QuEP: Building a Continuous Improvement of Emergency Plans Management

Ana-Gabriela Núñez
ISSI-DSIC
Universitat Politècnica de València, Spain
anunez@dsic.upv.es

Mª Carmen Penadés
ISSI-DSIC
Universitat Politècnica de València, Spain
mpenades@dsic.upv.es

José H. Canós
ISSI-DSIC
Universitat Politècnica de València, Spain
jhcanos @dsic.upv.es

ABSTRACT

While different governments worldwide have published sets of recommendations-or even laws-for increasing preparedness, a reference framework to assess the level of compliance of organizations is still to come. For instance, emergency plans often remain stored in closets where they stay until some emergency or major legal change occurs. Consequently, achieving actual preparedness is difficult to assess.

QuEP is a framework for the assessment and improvement of the management of emergency plans within organizations. It is inspired by the Total Quality Management strategy, and provides a hierarchy of emergency plan management maturity levels. The aim of QuEP is to guide organizations to assess and improve their emergency preparedness by following a set of principles, practices and techniques at the technical, human and strategic levels. In this paper, we show the model underlying the framework, and give details of the current framework evaluation processes.

Keywords

Emergency Plans Management, Maturity Levels, Expert Evaluation.

INTRODUCTION

Increasing protection of people and property is the overall goal of most of the emergency preparedness activities performed by organizations; among them, the elaboration of an emergency plan holding all the knowledge required to respond to the different hazards is of particular relevance. In fact, the need for such a plan has reached law-based mandatory status in many countries. In some of them, the content and management guidelines are stated in nation or state level laws, whereas in others they are just released as guidelines that organizations should follow. In both cases, the minimum content of plans is specified along with the procedures to register, maintain and use the plans. Examples of these sets of rules are the "Comprehensive Preparedness Guide" (CPG) 101, published by Federal Emergency Management Agency (FEMA) in the United States of America (USA)(CPG, 2010), the United Kingdom's "Guidance-Emergency preparedness" (UK, 2014), and the "Self-protection Law" (NBA, 2007) in Spain.

Despite the relevance of the emergency plan in the overall emergency management lifecycle, little attention has been paid to aspects related to the assessment of the quality of current plans. As a consequence, planners develop their plans without a reference framework allowing the assessment of the artifacts developed and providing mechanisms for the improvement of plans. But defining quality of emergency plans is not easy:

different communities have different views of quality, and a global quality model is still to come. In the meantime, however, we can look at the activities that the organizations perform to manage their plans to increase their preparedness. While in some cases an emergency plan is just printed and stored in a closet with the hope of not being used in the future-leaving the organization members to a clear under-preparedness state, in other cases some organizations show a proactive behavior that includes several activities aimed at keeping their members ready to respond to any type of adverse event.

QuEP is a framework for the maturity-based assessment of emergency plans management. It can be used to evaluate the planning process, and analyze the capabilities and all activities involved before, during and after the process of implementing an emergency plan in an organization.The foundation of the framework is the Total Quality Management, or TQM for short. TQM is an integrated effort designed to improve quality performance at every level of the organization (Charantimath, 2011; Oakland, 2003). It is viewed as a continuous way of life and a philosophy of perpetual improvement in everything the organization does. The TQM strategy is defined in terms of sets of principles, practices, and techniques (Dean and Bowen, 1994; Mandal, 2009).

The QuEP's core is a hierarchy of maturity levels that was introduced in an early stage of development in (Núñez et al., 2015). In this paper, we describe a more elaborated version of the maturity hierarchy and present in detail the quality model underlying QuEP. Specifically, we show the stakeholders involved in the quality management process, and the sets of principles, practices, and techniques that are present at the different levels of the maturity hierarchy. Given the large size of the sets, we focus in two particular principles to illustrate how QuEP works.

To assess the adequacy of QuEP to the needs of the different stakeholders, we have designed a Delphi process (Linstone and Turoff, 1975, 2011) for the evaluation of the framework. Our goal is to evaluate our proposal by professionals in planning and emergency management domain. This validation will eventually drive to changes in the model that will be part of a further version. We describe the design and implementation of the process, which is currently active.

This paper is organized as follows. Section 2 provides some background on quality management in different domains, including emergency management. Section 3 describes the development process of the QuEP framework, focusing on the QuEP maturity levels hierarchy. Section 4 introduces the QuEP Model, including the stakeholders, emergency plans management activities, principles, practices, techniques; it also includes the questions we defined to create the QuEP questionnaire to assess the maturity of organizations. Section 5 shows the expert evaluation method that is currently active to validate the QuEP proposal. Finally, Section 6 concludes the paper and outlines our further work.

RELATED WORK

There are diverse domains where frameworks and/or models for evaluating quality have been defined in the past. Such models are essential instruments for organizations helping in the search of solutions that improve their processes. Defining a model that accurately adapts to a domain is often difficult, as pointed out by (Foshay & Kuziemsky, 2014). In the healthcare domain, a Business Intelligence maturity model that addresses the characteristics and needs of healthcare organizations for improving them was introduced in (Brooks, El-Gayar, and Sarnikar, 2015).

Also, in specific domains, the models are essential instruments for the organization, helping to find better solutions. For example, in IT management, maturity models allow for a better positioning of the organization and help find better solutions for change (Becker, Knackstedt, and Pöppelbuß, 2009). Moreover, maturity models in IT management help to the organization in the performing of the evaluation from different perspectives, making it suitable for collaborative evaluation (Santos et al., 2011).

In the emergency management field, there are few research works focusing on quality aspects of the different stages of the Emergency Management lifecycle. We mention here the work of Berke and Lyles about quality of emergency plans; the discussion about what constitutes a good plan, and the importance of including principles related to plan quality in a conceptual framework is mentioned in (Berke and Godschalk, 2009; Lyles, Berke, and Smith, 2012). Finally, Meyerson (Meyerson, 2012) proposed a method for the development of a tool for the evaluation of plan quality of local governments.

So far, many research efforts have focused on the definition and improvement of planning models, methods and the associated tools, but a reference framework allowing the assessments about the capabilities of organizations with regard to emergency plans management is missing. This is the main focus of our current work, which is

described in the following sections.

THE QUEP FRAMEWORK

QuEP is a framework rooted on classical approaches to Quality Management; specifically, the Total Quality Management (TQM) has inspired its design and development process, described in BPMN notation (Weske, 2012) at Figure 1. After a detailed study of TQM approaches, we defined the QuEP Maturity Levels hierarchy. From there, we defined the so-called QuEP Model, which consists of a set of principles, practices and techniques allowing organizations to scale up levels in the maturity hierarchy. Then, the QuEP model evaluation is done following an iterative Delphi process where experts in different aspects of emergency management are involved. Finally, the QuEP Model is released after the expert evaluation rounds. We explain each subprocess in more detail below.

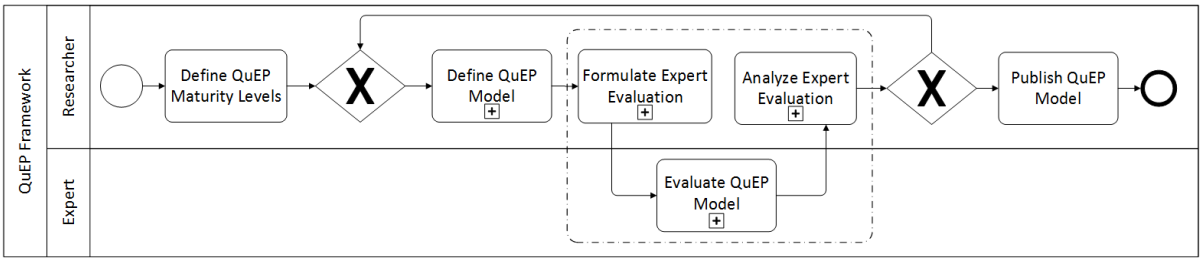

Figure 1. Development Process for the QuEP Framework

The QuEP Maturity Levels hierarchy

The QuEP Framework is intended to serve as a foundation for the continuous improvement of emergency plans management (Núñez et al., 2015). It is composed of ten maturity levels ranging from level 1 (representing the lowest maturity degree) to level 10 (the highest). The framework is depicted in Figure 2. Following (Camison, 1998, 2007), the levels can be grouped into three main categories or stages, namely Technical, Human, and Strategic.

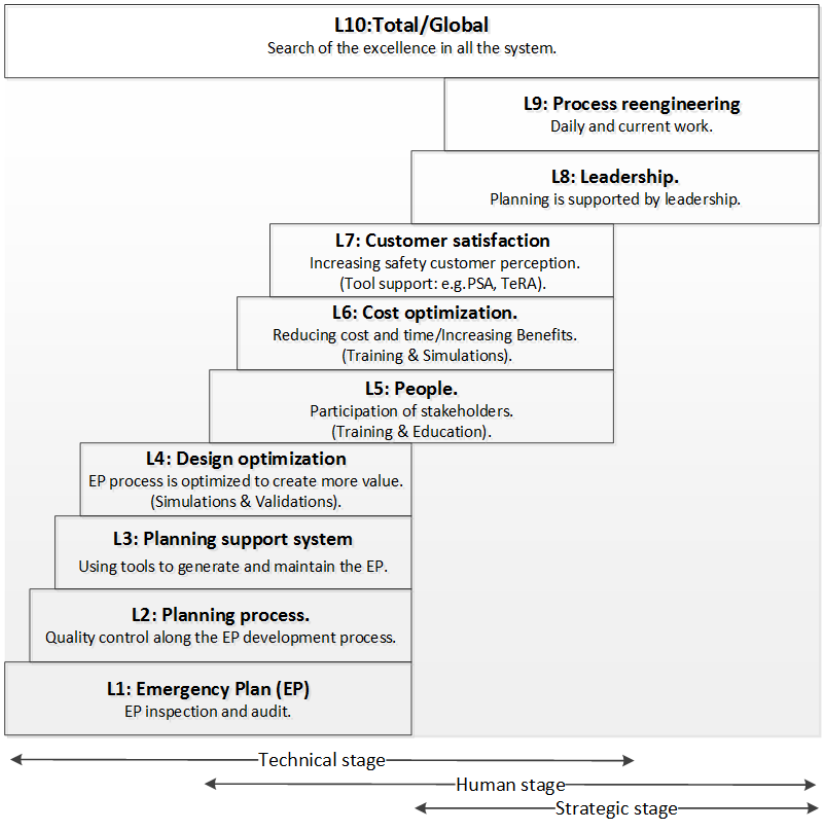

Figure 2. QuEP Maturity Levels

The hierarchy starts at the lowest level (L1), which assess the organization capacity to generate an emergency plan following the regulations, if any. L1 organizations have not defined any structured plan generation process, and planning is done in an ad-hoc style. In the upper levels, different improvements are assessed. L2 organizations have a specific and repeatable planning process that guides the planning activities. The level L3 is reached when a planning support system implementing the process defined in level L2 is used. The level L4 can be reached when there are different mechanisms for the improvement of the planning process and the plan itself, such as simulations and expert validation. Level L5 assesses the participation of the people involved in emergency plans generation and enactment, principally via training and education activities. Cost optimization is the main goal at level L6. Level L7 focuses on increased safety perception by potential victims of emergencies; it can be achieved by providing IT tools for early warning, evacuation assistants, and the alike. Level L8 covers leadership aspects. Level L9 uses process re-engineering techniques to improve the emergency planning process. The topmost level (L10) represents the excellence that an organization should reach to achieve the Total Quality.

THE QUEP MODEL

The QuEP Maturity levels are supported by a model to assess the planning process in an organization, called the QuEP model. Figure 3 shows the *Define QuEP Model* subprocess from Figure 1 that illustrates the steps followed to identify and define model components. Each task is explained in more detail below.

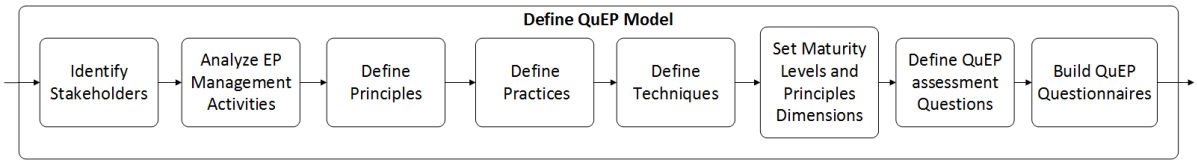

Figure 3. Define QuEP Model subprocess

Stakeholders

First of all, the stakeholders involved in the emergency plan management activities were identified. The QuEP model is organized around these stakeholders and their responsabilities (or roles) (Turoff et al., 2004; Turner, 1976). We recognized five different stakeholders, listed in Table 1. The organization managers are the ultimate responsible of plan management, and, as a consequence, are mostly involved in administrative and strategic tasks. The technical aspects of plan management are responsibility of planners, who use tools of different levels of sophistication to build the plans. The organization staff, that is, the people that work at the different departments of the organization, are involved in training activities so that their preparedness level remains adequate at any moment. The citizens, that is, the users of the services provided by the organization, must be able to access to the fragments of the plan that are relevant for their self-protection. And finally, the members of the different response teams need to access the parts of the plan that contain knowledge related to their specialities, as well as to participate in training sessions if needed.

Stakeholders	Responsibilities
Organization	• Access to emergency management legislation. • Plan registration. • Validation. • Education.
Planners	• Plan design and generation. • Notification of planning activities to the organization • Use of planning support tools.
Workers	• Participation in the planning activities. • Education and training.
Citizen	• Access to plans. • To follow the instructions of responders.
Responders	• Access to emergency plan. • Education and training. • Response.

Table 1. Summary of stakeholders and their responsibilities

Emergency Plan Management Activities

In the *Analyze Emergency Plan Management Activities* task, we analyzed the different activities performed during the emergency plan management. The input of this task includes the stakeholders and the legal regulations the organization must follow. For instance, we identified "deliver the emergency plan", "emergency plan must be based on standards and formats", "the organization must consider risk aspects", "authorities must disseminate emergency plan", "emergency plan must define teamwork and assign responsibilities", "emergency plan must specify inter-organizational coordination", "emergency plan must include goals and vision (objectives)", among other activities.

Principles

In the *Define Principles* task, we defined nine principles that guide the emergency plan management process following ideas from (Dean and Bowen, 1994). The principles are summarized in Table 2 and respond to the different viewpoints that can be applied to the development and maintenance of emergency plans. First of all, the development of any plan must be driven by the risk affecting the organization owner of the plan. The emergency plan must clearly define how it should be implemented. Additionally, all the stakeholders must participate in one way or another in the management of the emergency plan according to their responsibilities (shown in Table 1).

Principles	
(A) Risk Driven	The emergency plan is based on the analysis and study of the risks associated to a given organization.
(B) Implementation	The emergency plan must clearly define how it should be implemented.
(C) Participation	The emergency plan should be developed with participation of all the stakeholders.
(D) Monitoring and Continuous improvement	The emergency plan must continuously be evaluated and revised.
(E) Cooperation	Inter-organizational coordination is key in emergency management, resulting sometimes in joint plans.
(F) Safety People	The emergency plan elaboration must take cultural aspects into account.
(G) Leadership and Policies.	Risk and emergency management are very important axes within an organization and, as such, an emergency plan must include policies to handle them.
(H) Results of objectives	Goals must be clearly stated and work must be oriented to their fulfillment.
(I) IT & Innovation	Information technology significantly improves plan development.

Table 2. Summary of Principles

The quality of a plan must be continuously assessed and, if possible, improved using different techniques we will describe later. The plan is the result of the collaboration of the different stakeholders at intra and inter-organizational levels, sometimes resulting in plans built by aggregation of different component plans.

Being the goal of a plan to be an instrument for the protection of people, every social and cultural aspect of protection needs to be considered. Similarly, having clearly defined protection policies within an organization is crucial for the development of the plan. Such policies should be defined as a response to the strategic goals the organization sets at the beginning of the process. Last, but not least, the use of IT-based tools may result in a significant qualitative improvement of the efficacy of plans.

Practices

Each of the principles listed in Table 2 are implemented by means of sets of practices or activities performed during the emergency plan management. The *Define Practices* task covers this aspect. We have identified up to 26 practices associated with different principles. Table 3 shows the summary of principles and its most important practices. Due to space limitations, we will describe only two practices in the rest of the paper: the "Risk Analysis" practice, associated to Risk Driven principle, and the "Emergency drills" practice associated to the Monitoring principle.

EP. Principle	EP. Practice
(A) Risk Driven	• Risk analysis (Hazard, vulnerability and capability analysis and assessment). • Optimizing requirements of risks.
(B) Implementation	• Control in the development. • Cost of training and Timeline. • Analyze organizational resources.
(C) Participation	• Stakeholders involved. • Personal Training. • Teamwork and Roles.
(D) Monitoring and Continuous improvement	• Emergency drills. • Resource improvement and maintenance. • Process improvement. • Process for updated EP.
(E) Cooperation	• Inter-organizational coordination. • Coordination/Comunication.
(F) Safety People	• Analyze customer requirements. • Customer perception.
(G) Leadership and Policies.	• Standards and formats laws. • Leadership style . • System responsibilities. • Diffusion plan by authorities.
(H) Results of objectives	• Goals and Vision (Objectives). • Customer satisfaction. • Protection workers.
(I) IT & Innovation	• Tools support. • Information management & communication using IT.

Table 3. Summary of Principles and associated Practices.

Techniques

In the *Define Techniques* task we have identified a set of guidelines and recommendations associated with each practice. The organization should follow these techniques if the practices established for each maturity level are not covered. Techniques allow making effective their respective practices. Table 4 shows some examples of techniques. We identified 22 techniques for the "Emergency drills" practice, and 18 for the "Risk Analysis".

"Risk Analysis"	• Study the types of natural hazard and external risks by location and climate characteristics, occurrence and frequency. • Perform the appropriate identification and location of different risk elements that may cause an emergency. • Analyze people capability. • Include maps. • Analyze resources cost. • Analyze most vulnerable people. • Consider most vulnerable buildings/floors/zones. • Establish safe areas to ensure safety people in an emergency. • …
"Emergency drills"	• Perform an Emergency Drill. • Consider the costs of training and education. • The emergency plan should be describe the implementation and maintenance of the emergency drills according to the legal regulations. • Make public the planned emergency drills and its participants. • Have an emergency drills history. • Perform a report on the effectiveness of costs/resources involved in an emergency drill. • …

Table 4. Summary of Techniques

Maturity Levels and Principle Dimensions

The next task is *Set Maturity Levels and Principle Dimension*, in which the relation between principles and maturity levels are specified, with the goal of identifying what should be assessed in each level and what practices are affected. Figure 4 shows as example the detail to assess in each level for "A. RiskDriven" principle and "D. Monitoring" principle.

Dimensions		PRINCIPLES								
		A. RiskDriven	B.	C.	D. Monitoring	E.	F.	G.	H.	I.
MATURITY LEVELS	L10. Total/ Global									
	L9. Process reengineering	Risk analysis in daily activities and actual work			Continuous improvement in emergency planning exercises (Emergency Drills)					
	L8. Leadership	Direction style in the organization has the analysis of risks as a priority .			Detection of strengths and weaknesses from emergency exercises (Simulation and Training)					
	L7. Service	Specifying elements to increase the perception of safety by the risks analyzed.			Specify the necessary elements to increase the perception of safety by monitoring and continuously improving					
	L6. Cost optimization	Analyzing and optimizing costs related to the risks analyzed.			Optimizing costs of maintenance and updating of EPs, Training, Simulation, Emergency Drills.					
	L5. People	Analyzing people involved in the risk			Continuous assessment of people through Training and Education					
	L4. Design Optimización	Analyzing and optimizing the study of existing risks			Maintenance and continuous updating of EPs, analysis and development of emergency excersices (Emergency Drills)					
	L3. Planning support system	Analyzing Risks with any tool or structured system.								
	L2. Planning process	Defining a process for analyzing risks.								
	L1. Emergency Plan (EP)	Thorough analysis of all risks without any process.								

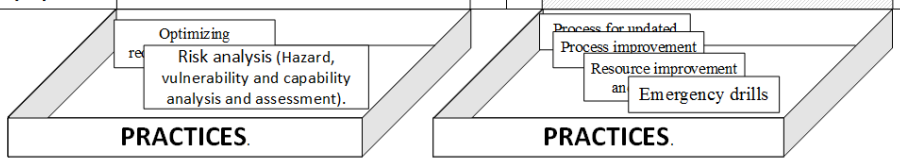

Figure 4. Maturity Levels, Principle Dimension and Practices.

While the Risk Driven principle has criteria defined for each maturity levels, the Monitoring principle does not have for levels L1 to L3 because there must be an emergency plan to start its continuous improvement. At the bottom of Figure 4, we show some practices identified for both principles: "Emergency drills", "Resource improvement and maintenance", "Process improvement", and "Process for updated Emergency Plans".

QuEP Questions

We use questionnaires to assess the organization according to QuEP. Therefore, the next task is to *Define QuEP Questions,* where a set of questions are evaluated for each practice. Table 5 shows some examples of the QuEP questions for the "Risk Analysis" practice of "A. Risk Driven" principle, and the "Emergency Drills" practice of "D. Monitoring" principle.

Risk Analysis	• Does the emergency plan specify the natural hazards that affect the organization? • Does the emergency plan specify the external risks? • Does the organization consider the costs of facilities and resources related to risks? • Does the organization consider the people's capacity in its facilities? • Does the organization consider the most vulnerable buildings/floors/zones? • Has the organization a good comunication between buildings/floors/zones? • Does the emergency plan use maps to specify the location of emergency elements? • Does the organización establish safety zones for evacuation? • Does the organization consider the most vulnerable people (childrens, disabled …)? • . . .
"Emergency drills"	• Has the organization performed any emergency drill? When? • Does the emergency plan describe the implementation and maintenance of the emergency drills according to the legal regulations? • Does the organization make public the planned emergency drills to all its members? • Does the organization perform the training and education to emergency response to all its members? • Does the organization include the costs of training and education in its budget? • Does the organization perform an analysis and report on the effectiveness of all cost and resources involved in a emergency drill? • ...

Table 5. Summary of Questions

Finally, in the *Build QuEP Questionnaires* task, the questionnaires are built to send to the organization from QuEP questions. At this point, we have formulated 24 QuEP questions for the "Emergency Drills" practice, and 19 QuEP question for the "Risk Analysis" practice. The completed QuEP questionnaires for these practices may be accessed in in the QuEP portfolio[1].

The QuEP Conceptual Model

Figure 5 summarizes the QuEP framework with a UML class diagram. There, the main entities of the model are represented as classes, and their dependencies as different types of relations (associations, aggregations and compositions). The principles (*Principle* class) are implemented as sets of practices (*Practice* class), which are in turn associated to specific maturity levels (*MaturityLevel* class) and performed by stakeholders (*Stakeholder* class). The techniques (*Technique* class) are part of the practices.

Our ultimate goal is the design and implementation of a tool for the assessment of the maturity level of organizations regarding emergency plans management; in other words, we want to make an implementation of

[1] http://quep.dsic.upv.es/preguntas/ (site in Spanish)

QuEP. Such a tool is defined in the form of a questionnaire that organizations must fulfill to be assessed. Such a questionnaire is represented in the model of Figure 5 by the *QuEPQuestion* class. For each practice to be evaluated, a set of questions has been designed. When all the instances of the *QuEPQuestion* class have been created, they are assembled in the questionnaires that are provided to the corresponding stakeholders, who will submit to the assessment server after their completion. In general, different stakeholders will receive different questionnaires since their views of the emergency plan management are different.

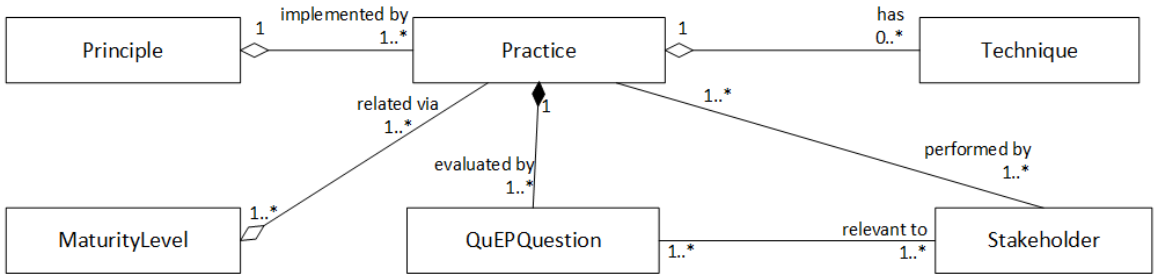

Figure 5. The QuEP Conceptual Model

THE EXPERT EVALUATION PROCESS

The QuEP model is being evaluated by experts in the emergency planning and management domain before its use in the assessment of actual organizations. The expert evaluation is based on the Delphi Method (Linstone and Turoff, 2011). This iterative method uses a series of questionnaires and multiple rounds to collect data from a panel of experts (Hsu and Sandford, 2007). After the questionnaire is returned, the researcher summarizes the results and analyzes them. Based upon the results, a new questionnaire for the respondent group is prepared and distributed. The number of iterations recommended to reach a consensus is three in most cases (Brooks, 1979; Ludwig, 1997; Custer, Scarcella, and Stewart, 1999).

Figure 6 shows the iterative expert evaluation process composed of three subprocesses: *Formulate Expert Evaluation*, *Evaluate Model QuEP and Analyze Expert Evaluation.* In the first subprocess, the research team proposes evaluation criteria and prepares the questions for the evaluation of every QuEP question. The criteria defined for the expert evaluation include aspects such as clarity and relevance of the QuEP question, the principle(s) a QuEP question belongs to, for which stakeholders the QuEP question is relevant, the correctness of the terminology, and, finally, any comment the expert may consider relevant. Next, the *Create Questions to evaluate QuEP Model* task is making the expert questions according to the criteria defined above. The defined expert questions are collected and organized in a questionnaire, which is used as a survey instrument for data collection in the *Build Expert Questionnaires* task. Finally, the questionnaires are sent to the previously selected experts. In some cases, the questionnaires were sent via email and in other cases the questionnaires were delivered personally (*Send Questionnaires to Expert* task).

In the second subprocess, *Evaluate Model QuEP,* it is the Expert who evaluates the QuEP Model, answering to the different questions through the following tasks: *Receive questionnaires*, *Evaluate questionnaires*, and *Send questionnaires responses*. In the third subprocess, *Analyze Expert Evaluation,* the research team *gets experts evaluations*, next, *studies and analyzes experts' answers*, and, finally, *evaluates results*. At this moment, the research team must decide whether to iterate a new round ot to conclude the process. For every new round, the results of the previous one are included as improvements in the QuEP model.

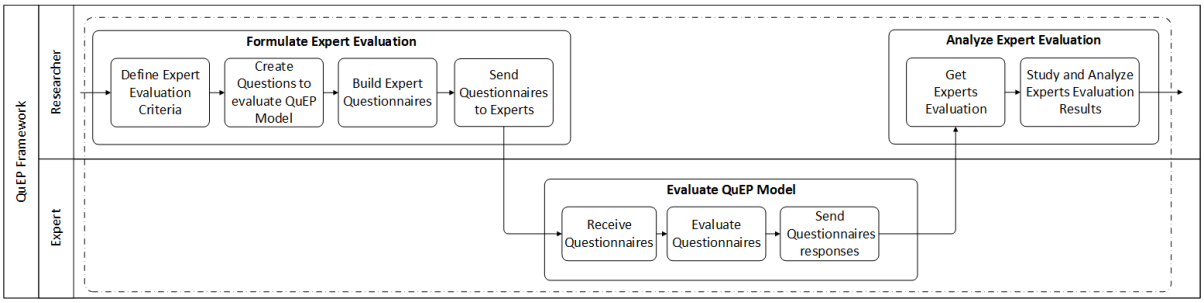

Figure 6. Expert Evaluation Subprocess of QuEP Model

The expert evaluation model

The QuEP model is extended with the components of the expert evaluation (see Figure 7). The expert evaluation questionnaires are composed by a set of expert questions (*ExpertQuestion* class) associated to a defined QuEPQuestion. Each expert question evaluates a QuEPQuestion according to the criteria defined (relevance, clarity, belongs to a principle, relevant stakeholders, correct terminology and comments and reviews). Each evaluable criterion has a set of response options (*ExpertAnswerOption* class) so that an expert chooses one or more options *(ExpertAnswer* class*)*. Furthermore, the expert question may have some comment made by the expert, as well as some response of the expert may also have some comment (*ExpertComment* class).

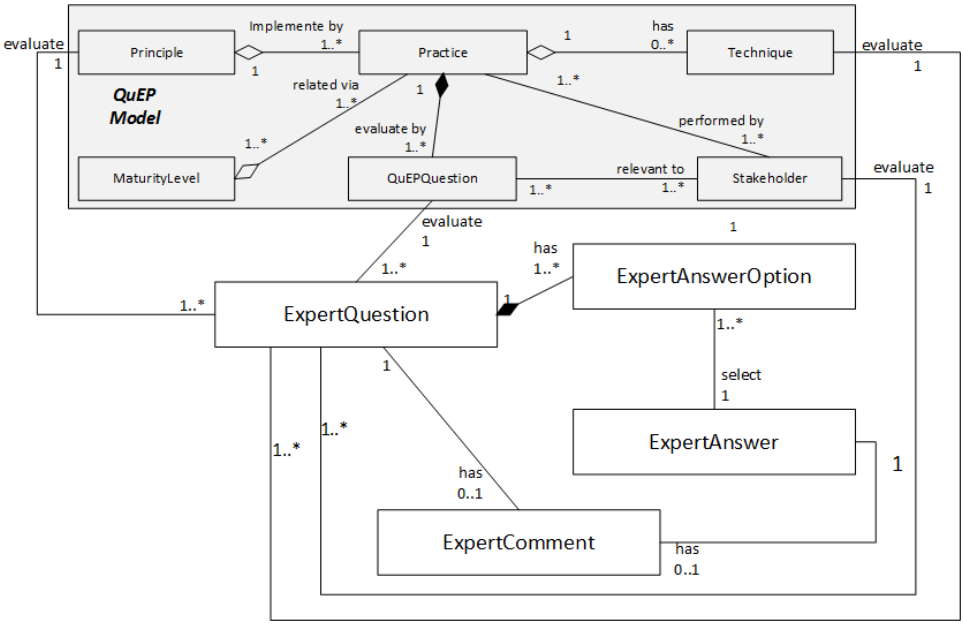

Figure 7. QuEP Model Extended with the Expert Evaluation Model

Example of expert question

Figure 8 shows the expert questions associated to each QuEPQuestion. The questions and answer options presented are related to the pre-defined expert evaluation criteria (*clarity* and *relevance* of the QuEP question, *relevant stakeholders* to the *QuEPQuestion*, *belongs to a QuEP principle*, *terminological correction*, and general *comments*). The expert fulfills the evaluation questionnaire and sends it to the researchers.

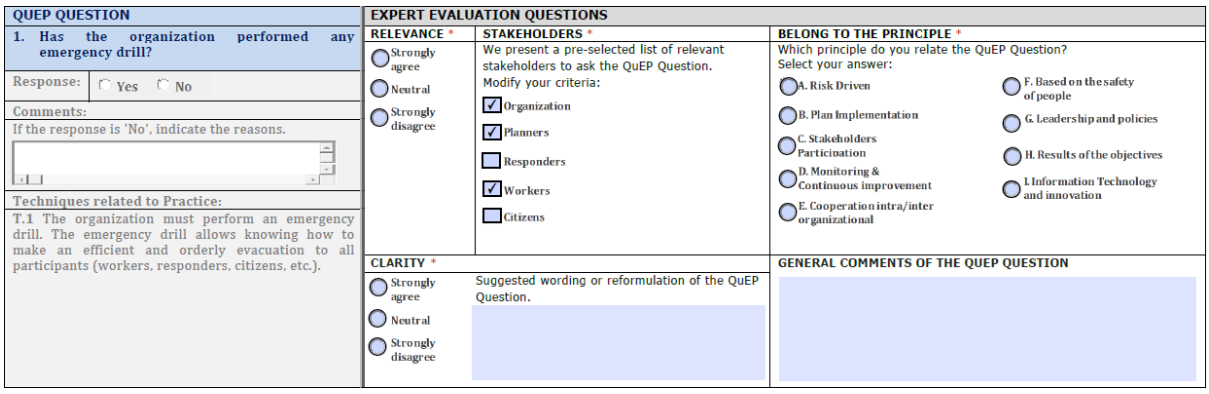

Figure 8. Expert Evaluation Questions associated to each QuEPQuestion

Applying the evaluation method

At the time of writing this paper, we are in the first round of the Delphi-based evaluation process. As we as mentioned earlier, we are currently evaluating only two practices of the QuEP framework ("Emergency Drills" and "Risk Analysis") and the QuEP evaluation questionnaires had been sent to selected experts in the emergency planning domain. The experts were selected from both the public administration and private organizations in order to have a representative sample. Specifically, four experts belong to public administration (two from local administration (*Fire Department of Valencia, Civil Defense of Ajuntament de Valencia*), one from state administration (*Planning Service of Agency for Safety and Emergency Response*) and one from federal administration (*Natural Hazard and Planning in Civil Defense*)) and three experts belong to private organizations *(Planning Units)*. The expert evaluation questionnaires may be accessed in the QuEP portfolio[2].

At this time, we are getting the answers from the experts, but we cannot show the results since they are still incomplete. We describe how we are applying the method, to carry out the second round based on the analysis of the expert evaluation.

Ongoing discussion of the results

The expert questions have been categorized in order to determine if each QuEPQuestion associated to a practice is approved, reformulated or removed. In the case of *relevance* and *clarity* criteria, the expert answers had been categorized as *[Strongly agree, Neutral, Strongly disagree]* and they have been summarizing to obtain a Likert scale to each QuEPQuestion as the sum of the expert answers. Similarly, the *relevant stakeholder* criterion has been categorized as *[Select, Deselect]* and the *belong to principle* criterion as *[Select correct principle, Deselect correct principle]*. The Likert scales obtained for each QuEPQuestion according to each criterion, along with their percentages allow us to determine the result of the expert evaluation (QuEPQuestions approved, reformulated or removed).

Figure 9 shows how the analysis of the expert answers is being performed regarding the *relevance* and *clarity* criteria. We are using Likert items categorized as *[(Strongly agree, 1), (Neutral, 0.5), (Strongly disagree, 0)]* to obtain an average value to these criteria, that is, *relevance value* and a *clarity value* associated to each QuEPQuestion. On the other hand, we define the analysis rules as follows: (a) a QuEPQuestion will be approved if the *relevance value* and *the clarity value* obtained are in the third quartile; (b) a QuEPQuestion will be removed if the *relevance value* obtained is in the first quartile; and (c) a QuEPQuestion will be reformulate if the *relevance value* is in the second quartile or the *clarity value* is not in the third quartile.

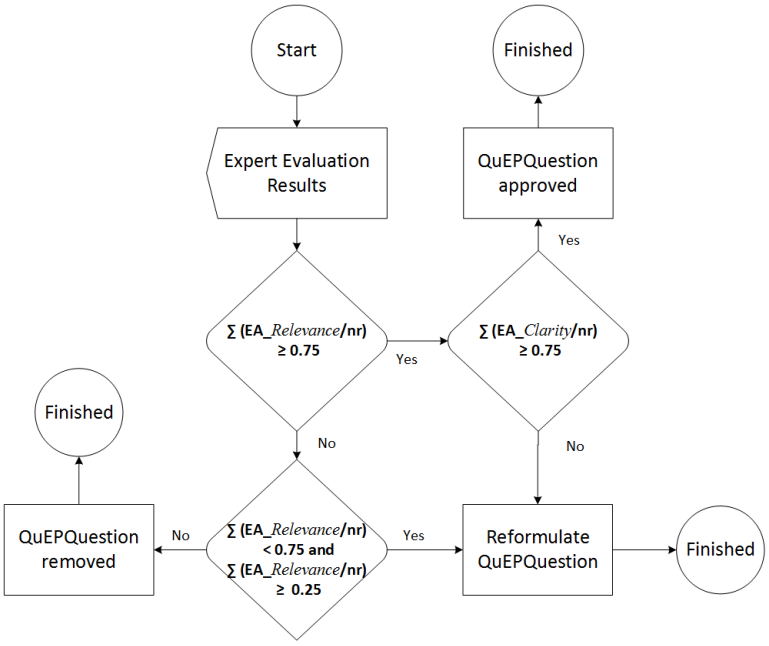

Figure 1. Evaluation flow of relevance and clarity criteria

[2] http://quep.dsic.upv.es/cuestionarios-de-evaluacion-expertos/ (site in Spanish)

The analysis of *relevant stakeholders* criterion is also being performed using an average *relevant stakeholders value* which is calculated using the expert answer categorized as [(Select, 1), (Deselect, 0)]. Then, the rule defined is: "The stakeholder is relevant to the QuEPQuestion if the *relevant stakeholder value* is >=0.5, otherwise the stakeholder is not relevant and this association between QuEPQuestion and stakeholder is removed of the QuEP model".

Finally, to the *belong to the principle* criterion, we calculate the *belong to the principle value* assigning [(right answer, 1), (wrong answer, 0)] and calculating the average. The rule defined is: "The QuEPQuestion belongs to a principle if the *belong to the principle value* is >= 0.75, otherwise the researcher checks the QuEPQuestion and the principles and practices of the QuEP model to propose another association between these components.

CONCLUSIONS AND FUTURE WORK

To complete the picture of Emergency Management, assessment and certification dimensions must be taken into account. We have introduced QuEP, the framework we have defined for the assessment of the quality of emergency plan management in organizations. Inspired by Total Quality Management approaches, QuEP defines a set of maturity levels which can be viewed both as evaluation criteria and a roadmap for the improvement of the organizations practices. We detailed the stakeholders involved in the quality management process, and a set of principles, practices, techniques and questions that are present at the different levels of the maturity hierarchy. To evaluate our proposal, we are currently running a Delphi process that is also described in the paper.

As for further work, we intend to keep working on our model based on the results of the evaluation process, and to implement an IT-based tool. We are negotiating with some organizations the establishment of pilot programs for the application of QuEP in real world settings.

Another interesting research line tries to link QuEP with resilience. Specifically, we are investigating how to improve emergency plans through building resilience in activities before, during and after the emergency plan management. This research will help organizations to identify, anticipate, and respond to the risks of catastrophic events to reduce their occurrence or the magnitude and duration of their impacts.

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REFERENCES

1. Becker, J., Knackstedt, R., and Pöppelbuß, J. (2009). Developing Maturity Models for IT Management. *Business & Information Systems Engineering,* 1(3): 213–22.
2. Berke, P., Godschalk, D. (2009) Searching for the Good Plan: A Meta-Analysis of Plan Quality Studies, *Journal of Planning Literature,* 23, 227–240.
3. Berke, P., Smith, G., Lyles, W. (2012) Planning for Resiliency: Evaluation of State Hazard Mitigation Plans under the Disaster Mitigation Act, *Natural Hazards Review*, 13, 139–149.
4. Brooks, K. W. (1979). Delphi technique: Expanding applications. North Central Association Quarterly, 54 (3), 377-385
5. Brooks, P., El-Gayar, O., and Sarnikar, S. (2015) A Framework for Developing a Domain Specific Business Intelligence Maturity Model: Application to Healthcare. *International Journal of Information Management,* 35(3): 337–45.
6. Camisón, C. (1998) Total quality management and cultural change: a model of organisational development. *International Journal of Technology Management*, 16, 479–493.
7. Camisón, C., Cruz, S., González, T. (2007) Quality management: concepts, approaches, models and systems.

Pearson/Prentice Hall, Madrid; Santiago, Chile.

8. Charantimath, P.M., (2011) Total Quality Management. *Pearson Education India*..
9. CPG 101, Developing and Maintaining Emergency Operations Plans, Version 2. (2010) https://www.fema.gov/es/media-library/assets/documents/25975 (Last accessed on Nov 2015).
10. Custer, R. L., Scarcella, J. A., Stewart, B. R. (1999) The modified Delphi technique: A rotational modification. *Journal of Vocational and Technical Education*, 15 (2), 1-10.
11. Dean, J.W., Bowen, D.E. (1994) Management Theory and Total Quality: Improving Research and Practice Through Theory Development. *The Academy of Management Review*, 19, 392–418.
12. Hsu, C., Sandford, B. A. (2007). The Delphi Technique: Making Sense of Consensus. *Practical Assessment, Research & Evaluation,* 12(10): 1–8.
13. Linstone, H., Turoff, M. (1975) The Delphi Method - Techniques and Applications. *Addison-Wesley Educational Publishers Inc*, 1–616.
14. Linstone, H., Turoff, M. (2011) Delphi: A Brief Look Backward and Forward. *Technological Forecasting and Social Change,* 78(9): 1712–19.
15. Ludwig, B. (1997) Predicting the future: Have you considered using the Delphi methodology, *Journal of Extension*, 35 (5), 1-4.
16. Mandal, S. K. (2009) Total Quality Management - Principles And Practice, 1E. *Vikas Publishing House Pvt Ltd.*
17. Meyerson, R. (2013). A Tool for evaluating plan quality of local Government emergency management response plans.
18. NBA, Spain's Self-protection Law. (2007) https://www.boe.es/boe/ dias/2007/03/24/pdfs/A12841-12850.pdf (Last accessed on Sept 2014; in Spanish).
19. Núñez, A.-G., Penadés, M.C., Canós, J.H., Borges, M.R. (2015) Towards a Total Quality Framework for the Evaluation and Improvement of Emergency Plans Management. *The 12th International Conference on Information Systems for Crisis Response and Management.*
20. Oakland, J.S. (2003). Total Quality Management: Text with Cases. *Routledge*.
21. Santos, R. S., Borges, M. R. S., Canós, J. H., Gomes, J. O. (2011) The Assessment of Information Technology Maturity in Emergency Response Organizations. *Group Decision and Negotiation* 20(5): 593–613. n.
22. Turoff, M., Chumer, M., Van de Walle, B., Yao, X. (2004) The Design of a Dynamic Emergency Response Management Information System (DERMIS). *Journal of Information Technology, Theory, and Application (JITTA),* Volume 5, Number 4, Summer, pp. 1-36.
23. Turner, B. A. (1976). The organizational and inter-organizational development of disasters, Adm. Sci. Q. 21, 378–397.
24. UK, Emergency preparedness. https://www.gov.uk/government/ publications/emergency-preparedness (Last accessed on Sept 2014).
25. Weske, M. (2012) Business Process Management: Concepts, Languages, Architectures, *Berlin ; New York : Springer*.