International Journal of Physical and Social Science
Vol. 7 Issue 4, April 2017
ISSN: 2249-5894 Impact Factor: 6.644
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

STUDY ON RISK OF MARINE TRANSPORTATION OF DANGEROUS CHEMICALS BASED ON SAFETY ENGINEERING RELIABILITY

Song weihua*

Abstract

With the rapid development of international trade, the development of international logistics has led to the necessity of risk research in China as a special exporter of dangerous chemicals. The main mode of transportation in international logistics is marine transportation. Therefore, on the basis of analyzing the risk of transport of dangerous chemicals at home and abroad, taking the marine transportation of dangerous chemicals as an example, from the aspects of personnel, ship, environment and goods, To carry out the reliability risk research, taking into account its risk changes with time is also dynamic, the establishment of a dynamic fault tree model for its risk analysis, and put forward countermeasures.

Key words: dangerous chemicals marine transport reliability.

* **Xi'an University of Architecture and Technology,China,shan'xi Province Research areas: logistics engineering**

1 Introduction

In the context of the current slow recovery of the global economy, strengthening regional cooperation is an important driving force for the development of the world economy and has become a trend. On December 12, 2014, Premier Li Keqiang put forward three new free trade zones in Guangdong, Tianjin and Fujian specific areas after the establishment of a new round of free trade zone after the establishment of the Shanghai Free Trade Area. Which can be seen in China to seek new markets and investment space determination, China's products will be faster pace to the world, international trade will also be more prosperous.

With China's dangerous chemicals marine transport continued to increase year by year, dangerous chemicals transport accidents continue to increase, the resulting risk of pollution hazards continue to increase. The safety management of marine hazardous chemicals has been increasingly affected by the risk of its risk, the high risk of its industry, the diversity of hazardous chemicals, the complexity of physical and chemical properties, the potential high risk and the high risk of accidents. Social attention. To effectively strengthen the marine pollution control transport accident prevention and control capacity to improve the marine hazardous chemicals transport accident emergency response capacity to control, mitigate or eliminate such serious accidents caused by serious social hazards, the establishment of marine hazardous chemicals transport risk It is necessary to evaluate the model. At present, there are relatively few quantitative models in this area. Therefore, this paper intends to establish the ocean transportation risk model of hazardous chemicals.

2 Analysis of Current Situation at Home and Abroad

Risk research is focused on risk identification and evaluation process, and the risk of transport of hazardous chemicals. At home and abroad scholars have been conducting various studies, the American Transportation Association has put forward quantitative methodology for quantitative risk analysis and evaluation and applied them to Dangerous goods in the actual transport process. Domestic and foreign research mainly in qualitative and quantitative aspects.

2.1 Foreign research and analysis

Developed countries on the risk of transport of dangerous chemicals research and development earlier, as early as 1971, US research experts to recognize the seriousness of hazardous chemicals transport accident, in its national transport safety committee issued a number of related management system to reflect the The risk of hazardous chemicals transport considerations, Ambisisi Ambituuni et al., Nigeria, for example, analyzed the 2318 cases of dangerous goods truck tanker accident from 2007 to 2012, the results show that 79% of the accident is caused by human factors, mainly dangerous Driving, 70% of accidents lead to leaks, fires and explosions, 81% lead to injury, death or both, the local government has stepped up supervision and improved policies to stimulate to reduce the occurrence of accidents [1]. Vytenis Babrauskas takes an explosive substance of ammonium nitrate as an example (after the explosion is extremely harmful and frequent accidents), pointing out that people only focus on the cause of the accident, while ignoring the cause of the accident caused by the study Found that uncontrollable fire is the main cause of the accident, and put forward two solutions, one is to change the material formula, the other is through technical means to control the fire [2]. F. Tena-Chollet et al., Taking oil and gas transportation as an example, conducted a global risk assessment study to develop a predictive code to analyze the risks of people, infrastructure and the environment on different supply routes, on the one hand Risk scenarios and the risk of high-risk elements of the risk assessment method, on the other hand is based on the existing geographic information system for modeling development tools to Paris, France as an example to determine the optimal route risk [3].

2.2 Domestic research analysis

Zhou Xiaolong, who collected and compiled from October 2006 to October 2010 between 408 dangerous goods road transport accident as the data base, from different perspectives on the case of the accident analysis, summed up the accident some of the characteristics of the accident The occurrence of the law, and as a basis for the prevention of dangerous goods transport accident prevention measures [4]. Yang Zhongmin on the status of hazardous chemicals transport and the

cause of the accident analysis, and corresponding to put forward some countermeasures for the relevant departments to learn [5]. Chen Lanfang and others for the characteristics of China's hazardous chemicals transport accident and emergency management of the status quo, from the coastal and inland two aspects, respectively, maritime systems, port terminals, cleaning companies and shipping companies to assess the object, to build waterway hazardous chemicals Transport emergency response system assessment framework [6]. Wu Xiaoming and others through the cross-river bridge dangerous chemicals transport risk measurement, clear its occurrence probability and serious consequences of accidents, put forward some preventive measures [7]. The analysis of pollution risk and the prevention and control, supervision and emergency system of the dangerous goods ship in Zhangjiagang section of the Yangtze River were carried out, and the risks of various pollution accidents were carried out in combination with the actual situation of hazardous chemicals, Analysis and from the accident prevention and control, maritime supervision and emergency system construction and other aspects of the three studies [8]. Li Jiemin and others in the "uncertain conditions of marine dangerous chemicals transport safety evolution mechanism" in order to study the impact of uncertainties on the transport system, based on the theory of dissipation of marine dangerous chemicals transport system safety evolution mechanism, from the energy point of view to establish the system The potential energy function model considers the entropy and energy of the system in the process of studying the security of the system. Using the entropy principle to derive the system safety entropy change curve, and the curve of the safety level division [9]. Yin Xin and others from China's oil and oil production and demand trends, oil maritime transport and handling capacity and oil maritime transport accident statistics in three areas, analysis of China's oil maritime transport status, put the oil in the shipment of the empty capacity, Tools and oil handling monitoring and other aspects of the prevention and reduction of maritime transport accidents [10].

From the above domestic and foreign research on the risk of dangerous chemicals transport can be seen, mostly from the cause of the risk of traffic accidents and the reasons for the analysis to analyze the main reasons, and put forward the corresponding preventive measures and mitigation

measures. Quantitative research model is relatively small, and does not take into account the sudden occurrence of dangerous goods transport accidents and dynamic. In this paper, marine transport of hazardous chemicals as an example, the use of safety engineering reliability method to establish dynamic fault tree model, and to solve, to get a greater impact on the failure mode.
And put forward the control measures for the failure mode.

3 questions raised

Hazardous substances are flammable, explosive, toxic, corrosive, radioactive and other characteristics, in the production, storage and transportation process is particularly vulnerable to casualties, property damage, environmental pollution and so on, hazardous chemicals transport accidents and general transport Accidents, often cause unpredictable losses, such as burning, explosion, leakage, etc., resulting in economic property damage, environmental pollution, ecological damage, casualties and a series of problems. Therefore, only the full understanding of the dangers of the transport of dangerous chemicals, and to strengthen the equipment, personnel and emergency rescue management, in order to effectively control and reduce the occurrence of dangerous chemicals.

Marine transport is the most important mode of transport in international logistics. It refers to a way of using ships to transport goods between ports in different countries and regions through sea lanes. International trade volume of more than 2/3, China's total import and export volume of 90% are using maritime transport. Maritime transport transport capacity, low sea freight, the channel extending in all directions, is its advantage. But the speed is slow, sailing risk, sailing date is not easy to accurately, is its shortcomings. Application of statistical methods to obtain the occurrence of marine transport accidents and personnel, ships, the surrounding environment, the goods themselves have a close relationship [10], and with the change of time the probability of accidents is uncertain, resulting in marine transport risk dynamics feature.
In view of the above analysis, the risk of marine transport of hazardous chemicals has dynamic

characteristics, so this paper will use dynamic fault tree to carry out risk analysis and modeling.

4 Model Establishment and Solution

Risk research focuses on risk analysis and evaluation. The dynamic of ocean transportation risk determines the complexity of its research. Therefore, this paper proposes a dynamic fault tree model from four aspects: human factor, equipment factor, environmental factor and cargo itself. Fault tree analysis flow chart shown in Figure 1:

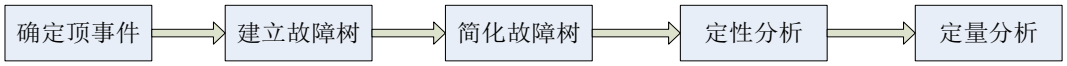

Fig.1 Fault tree analysis flow chart

A dynamic fault tree (DFT) is a fault tree that includes at least one dedicated dynamic logic gate. The introduction of dynamic fault tree is to solve the problem of reliability modeling and analysis of systems or equipment with dynamic characteristics such as fault recovery and timing correlation. The causal relationship with the fault can not be described by the traditional static fault tree, structural function, etc. DFT has extended the traditional static fault tree to have sequence dependency, various repairable systems, public resource pools, and cold and hot spare parts [11]. The dynamic logic gates mainly include Priority and gate(PAND), Function related door(FDER), Sequences (SEQ), Spare Spare Door (CSP), Warm Spare Door (WSP) and Hot Spare Door (HSP) [11].

The dynamic fault tree is established by the method of artificial tree construction. The process of constructing the dynamic fault tree is as follows:

First, determine that one of the least anticipated events is the top event (Er) that the hazardous material is not safe;

Second, any problem in the four aspects of the crew, the ship, the environment, and the goods directly leads to the occurrence of the top event, so they are connected with "or".

The construction of the dynamic fault tree is based on the following assumptions:

1 each ship is equipped with a spare crew, one of which appears to be physically or otherwise unable to continue to work, the other one can be replaced in time;

2 in the course of the ship if the failure, in the absence of timely repair will lead to the top of the eventoccur;

The dynamic fault tree is shown in Figure 2:

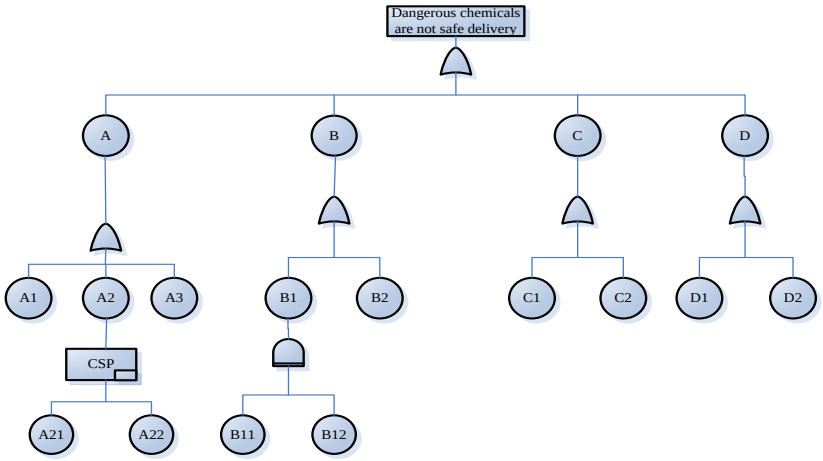

Fig. 2 Dynamic fault tree

Table 1 The meaning of each event representative

Intermediate Event	Event Meaning	Intermediate Event	Event Meaning
A	person's factor		
A1	driving skills		
A2	health status	A21	failure
A3	safety awareness	A22	timely replacement
B	ship factor		
B1	ship failure rate	B11	ship failure
B2	ship age	B12	not timely repair
C	environmental	D	cargo factors

	factors		
C1	shipwreck	D1	Cargoflammable and explosive
C2	foreign risk	D2	cargo leak

The dynamic fault tree constructed by Fig. 2 contains two dynamic fault gates, which are cold spare doors and priority gates. The traditional fault tree solution method is based on the Markov model, but the Markov model has the risk of combinatorial explosion, which is difficult to be applied to large fault tree analysis. There is also a method based on the top event probability approximation algorithm of trapezoidal formula , But there is still a combinatorial explosion problem, and the accuracy is low. The Bayesian network technology developed in recent years has inherited the description and reasoning of fault tree status, but also has the ability to describe the non-determinism of event polymorphism and fault logic. It is very practical for reliability and safety analysis.

According to the dynamic Bayesian network obtained by the dynamic module transformation, the probability of occurrence of the top event TE at any time t can be easily calculated by using a variety of mature algorithms.

$$P(t) = P(TE_t = 1 / X_{01} = 0, \ldots, X_{0m} = 0) \qquad (1)$$

In the formula (5): X0i- The state of the root node X in the initial network at time 0; m - the number of root nodes in the initial network.

Using its reasoning algorithm, it is easy to find the probability of the bottom event Xi at any time t:

$$I_i pr(t) = P(TE_t = 1 / X_{ti} = 1) - P(TE_t = 1 / X_{ti} = 0) \qquad (2)$$

In the formula (1): the state of the X_{ti} - root node X_i at time t.

The calculation steps of the dynamic fault tree analysis algorithm based on Bayesian network can be summarized as follows:

Step1 Each dynamic logic gate in the dynamic fault tree is transformed into a dynamic Bayesian

network;

Step2 Each static logic gate in the dynamic fault tree is transformed into a dynamic Bayesian network;

Step3 Dynamic Bayesian network integration: According to the dynamic fault tree in the connection between the logic of the door, all the dynamic Bayesian network integration, superimposed on the same node, to maintain its connection relationship unchanged, and then get dynamic Bayeux Network;

Step4 dynamic fault tree analysis: using the dynamic Bayesian network, according to (1) ~ (2) to calculate the top event probability, importance and other analysis results.

5 response measures

(1) human risk control

Because human behavior is dominated by people's consciousness, people's consciousness is easily disturbed by various factors. Therefore, it is effective to change the behavior of people to adapt to the outside world. Strengthen the training of professional skills and personnel safety education, to enhance their driving ability and safety awareness, increase the emergency training capacity for the emergency training courses, strengthen the training and study of personnel traffic laws and regulations, and enhance the properties of the hazardous materials itself Understanding, the relevant contingency plans, accident cases and other learning, and gradually enhance the safety awareness of the driver, consciously implement the "I want to be safe," the driving concept, this idea is no longer a slogan, but applied to the actual work due to People's consciousness and the reality of the outside world is different, so the subjective transformation of human consciousness, change the behavior of people to adapt to the outside world, in order to achieve the risk of efficient control, making the human production activities away from the disaster.

(2) the risk control of the ship

In the process of shipping, should be done before, during and after the inspection should pay attention to the regular maintenance of the ship, but also should be accurate to know the use of the

ship in the safe range of qualified. Development of expert systems and artificial intelligence technology, all-round, the whole process, a comprehensive monitoring of dangerous chemicals transport ship.

(3) environmental risk control

Timely to listen to weather forecasts, ahead of time to prevent preventive measures to know the weather in advance of the transport channel area to ensure that personnel and ships, the safety of goods integrity, and further reduce the transportation costs, to avoid the loss of property due to unnecessary accidents Of the external environment is the premise of effective human productive activities and other economic activities. The road in case of bad weather, because the situation to take measures to maintain a good psychological factors is very important, first slowly reduce the speed of navigation, the staff should always be alert to the supervision of ships and hazardous chemicals.

(4) the risk control of the goods themselves

Hazardous chemicals in the transport process is necessary to identify the type of hazardous chemicals, which need to do a good job outside the packaging identification logo. Different types of hazardous chemicals should be labeled with a corresponding risk identification in order to better identify. For example, flammable gases should be affixed with flammable liquid logo and the corresponding pattern. If you can not identify the relevant personnel should be asked. Packaging must take a solid, intact, tight leak, clean, anti-shock, anti-vibration, sunscreen, rain and other measures.

6 Conclusion

This paper mainly studies the risk analysis on the marine transport section of hazardous chemicals. Under the condition of considering the four main influencing factors of personnel, ship, environment and goods, the dynamic fault tree model is established and solved by Bayesian network method. Finally, Respond to the above four main influencing factors. Based on the complex characteristics of dangerous chemicals and the dynamic randomness in transportation,

this paper uses the dynamic fault tree model to study it. In this paper, the dynamic fault tree model is used to study the risk of dangerous chemicals. And the method of discrete Bayesian network is chosen in the solution mode, which is of great significance to the future study of dynamic randomness risk.

References

[1] Ambisisi Ambituuni, Jaime M. Amezaga, David Werner. Risk assessment of petroleum product transportation by road: A framework for regulatory improvement [J]. Safety Science 2015.79: 324-335

[2] Vytenis Babrauskas. Explosions of ammonium nitrate fertilizer in storage or transportationare preventable parties [J]. Journal of Hazardous Materials 2016.304: 134-149

[3] F. Tena-Chollet, J. Tixier, G. Dusserre, J.-F. Mangin. Development of a spatial risk assessment tool for the transportation ofhydrocarbons: Methodology and implementation in a geographical information system [J]. Environmental Modeling & Software 2013 46: 61-74

[4] Zhou Xiaolong, Jiang Juncheng. Statistical Analysis and Occurrence of Mobile Hazardous Hazards [J]. Industrial Safety and Environmental Protection .2012. (38) 1: 23-26.

[5] Yang Zhongmin. Dangerous chemicals logistics and transport safety [J]. Safety and Environment and Environment, 2007,7 (12): 32-35.

[6]. China Water Transport, 2015.2 (15), 2: 38-40. [8] Li Shuxia, Yan Xiaoqing. [6] Chen Lanfang, Wang Qingquan, Cao Lixin. Waterway Hazardous Chemicals Transportation Emergency Response Capacity Evaluation System Framework [J]. Analysis of uncertainties of dangerous road transport risk based on VC-DRSA [J]. Journal of Donghua University. 2013.8,39 (4): 499-513.

[7] Wu Xiaoming. Cross-river bridge dangerous chemicals transport risk prevention mechanism research [J]. City Road and Bridge. 2012.6,6: 137-140.

[8] Bi Deming. Zhangjiagang Yangtze River Dangerous Ship Pollution Risk Analysis and Prevention, Supervision and Emergency System Research [J]. Navigation Technology .2015.10: 44-45.

[9]. Journal of Harbin Engineering University (20). (35) 6: 707-715 [J]. Journal of Harbin Engineering University (Social Science Edition)

[10] YIN Xin. Study on marine transportation of dangerous chemicals [J]. Journal of Transportation .2009.1. (2) 6: 149-151.

[11] Duan Linghao, Guo Aimin, Pan Yong.Study on Dynamic Fault Tree Analysis Algorithm [J]. Electronic Product Reliability and Environmental Test, 2013.8,31 (4): 59-63.