SIIC041

DYNAMIC ACCIDENT MODELLING TO IMPROVE RISK ANALYSIS IN THE CONTEXT OF BHOPAL INDUSTRIES

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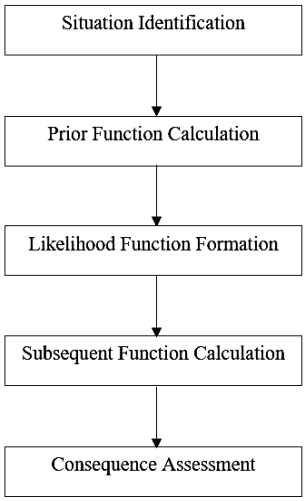
Abstract:
Chemical industries are complicated and dynamic to handle. Dynamic characteristics could include inspection time interval, ageing of components in plants and other dependent criteria can influence dynamic processes. The conventional risk assessment could measure dynamic changes in processes but only in limited capacity. Hence, it is significant to develop method for time-dependent effects to predict the probabilities failure rates for components in plant with time. In this study, dynamic risk assessment has been developed a technique based on Bayesian network (BN). BN is a structure optimal which organize cause-effect relations and dynamic BN capture change variables over time. This study proposed to develop dynamic accident modelling to improve risk analysis in the context of Bhopal industries. A methyl isocyanate (MIC) gas leakage scenario in the plant was quantified through identifying hazards through fault tree analysis. It has been observed that the developed method was able to provide updated probability failure of different components with time. In this study, Bhopal cases would be illustrated the mapping procedure of FT into BN and to identify factors to have significant influence on an event occurrence. Rupture disk, gas leakage and water accumulation in pipe contribute into gas explosion in Bhopal where the components and safety barriers started to fail by year and no inspection had done. Therefore, the finding showed a method for dynamic risk assessment which enable of providing updated probability of event occurrences through failure rates, considering sequential dependencies with time. The failure rates were simulated in GeNIe software. Therefore, dynamic characteristics could reduce cost of inspection, downtime and other maintenances. The possibilities of failure rate values for components tend to increase with time. But with maintenance work were done on equipment in every one year, then possibilities of failure rates become decreases and low possibilities of breakdown. The Bhopal failures were demonstrated the effect of sequential; dependency of one component on another component contributes to the risk. It could be concluded that with the increases in year of inspection interval, the probability of top event, MIC gas released to the surrounding would be reduced.

***Keywords*:**
Dynamic, fault tree, Bayesian network, Bhopal disaster, GeNIe software.

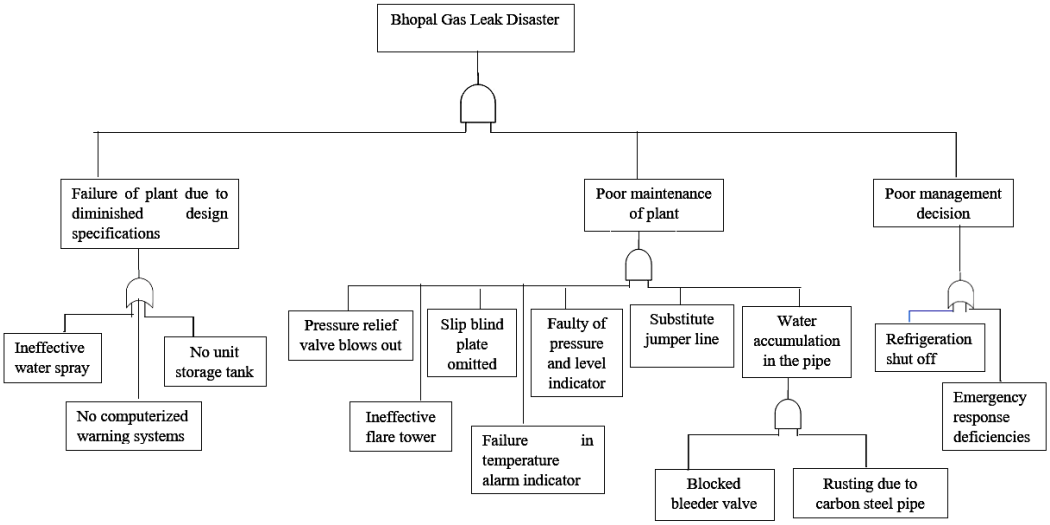
Objectives:

- To study on dynamic accident modeling that could be improved risk analysis in the context of Bhopal industries which could be applied for other accidents by using FTA and BN.
- To analyze critical factors on errors failed the safety assessment by identifying hazards in plant operation, remedial measures and control for risk minimization through data analysis and decision making theory.

Methodology:

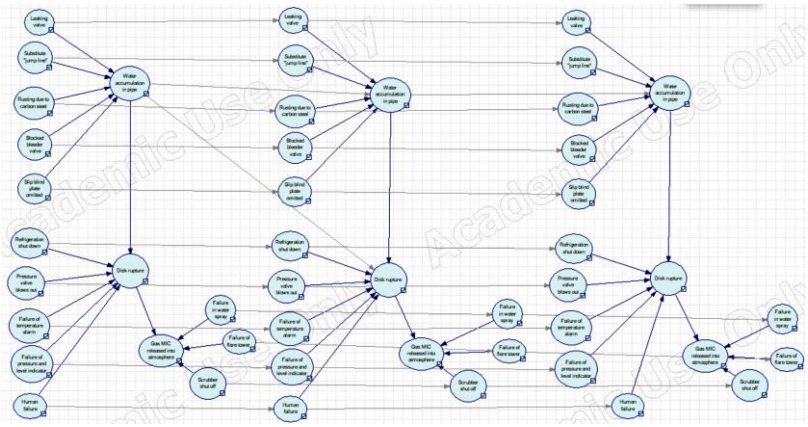


Steps in Dynamic Risk Assessment



Fault Tree of Bhopal Disaster

Component	Failure rates/year	Probability of failure rates (Year of Manufacturing MIC)	References
Leaking valve	0.122	0.177741125	[70]
Slip blind plate omitted	0.129	0.2023	[70]
Substitute jumper line	0.1315	0.213	[70]
Blocked bleeder valve	0.122	0.1755	[70]
Rusting due to carbon steel pipe	0.123	0.18	[70]
Scrubber shut off	0.167	0.154	OREDA
Refrigeration unit shut off	0.122	0.174693132	OREDA
Ineffective flare system	0.167	0.154	.OREDA
Ineffective water spray	0.068	0.018	OREDA
Pressure relief valve blows out	0.068	0.018	OREDA
Human Failure	0.067	0.014	[71]
Failure in pressure and level indicator	0.136	0.235	[71]
Failure in temperature alarm indicator	0.066	0.0139	[71]
Water accumulation in pipe	0.063	0.004347	[71]
Disk of tank rupture	0.062	0.00191	[71]
MIC gas leaking and released to the atmosphere	0.068	0.0191	OREDA

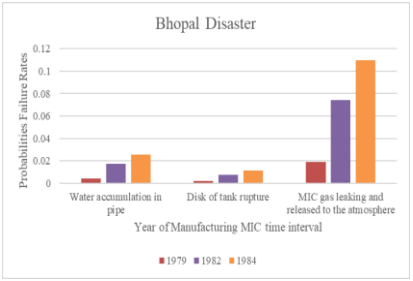


Bayesian Network with three-time slice

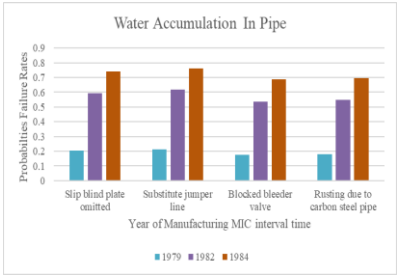
Results:

Probabilities of Failure Rates for:

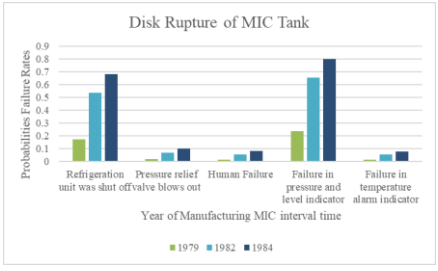
Top and Immediate Events



Water Accumulation in Pipe Occurrence



Disk Rupture



Conclusion:

In conclusion, the probabilities of failure rates values for components were different with time, due to the probabilities of failure rates tend to increase with time. However, with inspection or maintenance work were done on equipment in every 6 months or one year, then probabilities of failure rates became decreases and low possibilities of breakdown. Therefore, developing models in BN could quantify ageing of components and considering the cost dynamically by time.