Knowledge Base and Rule Base Safety Management Systems Development Strategies and Applications for Petrochemical Industries: A Brief Outline

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Knowledge Base and Rule Base Safety Management Systems Development Strategies and Applications for Petrochemical Industries: A Brief Outline

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Abstract. This review paper discussed about the development tactics and applications of knowledge based and rule-based decision support systems for health and safety in oil and gas sector. It recommends the users on the extent of health and safety concerns for risk and hazard investigation and prevention in which the system developers and researchers mostly face issues during selection and adaptation of development approaches. A complete and systematic review and classification of articles from last seven years has been conducted and briefly analysed, to investigate various methodologies employed in previously developed rule based (RB) and knowledge based (KB) decision support systems. All major bibliographic databases covering a broad series of health and safety fields were searched in various oil and gas production sector related studies. Eighteen articles met the KB and RB study. Twelve of these met the methodological prospective of required investigation. In this review paper, researchers briefly explain about the methodological aspects and industrial applications of rule and knowledge-based decision support systems for reducing work place risks and hazards in safety and health domain. Conclusions that can be extracted from this analytical review paper of the methodological variation and applications of rule based and knowledge-based decision support system is that both inferences are interrelated to each other. RB and KB inferences techniques and methods are used in both interpretations for developing decision support systems in the context of oil and gas extraction and production sector. But safety and health consider KB decision systems as more effective for taking suitable decisions due to real time information and experts' opinions which facilities safety professionals to take appropriate decision then RB reasoning decision support systems.

1. Introduction

Decision support systems are computer-based systems providing an appropriate decision to the users in a particular domain [1]. Development of framework of decision support systems consists of three major phases; Intelligence, choice, implementation [2]. Also, decision support systems are classified in four components such as: input, user expertise, output and decision. Decision support systems (DSS) provide

prevailing and flexible approach for extracting solutions to a variety of problems and issues in multiple industrial and non-industrial settings [3].

Especially in health and safety domain of manufacturing and production industries, decision support systems play an important and efficient role for reducing risks and hazards at workplace [4].Fire, fall, slip and trip, hazardous chemical and other such incidents are the most common cause of major injuries for workers and for the prevention of these incidents and hazards decision support and expert systems are widely used in different oil extraction industries for taking decisions for hazard prevention in real time. According to the available literature on the development of industrial based decision support systems specifically for oil and gas drilling safety is quite limited for knowledge base and rule base decision support systems. Therefore, this review paper has been carried out to briefly discuss and highlight the design and development methodologies and industrial applications of existing industrial safety and health decision support system with knowledge base and rule base inferences.

2. DSS Based on Rule Base Interpretation

The Rule based decision support system can be defined as, a particular system which collects required information and knowledge from the experts of that discipline in a constructive approach, and interprets that knowledge in the form of rules, such as IF and THEN statements [5]. These rules are also used to perform operations on data implication in order to reach suitable conclusions or recommendations. Normally, a rule-based decision support system consists of four main elements such as: detail record and list of rules, interpretational engine, working memory and user interface [6].

2.1 Detail Record

First main component of rule-based support systems is the record and list of detail rules which are specific and related with the particular domain of required field [7]. Example of a rule-based system is shown in Figure 1.

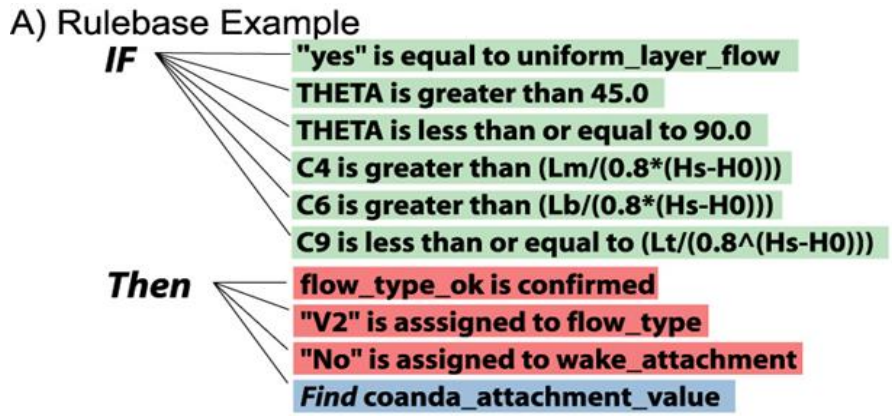

Figure 1. If-Then Rule Base Example

2.2 Interpretational Engine

The second component of rule base decision support system is the interpretational engine which takes on user requirement and enquiry regarding particular information with the help of defined rules [8]. Execution programs are run by performing the following match-resolve-act cycle.

a) Match: In this initial stage, all production will coordinate in opposition to the operational memory [8]. As a result, a conflict set is obtained. An instantiation of a formation is a requested rundown of operational memory components that fulfills the left-hand side of the production.
b) Conflict-Resolution: In this stage, one of the formation instantiations in the conflict set is selected for execution. On the off chance that no measures are fulfilled, the mediator stops.

c) Act: In this third stage, the activities of the formation chosen in the conflict determination stage are executed [9]. These activities may change the body of operational memory. Towards the end of this stage, execution comes back to the initial stage.

2.3 Temporary Working Memory/User Interface

These two components of RB decision support system are one of the main elements because without the working or operational memory and user system interface, system is not able to connect with the different user's domain in all over the world for sending and receiving input and output signals [10]. These interpretations are basically a computer program that provides method for analysis about information in the rule base, and for formulating respective conclusions. Figure 2 shows the architecture of a rule base system.

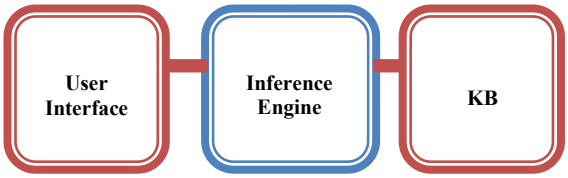

Figure 2. Architecture of Rule Base System

3. Implication of Rule Base Decision Support System in Health and Safety

Mainly, rule-based (RB) decision support systems for health and safety in oil and gas sector are: knowledge verification system, weather and environmental forecast strategy, knowledge acquisition, knowledge demonstration, bio separation, resource deployment, biochemical, Permit Control & Monitoring, working at height to confined spaces, training system [11]. Rule base reasoning systems are quite common in safety and health domain of small industrial organization which deals with limited data and specified it with several rules and conditions [12]. According to the detailed review it has been identified that the petrochemical industries prefer rule base reasoning systems for dealing with safety in standardized operations [13].

Alternatively, some experts have not emphasized on rule base systems due to limited knowledge and information to overcome life threatening hazards and risks [14]. But on the other hand, system developers consider rule base systems as easy to maintain decision support systems compared to knowledge-based systems [15]. According to the previous researchers, confined space advisor 1.1 and PCM systems in the domain of confined space and working at height of occupational and safety at oil and gas industries are considered as most effective decision support systems. Decision support systems based on rule-based approach are depicted from Table 1 [17].

Table 1. Approaches and Applications of Exciting RB Decision Support Systems

System	Safety Domain	Approach
Confined Spaces Advisor 1.1	Confined spaces that have hazardous conditions	Rule Base
DUST-EXPERT	Explosive dusts	Rule Base
Preventing falls from slips and trips	Preventing falls from slips and trips	Rule Base
PCMS	The system covers a range of safety domains from working at height to confined spaces, and excavation to electrical work.	Rule Base

Furthermore, as per comprehensive literature review its has been recommended that that rule-based systems are more appropriate if them merge with knowledge based systems and there is a sheer need of such systems which can also used for vestibule safety training activities at oil and gas industries to train workforce for safe operations [15-16].

4. Decision Support System Based on Knowledge Base Interpretation

Knowledge base decision support systems are artificial intelligence-based applications that use a database of knowledge. KB decision support systems are also called systematic form of database systems. These systems contain structured and unstructured information and knowledge [12]. Knowledge base support system has two major constructive parts such as knowledge base and inference engine. Knowledge base represent about the facts and particular knowledge in the form of data base and inference engine represent the logic and rules to the knowledge and information stored in database [13-18]. The term KB systems include all the organizational information and technology applications that may be helpful to manage the knowledge assets of an organization. Figure 3 explains the conceptual diagram of KB system.

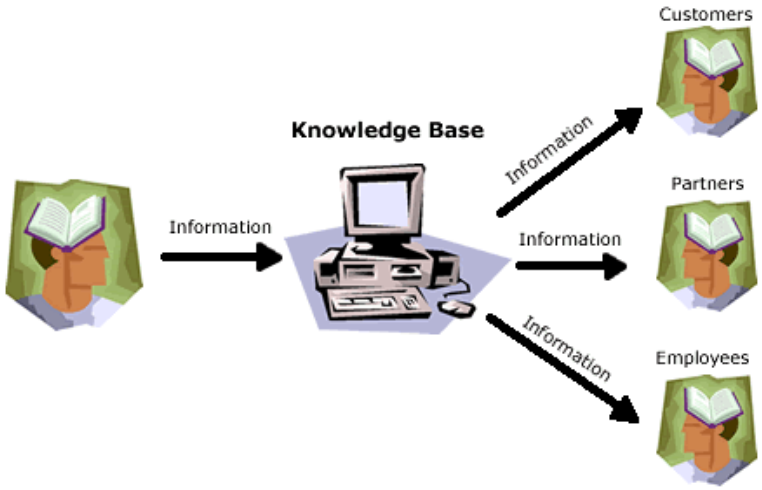

Figure 3. Conceptual Diagram of Knowledge Base system

Generally, the main applications of knowledge-based decision support systems for health and safety for reducing work place risk and hazards in oil and gas sector are: Fall and slip advisor system , hazard and risk analysis, workplace safety decision support system, knowledge management system, knowledge representation system, buildings environment evaluation system, chemical hazard incident management, fire risk assessment system, climate forecasting, safety strategic management, environmental protection, wastewater treatment in industries and incidents controlling system [12]. Based on detailed review it has been analyzed that most of the safety and health management systems are knowledge based and take decision according to the recommendation and knowledge provided by field experts [12].

Some safety and health experts suggested that those systems which contain real time accident investigations feedback from field experts are more effective than other systems. But also, regular maintenance and upgrading in the knowledge base of decision support systems are required on weekly or monthly bases which is considering to be bit costly and time taken. Most of the existing knowledge base decision support systems are used for accident prevention for fire and chemical awareness and construction safety at oil and gas industries worldwide as shown in Table 2 [17]. Such as Fire safety Advisor 1.0 a and E-Tool developed by occupational safety and health administration is working on knowledge base principles and reviewed and updated based on latest experts' knowledge on monthly bases [15-18].

Table 2. Approaches and Applications of Exciting KB Decision Support Systems

System	Safety Domain	Approach
SPONCOM	Fire prevention	Knowledge Base
Fire Safety Advisor 1.0a	Fire Safety	Knowledge Base
Hazard Awareness Advisor 1.0	Hazard Awareness	Knowledge Base
CSHM	Construction & Oil Gas	Knowledge Base
Hearing Protector Device Compendium	Noise	Knowledge Base
E TOO: Oil and gas well drilling and servicing.	Oil and gas industry work	Knowledge Base

5. Discussion

Approaches and applications of rule base and knowledge base decision support systems inferences for health and safety in oil & gas sector are technologically most important area of investigation from reducing and controlling work place risk and hazards. Quite a few conceptual methods are reported in this paper. Throughout this briefed review researcher analyze that knowledge and rule base interpretations are commonly used in many decision support system and expert systems due to the simplicity and convenience for solving the health and safety. For KB both knowledge and rules or logic are used for the development of decision support system [15-16].

This review it shows that in KB systems developers must have to relate the knowledge with rule base interpretation. In addition, Knowledge based systems also process data and rules to output information and make decisions. On the other side, Rule-based systems process data and output information, but they also process rules and make decisions [19]. The decision support systems in health and safety for reducing the risks provide a safe and comfy atmosphere to the workers by adopting these methodological approaches in development of system.

6. Conclusion

This paper discussed about the development approaches and applications of rule based and knowledge-based decision support systems inferences for health and safety in oil & gas industries in order to investigate which methodology in rule base and knowledge base decision support systems have been effective for safety and health related management systems development for petrochemical industries. Major bibliographic databases covering a wide series of safety and health discipline were explored in different oil and gas production sector related studies. For KB and RB 18 articles met the study's relevance criteria. Conclusion that can be extracted from this analytical review paper of the methodological variation and applications of Rule base (RB) and knowledge base (KB) decision support systems is that both inferences are used at petrochemical industries in different domains of occupational safety and health.

This brief literature review also highlighted that the knowledge-based decision support systems are considered as more effective for accident prevention then rule based decision support systems due to its dynamic nature and real time hazard controlling recommendations. Moreover, it is also recommended by the safety experts to develop such decision systems for accident prevention which are based on KB and RB inferences for vestibule training activities of oil and gas employees who are supposed to expose with hazardous conditions.

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