (22, 27).

c) Learn from both incidents and normal work (learning): RE corroborates comprehension normal work rather than just learning from incidents, in order to learn and publish and spread successful working strategies (16, 32). Learning requires organizational environments and instructions that encourage the reporting of incidents, errors, and recognizes adaptive strategies, although not tolerating punishable behaviours and actions (22, 27). Jeffcott et al., 2009 defined learning culture as "Organization response to events with repair and true reform rather than denial" (28).

d) Awareness: Staff should be aware both of their own current status and the status of the answer in organization in crisis situations. This is important for anticipating future changes in the environment that may affect the ability of system to operate (16, 32). Awareness is data collection that provides management with insights about the quality of human performance, the scope of a problem and the current state of the defences (28).

Methods and Materials

A descriptive survey was used to explore the perception of principle of Resilience Engineering in hospitals. To identify and

establish a common understanding of the underlying causes of hospital problems and challenges faced by nursing staff, we designed a questionnaire. Expert consultations and literature review were undertaken at first. As part of a large research project, we accessed seven hospitals. We asked them to complete a structured questionnaire. Responses were on a five-point Likert scale (ranging from 1= very low to 5= very much). The descriptive survey among the nurses who worked in various hospitals in Ahvaz City was conducted. The aim of this study was to design a questionnaire to assess crisis management based on Resilience Engineering approach. Collection of the data was performed by designing a special questionnaire. The questionnaire has mainly two parts with various questions on principles of Resilience Engineering about crisis management preparedness. The first part contained information about demographic data like name of hospital, age, sex, work experiences, etc. The second section was about top management commitment, flexibility, learning, awareness of employees on crisis management preparedness. The samples of this research included 113 nurses from seven hospitals in Iran in the year 2013. The questionnaire was developed by a review of questionnaires. In this study, a self-administered questionnaire was used to assess four principles of Resilience Engineering. The questionnaire consisted of 26 items distributed into four dimensions: Top management commitment (14 items), awareness (6 items), flexibility (3 items) and learning (3 items). The scale of answers ranged from one to five (very low to very much) and the items were grouped into four categories: awareness, flexibility, learning and commitment of management. All data were analyzed using SPSS statistical software.

2.1 Validity:

2.1.1 Face validity

The validity of questions was confirmed by eight specialists in occupational health and safety. Also using item impact method, the importance of each item was calculated through the judgment of 8 experts and items with score of 1.5 and more remained in the tool (33).

2.1.2 Content validity

To assess content validity, the tool was reviewed by eight experts. Also content validity ratio (CVR) was determined through 8 experts` judgment, and based on Lawshe`s table (34), items with the score of 0.75 and more remained in the tool. Content validity index (CVI) was determined by eight experts using a four-point scale described by Waltz and Bausell. The score of 0.80 was considered as the least acceptable CVI (33).

2.1.3 Construct validity:

Exploratory factor analysis (EFA) was performed to determine the underlying constructs of the questionnaire (35).

2.2 Reliability:

Reliability refers to the repeatability, stability or internal consistency of a questionnaire (36, 37). The reliability study shows the degree of internal consistency between the multiple variables that make up the scale, and represents the extent to which the items of the scale are measuring the same concepts (37). The reliability of the questionnaire was assessed by its internal consistency. For guaranteeing the maximum reliability of the scales proposed, the authors calculated Cronbach's coefficient (38, 39). If the items show good internal consistency, Cronbach's alpha should exceed 0.70 for a developing questionnaire or 0.80 for a more established questionnaire (37, 40, 41). To determine reliability, intraclass correlation coefficients (ICC) were used; values of 0.70 and higher show reasonable reliability (42).

2.3 Ethical considerations:

The study was approved by the Research and Ethics Committees at the University of Iran; The University Research Committee at the Ahvaz Jundishapur University of Medical Sciences. Participation on the study was voluntary and based on informed consent.

2.4 Data analysis:

Raw data were entered into SPSS15. The analyses included descriptive statistics to determine sample characteristics and distribution of responses about each research question.

Results

For the instrument validation, 113 nursing staff participated in the study. The purpose of this study was to design a questionnaire to assess crisis management in hospitals based on Resilience Engineering approach. Of the 150 distributed questionnaires, 113 were returned, resulting in 75.3% response rate. Empty and incomplete questionnaires were excluded from the study sample and the data analysis (n=37). The mean age of participants was 32.7 (SD=7.18) years. In this survey, 92% of respondents were female. Table 1 provides descriptive statistics for the questionnaire. (Table 1)

For Reliability analysis, Cronbach's alpha Coefficients were calculated for the scale and subscales (43). Cronbach's alpha internal consistency reliability for the original instrument was 0.951. In addition, Cronbach's alpha internal consistency reliability was calculated for four items, which were 0.871 for the awareness subscale, 0.769 for the flexibility subscale, 0.845 for the learning subscale and 0.865 for the commitment of management subscale.

For repeatability and to determine reliability, intraclass correlation coefficients (ICC) were used; values of 0.50 and higher show reasonable reliability. Results show that the ICC was 0.95. Table 1 provides results of Cronbach's alpha and ICC for items of questionnaire. (Table 1)

Face validity was determined using experts' opinions to correct the tool. The importance of each item was also calculated through item impact method based on experts' judgments. The scores of all the items were more than 1.5 (33).

Content validity was determined using experts' opinions to correct the tool. CVR and CVI were also calculated based on experts' judgments. CVR score was 0.75 and more for each item, CVI for each item was at least 0.80 and for the whole tool 0.85 (33).

Construct validity was evaluated by exploratory factor analysis (EFA). The Kaiser-Meyer-Olkin (KMO) and Bartlett's test demonstrated that the data was proper for factor analysis (KMO index=0.88, approx. Chi-square=1.85, df=325, P<0.001). Main component analysis with varimax rotation identified four factors with eigenvalues greater than 1 and factor loading equal or greater than 0.4; explaining 69.9% of variance observed (Table 2) (44). The results obtained from exploratory factory analysis are demonstrated in Table 3.

Table1: Results of questionnaire (descriptive statistics for the questionnaire) and results of Cronbach's alpha and ICC for items of questionnaire

Items	Mean	Std. Deviation	Cronbach's coefficient	ICC
Commitment of management	3.25	0.57	0.865	0.865
Awareness	3.17	0.69	0.871	0.843
Flexibility	3.26	0.73	0.769	0.769
Learning	3.15	0.83	0.845	0.845

Table 2: Component Transformation Matrix

Component	1	2	3	4
Commitment of	.71	.647	.261	.091
management	-.587	.745	-.153	-.277
Awareness	-.182	-.105	.895	-.393
Flexibility	.343	-.122	-.327	-.872
Learning				

Table 3: The results obtained from exploratory factory analysis of questionnaire (component matrix)

Component Matrix[a]

	Component			
	1	2	3	4
Q1	.743	.356	.012	-.024
Q2	.781	.252	-.221	.054
Q3	.764	.275	.008	-.074
Q4	.583	.353	-.040	-.071
Q5	.309	.433	.403	.492
Q6	.781	.341	-.081	-.181
Q7	.666	.318	.017	-.476
Q8	.663	.158	.364	-.276
Q9	.394	.686	-.133	.117
Q10	.846	-.014	.036	-.002
Q11	.725	.199	.323	.292
Q12	.757	.107	.135	.032
Q13	.754	-.280	.028	-.224
Q14	.756	-.353	.010	-.145
Q15	.816	-.335	-.099	.023
Q16	.770	-.068	.138	.405
Q17	.808	-.218	-.073	.222
Q18	.724	-.373	-.006	.201
Q19	.822	-.370	-.088	-.020
Q20	.470	-.430	.600	.070
Q21	.652	.377	-.106	-.056
Q22	.699	.167	.324	-.152
Q23	.572	-.047	-.475	.318
Q24	.749	-.403	-.137	.046
Q25	.811	-.317	-.069	-.060
Q26	.644	.264	-.199	.265

Table 4: Questionnaire

Top commitment management	To what degree do managers are able and updated in identifying and predicting probable difficulties in crises?
	To what degree are managers successful in setting up or developing a crisis committee, in executing periodical maneuvers and training quantitatively and qualitatively staff about crisis management?
	To what extent are managers successful in efficiently planning actions to timely evacuate or permit patients and provide physicians preparedness in crises?
	To what degree have managers proceeded on automating routine or complex acts? (software and hardware systems)
	To what extent do managers ignore procurement of maintenance services and health and safety at work caused by expensiveness (of economic)?
	To what extent do managers successful read the reports of events and near miss?
	To what degree is staff participation by management beneficial? (Each employee is responsible for the safety).
	To what extent do managers take actions to coordinate and communicate with the various departments of hospital, cut paperwork and long administration process in crises?
	To what extent are systematic programs or software system well defined to register and keep patient's information for the patient's pursuit in all the treatment steps?
	To what extent are managers able to reduce the risk of communication with people and give suitable information to media in crises?
	To what degree do you evaluate medicine operational management in the step before the entrance of patients to the hospital? (including sending physician and transmission of facilities to the location of crisis)
	To what degree do you evaluate managing of prevention, controlling of contagious maladies, vaccination and controlling mothers and infants' maladies in response to crisis?
	To what extent do managers take proper actions to set up a health and safety system and to evaluate the risk management?
	To what extent does hospital use qualified and experienced workforces in crises?
Learning	To what extent does organization pay attention to maintenance or reformation and inspection in lieu of denying of events and ignoring equipment imperfections?
	Does the hospital pay attention to similar/dissimilar occurrences and events in other hospitals in local, national and international levels and use their ideas and measures in crises?
	To what degree sharing information occurs?
Awareness	To what degree is data gathering from individuals' quantified and qualified performance, knowing how to perform personnel duty in crises?
	To what degree is data gathering from quality and quantity view of safety equipment in crises?
	To what degree do you evaluate data gathering and information about the range and extension of crisis occurrence and documentation?
	To what degree is sharing information from managers to personnel and vice versa?
	To what degree is waiver from routine surveys and contravention each instruction by personnel?
	To what degree do you evaluate gathering data related to crisis management from organizations and the communication and coordination with them?
flexibility	To what degree do you evaluate personnel safety instructions in responding well to crisis?
	Does planning facilities and obtaining them affect response to crisis?
	To what extent is hospital able to match and solve the complex and new problems without any interruption in its routine performance in crises?

Discussion

The aim of this article was to present a new questionnaire for assessing crisis management based on Resilience Engineering approach in hospitals in Iran. To develop the questionnaire we used the four principles of resilience represented by Costella et al., 2009 (16). The questionnaire consisted of 26 items grouped into four categories: Top management commitment (14 items), awareness (6 items), flexibility (3items) and learning (3items). The scale of answers ranged from one to five (very low to very much) on Likert scale. The results showed that the questionnaire is a valid and reliable instrument for assessing crisis management. Additionally, this research provided interesting information for researchers and practitioners since it identified the main tool that needs to be used to improve safety and preparedness for crisis. This paper surveyed four factors as follows:

Factor 1: Top management commitment

This factor contained 14 items and explained 12.9% of total variation in the factor analysis. This group of items indicated the management should develop safety and preparedness for hospital in crises. Since the management's commitment has a negative effect on work pressure and a positive effect on incentives and communication, managers should commit to develop safety in workplace. They can make use of strategy reward for employees' safety behavior. In addition, transmission of the safety information from managers to employees result in employees to be able to do their work with a maximum safety (39). Fernández-Muñiz et al. (2012) showed that management's commitment, and particularly communication, have an effect on safety behavior and performance(39).

This research confirmed the important role of the managers in set up crisis committee and preparedness for crisis. Administrating safety training for employees and performing maneuvers help managers make hospitals that are more resilient. Huang et al., 2012 investigated management commitment to safety as compared to employees' perceived safety training and its association with future injury. They concluded that the variable of employees' perceived safety training could be a proximal predictor for future injury outcome, which mediated the relationship between employees' perceived management commitment to safety, and injury outcome. When employees realize that their managers have high level of commitment to safety, they will believe in the value of safety training (45).

Managers can make use of safety and health management systems and Resilience Engineering approach to increase safety and hospital capacity against crises. Some researches indicated that Resilience Engineering could rise hospitals capacity in crises. Nemeth et al., 2008 presented examples of resilience on the response of the staff of an emergency department to surges in patient volume and design improvements to the infusion device control/display interface. They showed that resilience can improve the ability of health care systems to respond adequately to raising demands (46).

Factor 2: Learning

This factor consists of three items and explains how to learn from both incidents and routines (16, 32). Learning requires organizational environments and instructions to encourage reporting of incidents, errors, and to recognize adaptive strategies (22, 27). In addition, organizations must pay attention to maintenance and inspection of equipment in lieu of denying of events and ignoring equipment imperfections. Hospitals should pay attention to similar or dissimilar occurrences and events in other hospitals in local,

national and international levels and make use of their actions in crises. They can use sharing information between hospitals and learn from their actions when encountering crises. Furthermore, greater attention has been paid to the development of educational content for health care and first responders (47). Other cases that can be taken into consideration include poor skills, lack of a clear definition of responsibilities, unsafe hospital environment and equipment, incidents of unexpected events. Learning from these cases is important to promote quality in patient care and to determine crisis management activities (48). The results of our study indicated that hospitals did not apply Resilience Engineering approach but managers were familiar to principles of crisis management; thus, they have used these principles for preparedness against crisis and somewhat learning from past events could be of help to them.

Factor 3: Awareness

This factor consists of six items and indicates that managers should be aware of the quality and quantity of human performance (28) and how to perform personnel duty in crisis situations. Also, managers sharing information with personnel and vice versa plays an important role in raising coordination between them in solving problems in crises. Moreover, this factor indicates that when crisis occurs, managers must be scheduled for data and information gathering on the range and extension of crisis occurrence and documentation. They must collect information related to crisis management from organizations and communicate with them.

Factor 4: flexibility

This factor consists of three items and explains that the design of a work system must be flexible and should support the natural human strategies in coping with hazards (31). Flexibility is the ability of organization to adapt with problems in a way that maximizes capacity to solve the problem (28). Adaptation is an important element in the RE perspective. The capacity to adjust and adapt include knowledge in terms of anticipation (what to expect), attention (what to look for), and response (what to do). Adaptation is an essential means to face and cope with change and unexpected events (49). In a study, Jeffcott et al., 2009 indicated hand-on example of flexibility: Allowing certain frontline clinical groups admitting privileges when senior staffs are absent in order not to delay patient treatment in emergencies (28).

In this paper, we surveyed personnel's safety instructions learning in response to crisis and planning facilities and obtaining them. H Hospitals must to be able to match and solve the complex and new problems without interruption in their routine performances in crises. A major advantage of our study was that we designed a questionnaire for establishing relationship between crisis management and Resilience Engineering in hospitals. In other studies, crisis management and Resilience Engineering have been surveyed separately. A major limitation of our study was that we did not study and survey all the employees in various jobs in the hospitals.

The major recommendations of our study include paying more attention to raising awareness of staff through training courses. Another research shows that many medical and nursing professionals lack the knowledge and management skills required in crisis management and Resilience Engineering (11, 50). Therefore, managers should apply new information obtained in other hospitals in dealing with crisis and to learn various methods in preparedness for crisis and improve the staff's skills. Likewise, government should help to start and improve trainings on RE to raise the

capacity of resilience and crisis management.

Conclusions

Resilience Engineering is expected to have a significant impact on raising safety and reducing accidents. In this light, this study highlights the importance of Resilience Engineering approach in crisis management. According to the result of this study, we could assess crisis management based on Resilience Engineering in hospitals. Various factors affect safety performance in hospitals, including adequate knowledge and updated information for identifying and predicting the probable difficulties in crises. Sharing information between hospitals and data gathering from organizations plays an important role in rising awareness and preparedness in hospitals. Moreover, the role of management commitment is vital in creating a resilient and flexible hospital. Managers can apply training courses on safety and crisis management and Resilience Engineering for rising awareness and preparedness among employees. This is imperative that all personnel participate in training courses. On the other, improving safety, culture and attitude and creating suitable safety climate can increase safety and reduce injuries.

In this study, we designed a questionnaire that surveys all above cases. In conclusion, the finding of this study indicated that the questionnaire assessing crisis management based on Resilience Engineering in hospitals is a reliable and valid instrument for evaluating crisis management. Suggestions for future researches include separate and broader studies on four principles of Resilience Engineering. A checklist can also be designed for structure and non-structure indexes in hospitals, because these indexes influence safety and resilience of hospitals and can be used with this questionnaire simultaneously. Finally, effects of RE training in reducing errors and in increasing preparedness for crisis can be surveyed.

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