

A Systematic Review: Development Techniques and Utilization of Expert Systems Inferences for Health and Safety Environment in Oil & Gas and Petroleum Industries.

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Abstract— This paper explains about the development of intelligent expert systems for health and safety environment (HSE) in different oil and gas and petroleum industries for hazard analysis and avoidance, to advise the user on the extent of particular health and safety risks by using a detailed literature review and categorization of articles from last ten years with a keyword index and article abstract in order to investigate by what method and technique expert systems applications have been developed during this epoch. Five bibliographic databases covering a broad series of health and safety fields were searched in various manufacturing and oil and gas industries related researches. Twenty six met the study's relevance criteria. Fifteen of these met the methodological quality standard, this article review and classifies expert system development by using these mentioned classifications expert system utilizing rule base inferences, expert system utilizing knowledge base inferences, expert system utilizing neural networks inferences, expert system utilizing fuzzy logic inferences, expert system utilizing case-based reasoning inferences, with their functions and applications for different research and problem domains in manufacturing industries. A key advantage of expert systems in Health and safety in hazard analysis and avoidance is delivery of domain-specific expertise to people who are not specialists and who therefore might not avoid those hazards without interactive guidance. Conclusion that can be made from this systematic review paper is that ES development and implementation techniques are growing to develop in pursuit of expertise orientation implying that ES application development is an issue derived area. Methodology studies may increase our understanding on this domain. Lastly, the power of ES applications includes possibility to change continually and obtain new awareness which makes ES an application of future implementation.

Keywords— *Expert systems; Utilization of Expert system; Oil and Gas Expert Systems; Systematic review, Health And Safety Expert Syatem.*

I. INTRODUCTION

The phrase “expert system” was coined in the 1970's to reflect the target of a group of researchers to replicate by computer the problem solving expertise of human specialists in narrow areas of application. An Expert System is a computer-based system designed to respond like a human expert in a given field (Encyclopedia Britannica, Inc., 2006). An Expert System operates as a computer application that uses specialist domain knowledge to suggest solutions to problems in a particular discipline like oil and gas industries.[3] For example, expert systems can help to diagnose human illnesses, make financial forecasts and identify workplace risks and hazards. These types of tools may also be known as knowledge-based systems, decision-making tools and computer-aided learning. These intelligent systems offer dominant and flexible way for extracting solutions to a variety of problems and issues indifferent fields and industries.

Over the last seven years, an average of nearly 150 people has died and 4,000 have suffered a major injury annually as a result of various incidents in oil and gas and manufacturing industries. Falls from height, Fire, slip and trip, hazardous chemical and other such incidents are the most common cause of major injuries for workers in oil and gas industries (2010-2012 NHIS-OHS,). Evaluating the success of HSE, organizations use intelligent expert systems to manage risks at work in a number of areas and it can provide important lessons. In reducing workplace risk and hazards, intelligent expert systems play very effective and major role and also facilitate the workers and decision makers to follow the safety measures in sufficient way in this modern era of technology by using different Expert opinions and recommendations.[5]

Table 1 explain the brief discussion and application of ES.

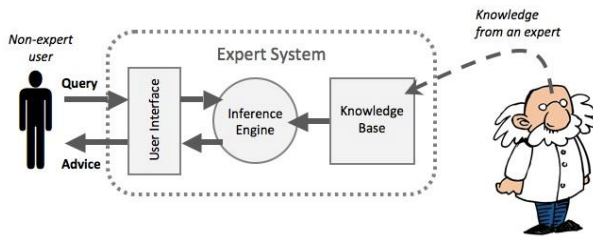


Fig 1 shows block digram of intelligent expert system.

Fig 1. Block Diagram Of Expert System.

II. EXPERT SYSTEMS UTILIZING RULE BASED INFERENCE

Rule base expert system can be explained as, system which obtained and gathered knowledge from experts of that field, and represents that knowledge in the form of rules, such as IF and THEN. This rule can then be used to perform operations on data for implication in order to reach suitable conclusion or recommendation.[8] These inferences are essentially a computer program that provides a methodology for reasoning about information in the rule base or knowledge base, and for formulating conclusions. Development of rule-based expert systems for health and safety in oil and gas and petroleum industries is carried out for following utilizations and applications: consultative system, knowledge verification/validation, forecast strategy, knowledge acquisition, knowledge demonstration, bio separation, resource utilization, biochemical, Permit Control & Monitoring, working at height to confined spaces ,training system, geosciences, Risk assessment system. Fig 2 shows block digram of rule base expert system.

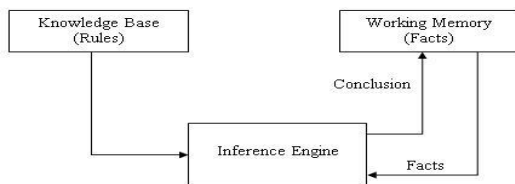


Fig 2. Block Diagram Rule Base

III. EXPERT SYSTEMS UTILIZING KNOWLEDGE BASED INFERENCE

Knowledge base expert system is human centered. This accentuates the fact that Knowledge base expert system have their extraction in the field of artificial intelligence and that they are attempts to understand and initiate human knowledge in computer systems (Wiig, 1994). Knowledge based system on the other hand is the engine which uses such information processes it in to rules and facts which can be used in archiving a specified goal.[5] The four main components of knowledge base systems are usually distinguished as: a knowledge base, an inference engine, a knowledge engineering tool, and a specific user interface (Dhaliwal & Benbasat, 1996). The term KBS includes all the organizational

information technology applications that may prove helpful to manage the knowledge assets of an organization, such as ESs, rule based systems, groupware, and database management systems of any industry (Laudon, 2002).[6]

Development of knowledge-based expert systems is done for health and safety in oil and gas and petroleum industries for following utilizations and applications: Fire Safety Advisor ,workplace risk analysis, decision support, knowledge management, knowledge representation, buildings environment evaluation, chemical hazard incident management, Fire risk assessment , climate forecasting, HSE strategic management, environmental protection, wastewater treatment in industries, workplace decision making and learning, chemical process and incidents controlling.Fig 3 shows block digram of knowledge base expert system.

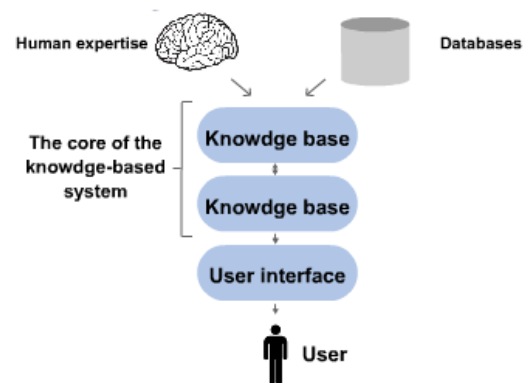


Fig 3. Block Diagram Of Knowledge Base

IV. EXPERT SYSTEMS UTILIZING FUZZY BASED INFERENCE

For the development of Fuzzy expert systems the method with is used is called fuzzy, A fuzzy expert system is an expert system that uses a collection of fuzzy membership functions and rules, instead of Boolean logic, to reason about data. The rules in a fuzzy expert system are usually of a form similar to the following equation(1) :

If A is low and B is high then C = medium (1)

If x is low and y is high, then z = medium, where x and y are input variables (names for known data values), z is an output variable (a name for a data value to be computed), low is a membership function (fuzzy subset) defined on x, high is a membership function defined on y, and medium is a membership function defined on z [11]. The antecedent (the rule's premise) describes to what degree the rule applies, while the conclusion (the rule's consequent) assigns a membership function to each of one or more output variables. Most tools for working with fuzzy expert systems allow more than one conclusion per rule. The set of rules in a fuzzy expert system

is known as the "rule base" (or knowledge base). Some advancement in development of fuzzy expert systems for health and safety is growing in oil and gas and petroleum industries for following utilizations and application, chemical hazards identification, uncertainly reasoning, HSE knowledge integration, wastewater treatment, water supply forecast, medical consultation system, workers performance indexing, system security, gesture recognition, and health and safety analysis, Fire fighting. Fig 4 shows block diagram of fuzzy base expert system.

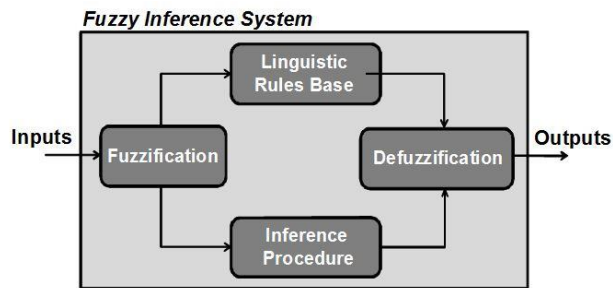


Fig 4. Block Diagram Fuzzy Base

V. EXPERT SYSTEMS UTILIZING NEURAL NETWORK INFERENCE

From the point of view of expert systems, neural networks are important mainly because of their learning abilities. In expert system development, construction of knowledge base is the most time and money consuming task. Neural networks are considered as devices that can minimize this charge by acquiring necessary knowledge from examples of the domain. Expert systems with neural network knowledge base are called neural expert systems. Neural network consists of a set of nodes and links between nodes [17]. Nodes have ability to take an input, execute some function and give an output (activation). Activation of a node follows a path defined by links and become an input for another node. Links between nodes are weighted. Therefore, effect of one node on another is defined by the strength of the weight between these nodes. Each node takes input from (and gives output to) many other nodes. Group of nodes that are connected to others in a similar way are called layer of nodes. The simplest neural network architecture has two layers: input and output. A group of two layered networks are universal computers because each of them is capable of implementing and, or and not gates (Mehrotra et. al., 1997). On the other hand, two layered neural networks can implement only linearly separable functions. For functions that are not linearly separable, we need at least three layers: input, hidden and output. It was shown that a three layered network is a universal computer (Mehrotra et. al., 1997). The most important property of neural networks is their learning ability. Learning

is achieved by exposing a network to a set of training examples and executing a learning algorithm.[13]

Development of rule-based expert systems for health and safety in oil and gas and petroleum industries for following utilizations and applications: ,workplace risk analysis, decision support, knowledge management, knowledge representation, buildings environment evaluation, chemical hazard incident management, Fire risk assessment , climate forecasting, HSE strategic management, environmental protection, wastewater treatment in industries, workplace decision making and learning, chemical process and incidents controlling [15]. Fig 6 shows the block diagram of neural ES.

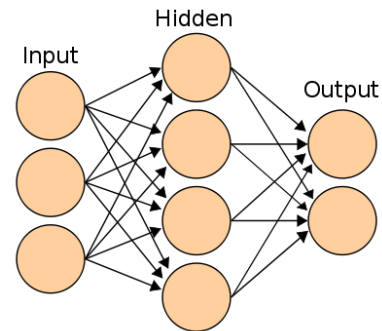


Fig 5. Block Diagram Of Neural Expert System

VI. EXPERT SYSTEMS UTILIZING CASE BASE BASE INFERENCE

Often human problem solving doesn't laboriously follow chains of reasoning from assumptions through to conclusions but seems to work form recollections of past situations which are then Reinterpreted to suggested solutions for similar problems. The idea of case based reasoning is to Automate this style of reasoning by collecting a library of formal descriptions of past problems along with their solutions [21]. New problems are then described in a similar formal language and a matching algorithm is used to compare features of the new problem to features of past problems in the library. The best matching past problem and its solution is then retrieved and automatically adapted to show its relevance to the new problem. If it is considered appropriate, the solution is then refined and the new problem-solution pair is stored in the case library where it may be reused. Development of Case-based reasoning expert systems for health and safety in oil and gas and petroleum industries for following utilizations and applications: manufacturing process design, knowledge management, power system restoration training, ultrasonic inspection, medical planning, medical application, fault diagnosis, e-learning, and knowledge modeling. .Fig 6 shows block diagram of case base reasoning expert system.

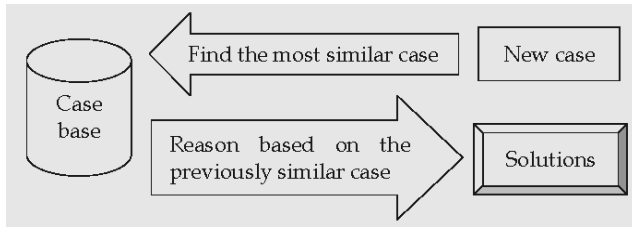


Fig 6. Block Diagram Case Base Reasoning

VII. DISCUSSIONS

Development techniques and utilization of expert systems inferences for health and safety environment in oil & gas and petroleum Industries are a broad category of research. Several detailed methods are techniques discuss in this paper as an examples for understanding the development solutions and recommendations to particular health and safety expert system. Consequently, Development techniques and utilization

of expert system are attracting much concentration and efforts.. During this briefed review researcher analyze that most of the expert system used appropriate required methods and techniques for solving the health and safety issue and problems. On the other side, some methodologies have common concepts and idea and also types of methodology.[25] For example , RBS and KBS. This may indicate that the development of ES in health and safety domain of petroleum industries techniques and methods is directed toward expertise orientation. In this paper articles discussed were from HSE oil and gas industries resources from reputed and authentic databases. After this review we can easily understand about the importance and effectiveness of intelligent expert systems in health and safety field to reduce the workplace risk and hazards and provide a safe and comfortable environment to the work force with the help of expert systems technology in this modern and advance era. Table 1 shows that the brief discussion and applications of different Health and safety in oil and gas sector expert systems.

TABLE 1: Breif Discussion On HSE Based Expert Sytems with Application and Utilization

Name Of ES	County	Industry Type	Industrial Domain	Utilization And Application	System Availibility	Lemgth Of Time system Excistence	Techniques
Permit Control & Monitoring System (PCMS)	UK	Oil And Gas, Pharmaceuticals.	The system covers a range of safety domains from working at height to confined spaces, and excavation to electrical work.	This system identifies workplace risks and hazards. It ensures that the permits are correctly completed in a user-friendly workflow set-up.	Purchased from company	6 years	Rule Base
SPONCOM	USA	Mining work & Oil and Gas	Fire prevention	Design for mining and oil and gas industries to access causes by fire and heat.	Purchased from company website.	10 Years	Knowledge Base
Confined Spaces Advisor 1.1	USA	Oil and gas and chemical industries apply the OSHA Permit Required Confined Spaces Standard.	Confined spaces that have hazardous conditions	The OSHA Confined Spaces Advisor was designed to provide users with interactive expert help to apply the OSHA 'Permit Required Confined Spaces Standard.	It is available for download from the internet and Purchased from company	10 years	Rule Base
Fire Safety Advisor 1.0a	USA	Oil and gas and chemical industries apply the OSHA Permit Required fire safety Standard.	Fire Safety	OSHA's Fire Safety Advisor provides users with interactive expert help to apply OSHA's Oil and gas and chemical industries Standards' for fire safety and emergency evacuation.	It is available for download from the internet in a software format and is downloaded approximately 600 times per month.	7 years	Knowledge Base
DUST-EXPERT	UK	This system was produced by Adelard for the	Explosive dusts	The system provides information on the safe design and operation of	Purchased from company	10 years	Rule Base

		Health and Safety Executive.		plant that are subject to dust explosions.			
Hand-arm Vibration Calculator	GB	Health and Safety Executive (HSE)	Vibration	It identifies workplace risks by assisting in calculating exposures for whole-body vibration.	Free, downloadable software from the HSE website.	7 years	Fuzzy
Hazard Awareness Advisor 1.0	USA	Oil and gas and chemical industries apply the OSHA Permit Required fire safety Standard.	Hazard Awareness	This is a hazard identification tool, which advises on a range of areas such as slips and falls, noise, ventilation and radiation.	It is available for download from the internet and Purchased from company	8 yaers	Knowledge Base
Preventing falls from slips and trips	Canada	Oil and gas and chemical industries apply the OSHA Permit Required falls from slips and trips safety Standard.	Preventing falls from slips and trips	This system an online expert system on how to prevent injuries in the workplace that are a result of slips, trips or falls from the same level.	It is available for download from the internet	6 years	Rule Base
CSHM	China	Construction and oil Gas Industries	Construction & Oil Gas	This expert system identifies workplace risks in the Chinese construction industry by monitoring and assessing construction safety and health performance.	It is available for download from the internet and Purchased from company	7 years	Knowledge Base
Action Checkpoints for Comfortable Work	Japan	National Institute of Industrial Health (NIIH) (Japan)	Workstation Interface and genral work industries.	This expert system identifies workplace risks and their solutions.	It is available for download from the internet and Purchased from company	8 years	Case Resaoning
EASE System	UK	‘This system was produced by the Artificial Intelligence Applications Institute (AIAI) for the Health and Safety	Hazardous Substances	This tool guides risk assessment by providing both authorities and manufacturers with computer based guidance from the Regulator.	Computer software which can be used in Windows applications	10 years	Neural
Hearing Protector Device Compendium	US	The National Institute for Occupational Safety and Health (NIOSH)	Noise	This system is a search engine which helps you to search for different types of noise protectors by selecting different manufacturers and models.	Free, internet based.	6 years	Knowledge Base
Oil and gas well drilling and servicing e-tool	US	Occupational Safety and Health Administration (OSHA), U.S. Department of Labou	Oil and gas industry work	supports regulatory compliance by providing you with information on to how to go about oil and gas drilling.	Free, internet based.	7 years	Knowledge Base

VIII. CONCLUSION

In this review paper of development techniques and utilization of expert systems inferences for health and safety environment in oil & gas and petroleum Industries are discussed, from ten years with a keyword index and article abstract in order to investigate by what method and technique expert systems applications have developed during this epoch. Five bibliographic databases covering a broad series of health and safety fields were searched in various manufacturing and oil and gas industries related researches. Conclusion that can be made from this systematic review paper is that ES development and implementation techniques are growing to develop in pursuit of expertise orientation implying that ES application development is an issue derived area. Methodology studies may increase our understanding on this domain. Lastly, the power of ES applications includes possibility to change continually and obtain new awareness which makes ES an application of future implementation. After this review we can easily understand about the importance and effectiveness of intelligent expert systems in health and safety field to reduce the workplace risk and hazards and provide a safe and comfortable environment to the work force with the help of expert systems technology in this modern and advance era.

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