STCW 78: Manila Amendments and Some Risk Assessment Aspects

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Abstract: in accordance with Manila Amendments to STCW 78 all the officers are required to have knowledge, understanding and proficiency in "Situation and risk assessment". The term "risk" occurs in different parts of the STCW 78 Code and applies to safety, security and protection of environment issues. The paper analyses the Manila Amendments to STCW 78 and researches some aspects of the qualitative technique for risk assessment based on fuzzy logic approach.
Keywords: STCW 78, Manila amendments, , risk, safety, protection of environment.

1. INTRODUCTION

The International Convention on Standards of Training, Certification and Watchkeeping (STCW), 1978 as amended, sets qualification standards for masters, officers and watchkeeping personnel on seagoing merchant ships. The work on amending the STCW Convention and Code was launched by STW Sub-Committee of IMO in January 2006 and culminated in a Diplomatic Conference in Manila, Philippines in June 2010. These amendments are known as „The 2010 Manila Amendments".

2. CONCEPT OF RISK IN STCW 78 CODE

Manila amendments to STCW 78 includes standards on situation and risk assessment in different fields of ship operation. Seafarer should comply with these standards and have knowledge, understanding and proficiency in risk assessment. If to look through the text of STCW 78 Code we can find a lot of provisions containing the term „risk" (Table 1).

Meanwhile, reading Chapter VIII and Part B of the Code you also face with terms containing risk, for example: risk of collision, specific risks, risks of over-reliance on ARPA (ECDIS), potential risk of improper functioning of the system; potential risk of human errors; reducing the risk of human error; risk assessment systems, risk of flooding, risk assessment before approaching ice-infested waters...

Without doubt the concept of risk is central one in Safety Management System of every and each shipping company and taking into account the IMO Resolution A. 1022

(26), which is in force from 01 June 2010 and also new risk-based format of inspections of ships set by Paris MOU from 01 January 2011 and also the new standard ISO 31000 - "Risk management- principles and guidance on implementation", it's obvious to note that including the concept of rick into Manila amendments to STCW 78 Convention and Code is a very much timely measure. Risk assessment and situation awareness are logically linked with other MET concepts as they are linked in reality with safety at sea.

In accordance with publication [3], "the concept of risk stands central in any discussion of safety. With reference to a given system or activity, the term 'safety' is normally used to describe the degree of freedom from danger, and the risk concept is a way of evaluating this."

Table 1. STCW 78 competences containing the provosions on risk assessment

Competence	Tables of minimum standard of competence
Application of leadership and teamworking skills	*A-II/1,A-III/1, A-III/6*
Application of leadership and managerial skills	*A-II/2, A-III/2*
Maintain the safety of navigation through the use of ECDIS and associated navigation systems to assist command decision making	*A-II/2*
Forecast weather and oceanographic conditions	*A-II/2*
Safe use of electrical equipment	*A-III/5 ,A-III/7*
Ability to safely perform and monitor all cargo operations	*A-V/1-1-2 ,A-V/1-1-3, A-V/1-2-2*
Apply occupational health and safety precautions	*A-V/1-1-2 ,A-V/1-1-3, A-V/1-2-2*
Minimize the risk of fire and maintain a state of readiness to respond to emergency situations involving fire	*A-VI/1-2*
Take immediate action upon encountering an accident or other medical emergency	*A-VI/1-3*
Apply immediate first aid in the event of accident or illness on board	*A-VI/4-1*
Assess security risk, threat, and vulnerability	*A-VI/5*
Recognition of security risks and threats	*A-VI/6-2*

Simple statistical research of STCW 78 Code made with the help of Leximancer software resulted in the conceptual map (see Fig.1). The map provides three main sources of information about the content of document :

- The main concepts contained within the text and their relative importance;
- The strengths of links between concepts (how often they co-occur);
- The similarities in the context in which they occur.

The conceptual map shows the more deep links of the concept „risk" with other main concepts of STCW 78 Code (see Fig.1), where the concept „risk" is in the center of conceptual map. It means that risk in STCW 78 Code possesses a high degree of centrality. It is located on crossing of two main STCW themes as "Training" and "Ship". It is something like mathematical expectation of random sequence of the most frequent (important) STCW concepts. We can conclude that directly or indirectly the concept "risk" exists in all other concepts of the Code and professional training needs to pay attention to this concept seriously.

The more closer the concepts appear on the map, the more contextual similarity they have. So, the concepts „grounding", „collision", „situation" and „communication" are the most contextually similar to the concept „risk".

The results concerning the concept „risk" shown in Fig. 1 differs from results published in [2], as the there is another set of surrounding concepts, which were selected intentionally automatically as the most frequent (important) in the text.

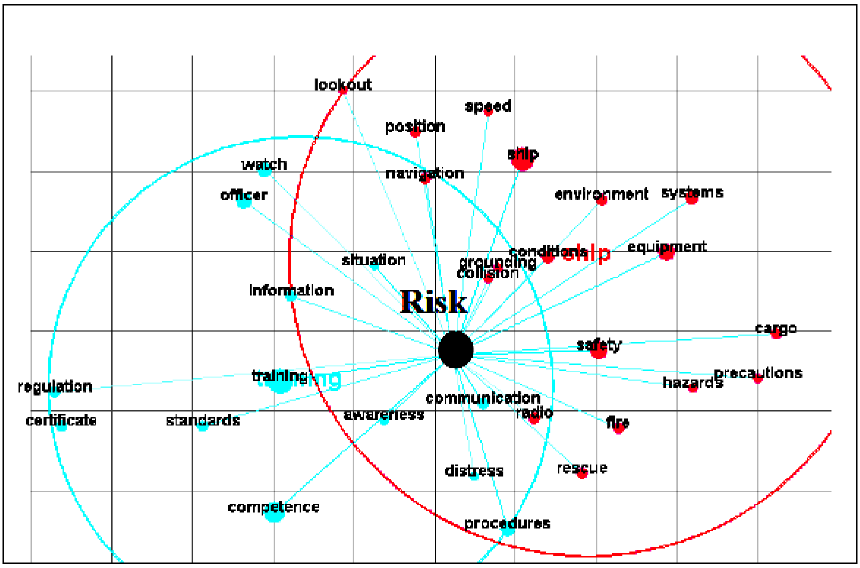

Figure 1. STCW 78 Code risk conceptual map.

So, taking it into account it is important to note that from automatically chosen the set of the most co-occurring concepts, the concept "risk" - is connected to all others and that is why these concepts can be used as risk management options and risk management measures.

What is risk ? In shipping the actors tend to view risk in an objective way in relation to safety, and as such use the concept of risk as an objective safety criteria. In shipping the following definition of risk is normally applied [3]:

$$R = PC \quad (1)$$

where *P*- the probability of occurrence of an undesired event (e.g. a ship collision) and *C*- the expected consequence in terms of human, economic and/or environmental loss. Equation (1) shows that objective risk has two equally important components, one of probability and one of consequence. Risk is often calculated for all relevant hazards,

hazards being the possible events and conditions that may result in severity. For example, a hazard with a high probability of occurrence and a high consequence has a high level of risk, and a high level of risk corresponds to a low level safety for the system under consideration. The opposite will be the case for a hazard with a low probability and a low consequence. Safety is evaluated by summing up all the relevant risks for a specific system.

The modified approach for risk assessment is given in publication [1], where formula (1) is transformed by the following way:

$$\text{Log}\,(R) = \log\,(P) + \log\,(C), \text{ or}$$
$$RI=FI+SI \qquad (2)$$

Where *RI, FI, SI* consequently risk , frequency and severity indexes.

Table 2 contains two approaches of risk assessment technique : quantitative and qualitative ones. Let's try to understand how are these approaches linked with each other.

3. FUZZY INFERENCE SYSTEM IN RISK MATRIX MODELING

We applied MATLAB fuzzy inference system (FIS) to make a model of formula (2). The structure of a model is shown in Figure 2. We used triangular membership functions (mf) and composed 28 fuzzy rules strictly in accordance with Table 2 data.

Table 2. Risk matrix

Risk Index (*RI*)					
		SEVERITY *(SI)*			
		1	2	3	4
FI	FREQUENCY	Minor	Significant	Severe	Catastrophic
7	Frequent	8	9	10	11
6		7	8	9	10
5	Reasonably probable	6	7	8	9
4		5	6	7	8
3	Remote	4	5	6	7
2		3	4	5	6
1	Extremely remote	2	3	4	5

The authors of publication [4] point the fact that the scale values for probability and severity are essentially arbitrary. There is no reason why the two scales should be the same or different. Similarly, there is no reason why they should be linear or nonlinear. Even linear scales do not divide the space linearly. If to follow this view the linguistic variables describing indexes FI and SI can have different and sometimes ambiguous values due to their fuzzy borders of frequency (probability) and severity.

Following [4] we can suppose that the configuration of risk matrix based on Table 2 suffers from a false symmetry, whereby equal values do not necessarily refer to equally risky situations.

So, to check the above the fuzzy model of nonlinear index *FI* was applied based on values of words describing their meaning in frequency terms from article [5] as follows: 300 (always), 261(very often), 237 (usually), 222 (often), 222 (rather often), 216 (frequently), 216 (generally), 150 (about as often as not), 102 (now and then), 87 sometimes), 84 (occasionally), 66 (once in a while), 48 (not often), 48 (usually not), 27 (seldom), 24(hardly ever), 21(very seldom), 15 (rarely), 6 (almost never), 0 (never). Here the numbers set the values of correspondent linguistic variables.

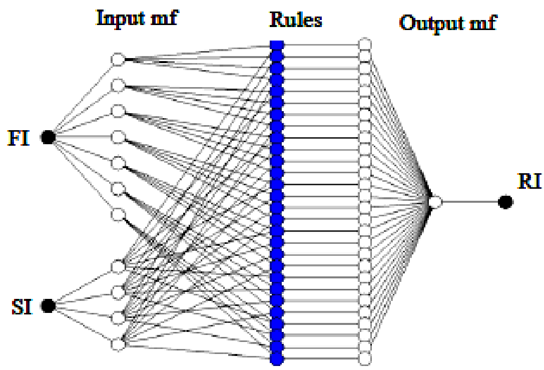

Figure 2. Strucure of FIS of concept „Risk"

The following fuzzy values were applied to Frequency Index in table 2: extremely remote = (15) rarely, remote = (27) seldom, reasonably probable = (84) occasionally, frequent= (216) frequently and the linear scale 1-7 was quantified in appropriate with the following nonlinear sequence: 15,27, 84, 216.

Linear and nonlinear results of FIS are shown in Figures 3-5, where from left to right you can see the transformation of linear model to nonlinear one. If to assume that interval RI=5-8 can be considered as a tolerable risk zone (T), then interval RI<5 is negligible risk zone (N) and RI> 8 is intolerable risk zone (I), then we can see the changing of configuration of these zones on Figures 4 and 5. This geometrical changing of N, T and I zones puts the task of need of more comprehensive research in this area ,as risk-based decision making procedure may lead to a very much ambiguous situation.

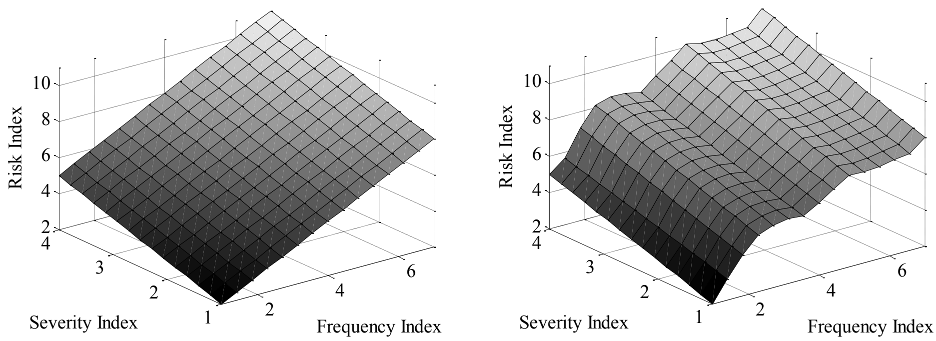

Figure 3. 3D Risk matrix (linear and nonlinear from left to right)

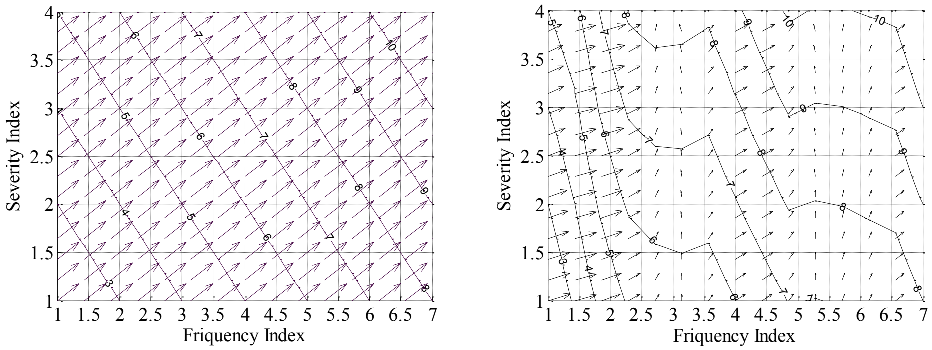

Figure 4. 2D Risk matrix with risk gradients and risk contours (linear and nonlinear from left to right)

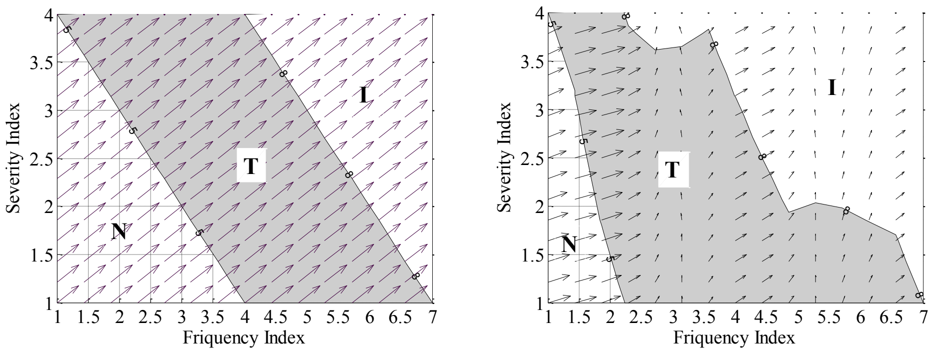

Figure 5. 2D Risk matrix with negligible (N), tolerable (T) and intolerable (I) risk zones (linear and nonlinear from left to right)

4. CONCLUSIONS

1. Concept "risk" in STCW 78 Code possesses a high degree of centrality. It is located on crossing of two main STCW themes as "Training" and "Ship". It can be interpreted as something like the *mathematical expectation* of random sequence of the most frequent STCW concepts. It is possible to conclude that directly or indirectly the concept "risk" exists in all other concepts of the code and professional training needs to pay attention to this concept seriously.
2. So, taking into account the above conclusion it is also important to note that from automatically chosen set of the most co-occurring concepts, the concept "risk" - is connected to all others and that is why these concepts can be used as risk management options and risk management measures .
3. FIS is convenient and flexible tool for linear or nonlinear modeling of risk matrix. Both techniques ,as quantitative and qualitative ones can be used for practical and theoretical application.
4. Transformation from a quantitative to qualitative risk assessment demands preliminary more accurate standardization of meanings and values of appropriate linguistic variables both frequency and severity of consequences.

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