The Formal Specification for Competency Requirements

ROSLINA MOHD SIDEK, A.NORAZIAH
Faculty of Computer Systems & Software Engineering
University Malaysia Pahang
Lebuhraya Tun Razak 26300 Kuantan
MALAYSIA
roslinams@ump.edu.my, noraziah@ump.edu.my

Abstract: - Competency is a vital characteristic to all area of action, especially in an emergency situation. This is because people must react according to what they supposed to react. If an individual lacking competence in the job or life, the person may take wrong action and make more loss in the area of work or situation such loss of life, injured, and others. To make them competence, people need to attend training. The training give them knowledge and skill. So, good attitude with knowledge and skill make them competence. A chemical company in Pahang, Malaysia has been selected as a case study to model the framework of emergency, response and preparedness (ERP). The framework of ERP was according to the company's competency by considering three elements which are the skill, knowledge and attitude. This paper presents the initialization theorem, pre-condition calculation and properties proving for competency requirement. The competency requirement specification written uses Z notation.


1 Introduction
The Occupational Competency association was initiated by David McClelland in the 1960s with a view to moving away from traditional attempts to describe competency in terms of knowledge, skills and attitudes and to focus instead on the specific self-image, values, behaviors, and motive personalities i.e. relatively enduring characteristics of people that are found to regularly distinguish due to typical performance in a given job or role. It should be noted that different competencies predict outstanding performance in different roles, and that there is a limited number of competencies that predict outstanding performance in any given job or role. A formal specification of the system developed for inconsistency. This technique is effective in discovering clearer, errors and omissions [1]. The argument for the use of formal specification forces a detail analysis of the specification of requirement. It demonstrates the development program meets its specification so implementation errors do not compromise dependability. In this paper we used Z notation to show the formal specification of the Emergency Response and Preparedness (ERP). According to ISO 14000 [1], the organization is required to establish procedures for identifying the potential for and responding to emergency situations and accidents that can have an impact on the environment. It because many environmental impacts of an emergency or accident situation are minor in nature, it appears that all potential emergency or accident situations need to be identified before a resolve of environmental impacts can be made. An organization that attempts to identify potential emergency or accident situations based on a review of its environmental aspects would likely miss the environmental impact potential of, say, an automobile accident. Staff in any critical have to know and should be prepare to act if hazard occur. So, same with the chemical plant the emergency response and preparation for situation consider as very critical part. In this paper we choose one chemical plant to know the activities of the ERP. So, in developing software to the ERP we need to consider this critical area to make sure our requirement is complete according to the requirement needed. Formal specification is the detail explanation about the area that we study. Through this formal specification, we can help to clear all the relevant specification, thus unambiguous event can also be comprehensible. This formal specification uses Z notation to describe the requirement.
In this paper, we present a formal specification using Z notation for competency requirements. The illustration is used to make it understandable by an example Assessment for Emergency Response and Preparedness in the area of safety and health in a company which chemical plant. Depending on the assessment model, we derive the logic statement. Next, we set up a basic type of the system and initial state of the system. After that, we create a Venn diagram to show the relation between basic types that involve in the system. Finally, from the Venn diagram, we convert into the state schema.

This paper is structured as follows: in Section 2 we discuss research background. Section 3 describes the competency framework. Section 4 presents the result in Emergency Response and Preparedness. This section explains how to do individual assessment that relate on the skill, knowledge, and attitude. Finally, we conclude the paper in Section 5.

2 Research Background
In this section, we present the concepts of ERP, and Z notation.

2.1 Emergency, Response and Preparedness (ERP)
The objectives of emergency respond training in the company are to understand what are the properties and behaviour of different emergencies and how they can cause damages, design effective Response Strategies, understand and apply good Response Techniques, Learn about Emergency Response Equipment, and be able to carry out an effective Emergency Responses when an emergency occurs. The training duration is five hours during off day and the location is Fire Department training room.

The module included first, the Fire Awareness & Prevention is to identify situation which could lead to fires or other emergencies, second, Smoke Alarm System to explain to the individual about the location the happened, operation and the limitation of alarm system, third, Sprinkler Systems. Forth is Evacuation Procedures (Theory) individual to identify emergencies according to the emergency alerts and signals given, fifth is Evacuation Procedures (Practical) implementation to the appropriate changes to emergency procedures in an emergency situation, sixth is Portable Fire Extinguishers & Fire Blankets to identify the type of emergency control equipment and the limitations, location of emergency equipment, assess emergency situation and the effectiveness of first attack action. Lastly, is the Other Fire Emergencies can demonstrate an understanding of other fire emergencies that could occur? It also identifies considerations for bush fire prevention around the emergency area and addition equipment required if the area is rural areas.

This module delivers for both theory and practical. To access the knowledge transfer is effective the quiz and practical given. Besides the respond and preparedness staffs also need to have skill and knowledge in emergency facing. The skill and knowledge required at completion of the training. The ERT should have the following knowledge and skills: Fire awareness & prevention, smoke alarm system, sprinkler system, theory of evacuation procedures, and practical of evacuation procedures, Portable Fire Extinguishers & Fire Blankets, and Other Fire Emergencies.

2.2 Z Notation
The Z systems are modelled using sets and relations between sets. This method is an approach for the industrial development of highly dependable software. It has been successfully used in the development of complex real-life application be it constructs specification in software specification. The use of mathematical statement will make very hard to understand the process of the system. Also, set and relation between sets in mathematic we can show using the Venn diagram. The formal description is easy to chunks that are distinguished from association text using graphical highlighting called schema. It used to introduce state variables, define constraints and operation on the state [6]. In Z notation the specification shows in diagram approach. The Z notation is quite similar with the B notation. In this report will used Z/Eve notation to produce the formal specification. The Z notation is also similar with other programming language because there is syntax for the statement that we want to form.

3 Competency Framework
The model of individual ERP is shown in Fig 1. Individual should know their job in the area of working and they need to follow the task given which is according to the Set Task Standard. In this Set Task Standard, they fulfil the three elements which are knowledge that needed skill in that area and attitude. The three elements will be assessed if the situation still not achieve the standard set, they should be retrained until achieve the standard.
4 Formal Specification

In formal specification need to assign set involved in the competency. The main elements in competency are skill, knowledge and attitude. All these three elements should get from training until competence. So, the set is [Competence]. The state diagram for ERP is like the Fig 2 and Fig 3 shows the initial state for competency. Operation involve in this competency such as KnowledgeOk, SkillOk, AttitudeOk. Then the error handling for this competency such as NotKnowledgeable, NotSkill, NoAttitude. Query for this competency is alreadyKnowledgeable, alreadySkill, and AlreadyAttitudeOk. The knowledgeOk in Fig 4.

User interface for the operations such as knowledgeable, skilful and attitude are followed:

Knowledgeable = KnowlegeOk ∨ NotKnowledgeable ∧ AlreadyKnowledgeable … (1)

skilful=skillOk ∨ NotSkill ∧ alreadySkill … (2)

Attitude = attitudeOk ∨ NoAttitude ∧ AlreadyAttitudeOk … (3)

The verification is to check whether the individual is competence or know is the individual should fulfil the skillOK, KnowledgeOk and attitudeOk. The schema shows the combination of these elements the individual is competence in the work area.

Competence = skillOk ∧ knowledgeOk ∧ attitudeOK … (4)

The validation we have three type of proving: initialization theorem; pre-condition calculation; properties proving. The validation in initialization theorem as like below:
This schema shows the successful skillOk process. Then, extend training statement in the declaration part shows in Fig. 6.

```
skillOk
```

```
Skilled, Skilled' : P Staff
Knowledgeable, Knowledgeable' : P Staff
WithAttitude, WithAttitude' : P Staff
S? : P Competence
Msg! : report
```

```
Skilled ∧ Knowledgeable ∧ WithAttitude ⊆ Competency
Skilled' ∧ Knowledgeable' ∧ WithAttitude' ⊆ Competency
S? Skilled
Skilled' = Skilled ∪ {S?}
Knowledgeable' = Knowledgeable
WithAttitude' = WithAttitude
Msg! = success
```

Fig 6. Extend training statement

Then write the post-schema to the process part to using the exist statement shows in Fig 7.

```
skillOk
```

```
Skilled : P Staff
Knowledgeable: P Staff
WithAttitude: P Staff
S? : P Competence
```

```
∃ Skilled' : P Staff, Knowledgeable' : P Staff, WithAttitude' : P Staff, Msg! : report
Skilled ∧ Knowledgeable ∧ WithAttitude ⊆ Competency
Skilled' ∧ Knowledgeable' ∧ WithAttitude' ⊆ Competency
S?≠ Skilled
Skilled' = Skilled ∪ {S?}
Knowledgeable' = Knowledgeable
WithAttitude' = WithAttitude
Msg! = success
```

Fig 7. Write the post-schema to the process part

Then use the one point rules [6] concept to simplify the statement shows in Fig 8.

```
```

Fig 5. Precondition Calculation for SkillOK
The statement prove that the person can be skilled with the pre-condition of not yet skill shows in Fig 9.

The last schema proves that the skill full staff should not element to the set Skilled. The critical properties of the competency shows in Fig. 10:

The truth table in Table 1 shows the verification of competency of this ERP. So, this competency is valid to show axiomatic of ERP.

5 Conclusion
The key components of Individual Emergency, Responses and Preparedness are formalized in order to be sharp, precise and prevent their multiple interpretations. The schema describing the basic system elements was large due to multiple security constraints of social environment. In our future work our focus is to use symbolic computational environment to produce an animation of the formal specification to further refine the framework.

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References: