Knowledge Based Decision Support System in Steel Industries

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Abstract. Knowledge-based information system (KBIS) is a structure which is based on understanding, which develops approaches to aid people in decision-making and to gain knowledge of best business practices. Anticipations from these approaches are to converse with human beings but the essence and manner of aid given are important issues. DSS i.e Decision Support Systems is a peculiar kind of information system that eases the growth of product designs of viable quality, functional practices and business decision-making. Developing and executing a decision support program for a steel plant is an asking job. Various business functional fields like production and supply chain, product planning, marketing, and finance, which is required to take several censorious decisions. A KBIS clubbed with DSS will be very useful tool for steel industries in decision making. A detailed discussion on the structure of KBIS and DSS is carried out in this paper. A significant portion of this article is dedicated to the execution of KBDSS i.e knowledge based decision support system in steel industries. The article summarizes with the advantages and shortcomings of KBDSS execution.

Keywords: Knowledge based Information systems, Decision support systems, KBDSS, steel industries.

1. Introduction
Due to unparalleled increase in complexity fuelled by ever-changing design requirements, ambitious architectural designs and international competition; the Architecture, engineering and construction (AEC) sector requires a drastic reduction in delivery times. This sector is experiencing a move towards prefabrication in order to obtain higher environmental and quality performance and improve the sector's efficiency (Construction Industry Council, 2013). In view of changing customer needs and the level of client involvement, this becomes tedious for the organizations to deliver product on time. Solution lies in the hand of knowledge based dynamic DSS with a sound decision making. Decision-making is a information-intensive process, with information playing a major role in facilitating and shaping decisions. With increased use of electronic communication systems and exposure to the world market, the steel industries are facing a lot of difficulties not only in continually improving their efficiency but also to maintain a given level of quality in their product. This has led to high demand of the experienced employees who are capable of taking right decision at right time and right place. However the industries are facing difficulty in making the ends meet. As the knowledge required taking decisions are extensive in nature and are acquired through long experience. The problem...
worsens if the decision to be taken requires expertise of more than one field. This has led the researchers to think in the direction of knowledge based decision support systems.

1.1. A Knowledge based/Engineering systems subsection
To make fast and efficient decisions and to contribute to the information retrieval system in response to specific queries, KBS i.e Knowledge-Based Systems which is regarded as rule-based systems (Mahapatra, 1997) are integrated with a database of knowledge experts with linkages and coupling architecture (Laudon and Laudon, 2002). The aerospace, automotive and shipbuilding industries have developed digital tools, called Knowledge-Based Engineering (KBE) systems, which support design through automation of reusable knowledge. KBE process automation is seen as a possible solution for improving quality and reducing delivery times and costs for Engineering-To-Order goods (Willner et al., 2016). KBE's goal is to reduce design effort by automating repetitive activities, reusing information and promoting product creation in a multidisciplinary environment (Verhagen, Bermell-Garcia, Van Dijk, & Curran, 2012).

Knowledge is the "comprehension, understanding, or knowledge gained through education or experience; something experienced, interpreted, observed, inferred, or understood. In simpler words the ability to use information provided is knowledge. After having a good understanding of knowledge, the knowledge base can be defined as a collection of rules, procedures, and facts, into schemes. A knowledge base is generally considered as the collection of all the information about a specific area of interest. These systems are anticipated to converse with human beings as users, but the kind of the assistance provided and the way in which it is delivered are the important issues associated with it. KBS needs a knowledge base and a reasoning mechanism.

1.2. Architecture of a knowledge based system
The knowledge based system consists of a knowledge base and a reasoning mechanism i.e. they have understanding and familiarity of the subject as well as the ability to infer from that understanding. Before going into the architecture of the knowledge based system it is good to know, in brief, how a knowledge base is developed. Development of knowledge base is pictorially depicted below (figure.1).

Another important part of a knowledge based system is the rule sets which help the system to infer from the acquired knowledge. Besides the rule sets should also be editable so as to impart the much required flexibility to the overall DSS. The rule set is always accompanied by a interpreter mechanism and they work in a synchronous way to deliver the required information. The working and architecture of a rule set can be shown pictorially as (figure.2).
After being well versed with the architecture of the knowledge base and the inference system the detailed architecture of the knowledge based system can be easily understood. The generalized architecture of the knowledge based system can be easily described as follows (figure.3).

The user input the current problem data through the user interface and data is acted upon by the inference system (rule sets) with the help of the knowledge base to give the required output. The knowledge base editor adds to the flexibility of the system by allowing the user to make changes in it.

2. Decision Support Systems
Decision Support Systems (DSS) is a particular type of information system that facilitates business decision-making and operational activities. It is seen as a computer-based system that can help decision-makers to use models and data and solve defined issues. Rauscher, 1999 in his study depicted that to promote optimal decision making within the supply chain there is a requirement of automating number of activities practically. DSS is intended to incorporate wellsprings of unavailable data, and fills in as a standard wellspring of information that can be altered to combine the most recent new advancements (Plant and Hu, 1992). All the more as of late, such methodologies have been applied as PC programs, either as independent gadgets or as coordinated computational conditions for complex dynamic, frequently enlarged by a scope of procedures got from data science, intellectual brain research and man-made reasoning. Such computational environments are often called as DSS.

DSS are not only capable of taking decisions by themselves rather they automate several tasks which are required in critical decision making. Thus in a decision support system the decisions and the decision making are the core. Hence the modeling of a good decision support system depends upon the
better understanding of the process parameters and the quality of the knowledge base. An appropriately created DSS is an intuitive programming based framework intended to help chiefs assemble valuable data from an assortment of crude information, records, individual information or plans of action to distinguish and address issues and take choices (refer figure 4). DSS can improve human cognitive disabilities by incorporating numerous roots of information, offering smart ingress to specific knowledge and assisting in the decision-making process.

Figure 4 Evolution of the decision support system

- **Architecture of a Decision support system**

  Modeling a good decision support system requires a better understanding of its architecture. Besides it is also important to know what is expected from a decision support system i.e. what job it has to perform. The decision support system should have a computer generated knowledge base and a human like judgment capability. In order to have such capabilities a properly structured DSS has primarily two sub systems

  a) Model base management system (MBMS)
  b) Data base management system (DBMS)

  MBMS is a progression of PC programs incorporated with a DSS that permit clients to construct, alter, upgrade and additionally erase a model. Clients assemble formats and related information base documents for settling on itemized choices. The made models and information bases are put away in direct access stockpiling gadgets, for example, hard disks, in the model base and data base. DBMS is a progression of PC programs that assemble and keep up the information base, and screen admittance to the information that is put away in it. The DBMS may either be an autonomous program or be inserted inside a DSS generator to permit clients to build an information base record to be utilized as a contribution to the DSS.

  Besides this one of the important components of the DSS is the user interface. The user interface allows the human beings to interact with the system. Providing an appropriate user interface must take into account a variety of important things, including selection of input and output devices, screen design, color usage, data and information display format, use of different interface types, etc. (refer figure. 5).
The database and the knowledge base provide the required data and the reasoning capability to the DSS. This information is present in a DSS in the form of DBMS and MBMS. These information and rules are used by the users to arrive at a conclusion or take decisions according to the situation. The DSS is provided with the requisite computer based software’s to help the users. The users interact with the system with the help of a user interface which are generally graphical i.e. GUI.

![Figure 5 Generalized architecture of a decision support system](image)

3. Literature survey
A number of researchers have done work on the development and implementation in different fields of the multi-objective knowledge-based decision support system. DSSs have helped to boost productivity efficiency in the design of production line, selection of process and machine tools, commitment of outsourcing, condition-based maintenance etc.

Taha and Rostam (2012) and Alberti et al. (2011) during his studies developed their DSSs for the selection of machine tools using multi-criteria weighted average, fuzzy analytical hierarchy processes and performance tests. Yam et al. (2001) introduced a DSS which supplemented traditional condition-based maintenance by adding fault diagnosis and predicting deterioration of equipment. Thus the developed system has shown to help manufacturers to increase productivity efficiency across business and manufacturing process levels; however, they have not been linked to sustainability performance enhancements.

Ruijun Zhang et al. (2011) in his study developed a cost optimized DSS having a general database including all the pre process data for materials and elements and then implemented it in a multi role decision support system. The DSS consisted of a mechanism for extracting necessary data from the database developed, and an expert system reasoning mechanism. The authors suggest that the cost
optimization model which aims at minimizing the cost of production under the constraints of maintaining the alkalinity, proportion and supply of each element (constituent of the product) is a non-linear programming model. A rule set was developed using IF THEN ELSE logic to contribute to the knowledge base. Hence the system developed was an expert system which fully utilizes an expert’s knowledge to arrive at an optimal decision using a reasoning mechanism.

P.A. A. Manohar et al. (1999) built a system that combines knowledge-based method and mathematical modeling to produce an expert system designed to optimize steel rolling schedules while manufacturing specific steel composition to meet customer requirements.

The authors divided the expert system into two modules. The first module makes the use of both mathematical technique and knowledge system to generate a list of steel making compositions. This is done by using mathematical iterations and knowledge elicitation (KEL) techniques like questionnaires, interviews etc.. The second module evaluates the composition decided in the first module using mathematical modeling techniques. The evaluation of the composition gives an idea about the metallurgical parameters which in turn decides the mechanical properties of the steel. The knowledge base used in the system consists of four modules with following contents:

- KB I consists of the information on properties and composition corresponding to relevant material standards.
- KB II consists of the knowledge rules like IF THE ELSE logics etc.
- KB III consists of the upper and lower limits of the composition based on the standards.
- KB IV consists of the rules regarding process limitation and design strategies.

Rajib K Mohapatra et al. (2007) during his work proposed a model with the goal of reducing material handling costs in steel plants by optimizing the flow of materials. The use of knowledge-based decision support system was done to develop a non-linear optimization model for material handling without affecting the production requirements. The development of the model was to handle two important factors: a) minimization of handling cost and b) optimization of quantity. On the basis of conclusions made by the authors suggested that cost minimization model aimed at minimization of the material handling capacity which can be increased in case of emergency where as material handling quantity maximization model such a situation does not arise as there is always surplus material in the stock. At the same time it was observed by the authors that in quantity maximization case the cost either remained same or showed a marginal increase. On the basis of above conclusions quantity maximization model was suggested as it allowed flexibility in the material handling system. The information retrieved from the model can be used along with the resource-knowledge-information chain to develop a decision support system.

C.J. Rick and M. Engholm (2010) in their study elaborate several variables affecting the design consideration, selection and use of ferrous-alloys, with the aim of optimizing cost of production. The paper consists of a discussion on the raw material selection and assumes the ferrous alloy and scrap to be equivalent as far as economical considerations are concerned. The authors verified these factors on the basis of different case studies and found it to be correct. Hence the authors concluded that during ferrous alloy utilization analysis, it is possible to optimize the economic with environmental value for various materials by selecting the right approach. Alloys may also be designed or modified to suit specific customer requirements. For this research, computer simulations are useful, because they can evaluate the real cost for various situations for a certain alloy.

### 4. Implementation of decision support system in steel industries

The implementation of decision support system is a complicated task in a steel plant. There are numerous operational zones whose smoothness in function lies with critical decisions viz. product planning, manufacturing/production, finances, supply chain network and advertisement/marketing (refer figure 6). Besides, there are several fields which are always borne in mind while modeling a decision support system. These fields include multi-objective optimization which sometimes includes mutually conflicting objectives and a decision has to be taken to arrive at the best possible output.
These fields also include the artificial intelligence (reasoning and judgment capability), computer know how, management practices, organizational constraints, government legislations and last but not the least the employees’ psychology. These related factors act as the guide to model the required DSS for steel plant.

Once the functional area for which the DSS is to be designed is finalized and the related factors are taken into consideration the actual modeling of the decision support system starts. The required DSS is developed in three phases a) modeling b) implementation and c) editing. All the three phases should be started simultaneously as the model has to be validated by implementing it and the required changes are to be made to it on the basis of results obtained from the trial run. The DSS in a steel plant generally has four parts a) the decision maker which may be at the departmental level or at the plant level, b) data that may be the real time data or the data stored in the data base, c) modeling parameters which include the manufacturing constraints ie workers’ capability, plant capacity etc and d) a user interface that is generally a graphical user interface.
5. Conclusion

Although the implementation of the knowledge based decision support system is a very complex process, the steel industries in the modern world are doing it because of the rich benefit which the system provides in terms of increase in overall productivity. The benefits which the concerned industries are enjoying can be summarized as:

- Incremental development
- Reduction in dependence on domain experts
- Better understanding of the problem
- Flexibility or adaptability for different situations
- Simulation of expertise

There are several other advantages but the improper implementation of the knowledge based decision support system may sometimes prove to be disastrous. The major reasons behind the KBDSS to be disastrous can be summarized as follows:

- Excessive Aspirations
- Inadequate Resources for implementation of DSS
- Inadequate problem definition
- Poor data availability
- Negligence in framing the reasoning mechanism
- Technology Transfer & Sociology

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