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RISK ASSESSMENT AND RISK CONTROL USING BAYESIAN NETWORK

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***Abstract*— This research presents an innovative approach towards Bayesian network into hazardous industries risk assessment. This case study has been developed and applied in hazardous industries but have potential for being adapted to other industries. Various application of Bayesian network modeling tool in risk analysis of industries have been widely seen in relevant literature. However a basic problem in Bayesian approach is that it requires too much information in the form of prior probabilities and such information are difficult to get if not impossible to obtain in risk assessment. The best way to estimate prior probabilities of accidents is to use expert opinion as a measure of uncertainty in risk analysis. This research have an analysis of factors related to accidents based on Bayesian belief network .To build Fault Tree method accidents cases are analyzed first, which is available to find all the factors causing the accidents, further it analyzes the factors qualitatively and quantitatively with Bayesian network method, finally determines the risk management program to guide the risk control operations. The results of this study show that bad condition of machine, environment, has the leading posterior probability; therefore, it is the important factor that might responsible for accidents, so there should pay more attention to all the factors when preventing accidents.**

***Keywords*—: Bayesian network, accident factors, posterior probability, prior probability.**

I. INTRODUCTION

The concept of risk assessment and management is becoming more and more widely used in hazardous industries. Various research have been conducted in this area. Risk is commonly defined as a measure of an incident, Along with the cause of harm or damage that it could result. Risk assessment is a systematic and science-based process for describing risk. The main purpose of assessing risks are usually to prevent accidents .To quantify high risk areas both the absolute risk level and the relative importance of different causes have to be quantified. One of the challenges that a risk controller face is to understand complex safety systems, particularly in the case of rare events. Once this risk information is identified, the analyst can use it to develop the corresponding risk control program, form appropriate policies and allocate resources that will reduce the risk.

By using Bayesian network a risk assessment case study has been carried out. To construct a BN, it is necessary to identify the relationships among various factors and their conditional Probability. In this research, an innovative approach towards Bayesian network for risk assessment is presented.

Industries have always been characterized as a relatively risky area for work. Even with the development of modern technology and innovative navigation equipment, accidents are still a major concern. As the awareness of environmental protection and associated safety issues has increased, research of various kinds into risk assessment and analysis therefore forms an important research areas. The causes of accidents are different and complex, so such research is different to measuring the risk levels. Risk assessment indicator is needed to examine the comparative safety levels among shipping, along with an evaluation mechanism for measuring the overall industrial safety. Good indicators can provide better information about the risk level. Using BNs, industries accidents can be analyzed so as to quantify the most important factors, and to determine the relationships among these factors. The Bayesian method and a database of data collected from various sources are used to calculate the prior probabilities for the BN's nodes.

II. ANALYSIS OF FACTORS

From 2008 to 2012 there had been 40 cases of accidents in different industries, in which included 15 death cases causing 10 deaths and 20 serious injury cases causing 15 seriously injured persons. In this 40 cases of accidents, research accounted for 17 cases, in which there are 11 cases of serious injury 3 cases of minor injury and 3 cases of death. It can be seen that the accidents related to machine response, decision making capacity of human and environmental condition is a major part of the accidents in hazardous industries. This study analyzed all these factors only which is responsible for accidents .With the help of analysis of the cause of the accidents carefully, this research find that all of the reasons can be divided into two cases: direct causes and indirect causes.

Direct causes:

•**mechanical, physical or environmental factors**: - The poor geological condition. Safe distance is not enough from the machine, the working environment is poor, noise, inadequate lighting, etc.

•**Human factors** :- Knowledge of safety education of workers is not enough, lack of safety awareness of the operating personnel are weak and lack of self-awareness of security, the management of safety guard officers is poor, Inadequate inspection procedure, etc.

Indirect causes:

The operation process starts without warning, No specific pre safety measures, poor awareness program for workers, etc.

The above causes can be summarized as shown in Table 1.

Table 1. List of factors for accidents

Code	Factors	Description
F1	Machine condition	Including condition of machine, environment of machining condition
F2	Machine type	Including type of machine using in hazardous area
F3	Skill of workers	Inadequate training of workers, insufficient knowledge
F4	Age of worker	Including age of worker above 40 years and below years
F5	Visibility	Including the light, fog etc.
F6	Weather	Including the climate and environment ,noise etc.

Table 2. List of events for accidents

Code	Event	Description
A	Machine Response	The reason of machining depends upon the condition of machine, and type of machine.
B	Worker judgment	It depends upon the age of worker and skill of worker.
C	Environmental factor	It depends upon the geological condition of the environment such as visibility and weather.

III. BAYESIAN NETWORK ANALYSIS

BN depicts a set of random variables and their conditional dependencies by directed acyclic graph (DAG). It can be termed as a probabilistic graphical model. The DAG consists of a set of nodes that represents variables and edges that represents the probabilistic causal dependence among the variables. The structure of the nodes represents causal dependence between variables and this provides the qualitative part of causal reasoning in a BN. The relationship between variables and the relevant states are given in a CPT which is attached to each node, which provides the quantitative part.

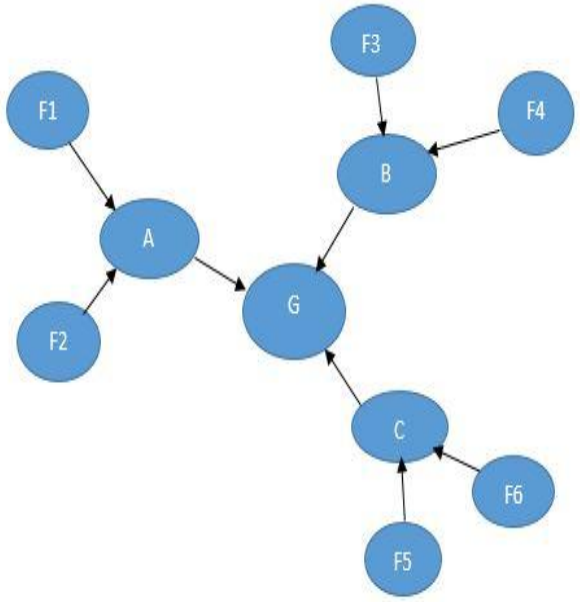

Fig 1. Bayesian network model

Based on principle of Bayesian network constructing a Bayesian model relating the factors for accidents, factors and there explanation are listed in Table-1 and factors responsible for accidents are represented in Table-2

Considering all the factors cause for accidents in hazardous industries are described in Table-3 and Table-4 are constructed in which table column refers to every factors cause for accidents .Three types of importance 1, 0.8 and 0.5 is used to discriminate between death and serious injuries and minor injuries respectively. The factors cause for accidents having different probability which represent its contribution towards the cause of accident. For example in the 4/05 factor (F3) has large contribution towards accidents it plays a leading role in occurrence of accidents. Similarly by accumulating all the factors and there impacts towards accidents this study get a prior probability of each and every cause.

Figure 1 represent F1 (i=1, 2, 3, 4, 5, 6). In the table 4 the probability of each factor is tabulated such that F1
(0.1+0.2+0.15+0.15+0.1+0.15+0.1+0.1+0.2)*0.8+
(0.1+0.1)*1+ (0.1+0.1)*0.5 =1.3
Similarly all factors are calculated. Than to find probability foe each factors
P (F1/T) =1.3/ (1.3+1.06+4.81+0.63+0.88+1.44) =0.132
Similarly the probability of all factors are tabulated in table 4

Table 3. Probability of accidents due to basic cause

Date	coefficient	F1	F2	F3	F4	F5	F6
4.05	0.8	0.1	0.1	0.5			0.15
4.11	0.8				0.1	0.1	
6.14	0.8	0.2	0.2				0.3
10.06	0.8	0.15	0.15	0.6			
12.21	0.8	0.15	0.15			0.5	
7.09	1	0.1		0.6			0.2
2.29	0.8	0.1		0.5			0.2
2.03	0.5	0.1		0.6		0.5	
2.25	0.8	0.15	0.15				0.2
2.28	0.8	0.1	0.1	0.5			0.2
3.19	0.5			0.8			0.4
5.11	0.8	0.1					
6.11	0.8	0.2	0.1		0.5		
4.04	1			0.8			
7.28	1	0.1	0.1	0.6			
9.05	0.8			0.6			
1.12	0.5	0.1	0.2		0.3		
Total		1.36	1.02	4.81	0.63	0.88	1.44
Probability		0.132	0.104	0.47	0.063	0.086	0.142

Table 4. Probability of accidents due to basic cause

BASIC CAUSE CODE	PROBABILITY
F1	0.132
F2	0.104
F3	0.47
F4	0.063
F5	0.086
F6	0.142

IV. CONCLUSION

It is easy to analyze the unexpected factors with the development of Bayesian network which are responsible for accidents and predict consequences which coupled with the help of expert opinion and subjective judgment, in hazardous industries. There are many practical engineering applications and there may a lot of problems in which Bayesian network are applied. This research covers the study of basic causes and their contribution towards accidents in hazardous industries. For this various accidental cases are analyzed and with the help of expert opinion the contribution of basic causes are quantified .By knowing the percentage contribution of factors responsible for accidents it become easy to do safety operation before it happens.

V. REFRENCE

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