A Review on Knowledge-based Expert System: Concept and Architecture

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ABSTRACT
A Knowledge-based expert system use human knowledge to solve problems that normally would require human intelligence. Expert systems are designed to carry the intelligence and information found in the intellect of experts and provide this knowledge to other members of the organization for problem solving purposes. With the growing importance of human resource management and increasing size of the organizations, maintenance of employee related data and generating appropriate reports are the crucial aspects of any organization. Therefore more and more organizations are adopting computer based human resource management systems (HRMS). This paper explains the architecture, knowledge representation techniques and application areas of knowledge-based expert system in Human Resource.

Keywords
Knowledge-based Expert System, Knowledge Base, Inference Engine, ACRS

1. INTRODUCTION
Expert system is one of the areas of artificial intelligence. An expert system also known as knowledge based system is a computer program that contains the knowledge and analytical skills of one or more human experts in a specific problem domain. The goal of the design of the expert system is to capture the knowledge of a human expert relative to some specific domain and code this in a computer in such a way that the knowledge of the expert is available to a less experienced user [2].

Expert system is a computer program that simulates the judgment and behavior of a human that has expert knowledge and experience in a particular field. It contains a knowledge base containing accumulated experience and a set of rules. Expert system provides high quality experience, domain specific knowledge; apply heuristics, forward or backward reasoning, uncertainty and explanation capability. Rule based expert system contains knowledge base, Inference engine, knowledge acquisition, explanation facility and user interface. For knowledge representation techniques, forward and backward chaining rules are used. Expert systems are designed to emulate an expert in a specialized knowledge domain such as medicine or any other area of knowledge where there is a shortage of expert knowledge [2]. The knowledge base elicited from the expert by a trained knowledge engineer using various methods can include methodical interviews and the repertory grid technique. Often the expert knowledge area is "fuzzy" in nature and contains a great deal of procedural knowledge, so the knowledge engineer must be an expert in the process of knowledge elicitation. Knowledge-based systems represent a way that expertise can be captured, coded, and reused. Fundamentally, a knowledge-based system consists of some representation of expertise, or a problem to be solved, and some mechanisms to apply the expertise to a problem in the form of rules [7].

2. CHARACTERISTICS OF EXPERT SYSTEM
The most important ingredient in any expert system is the knowledge. The power of expert system resides in the specific, high-quality knowledge it contain about task domains. In expert systems, knowledge is separated from its processing i.e. the knowledge base and the inference engine are split up. A conventional program is a mixture of knowledge and the control structure to process this knowledge [3]. This mixing leads to difficulties in understanding and reviewing the program code, as any change to the code affects both the knowledge and its processing. Expert system contains a knowledge base having accumulated experience and a set of rules for applying the knowledge base to each particular situation that is described to the program. Sophisticated expert systems can be enhanced with additions to the knowledge base or to the set of rules. Expert system can be built from scratch, or built using a piece of development software known as a 'tool' or a 'shell'. A shell is a complete development environment for building and maintaining knowledge-based applications. It provides a step-by-step methodology, and ideally user-friendly interface such as a graphical interface, for a knowledge engineer that allows the domain experts themselves to be directly involved in structuring and encoding the knowledge. [5].

2.1 Characteristics of an Expert System

1. Expert system provides the high-quality performance which solves difficult programs in a domain as good as or better than human experts.

2. Expert System possesses vast quantities of domain specific knowledge to the minute details.
3. Expert systems apply heuristics to guide the reasoning and thus reduce the search area for a solution.

4. A unique feature of an expert system is its explanation capability. It enables the expert system to review its own reasoning and explain its decisions.

5. Expert systems employ symbolic reasoning when solving a problem. Symbols are used to represent different types of knowledge such as facts, concepts and rules.

6. Expert system can advice, modifies, update, expand & deals with uncertain and irrelevant data. [6].

3. ARCHITECTURE OF AN EXPERT SYSTEM

An expert system tool, or shell, is a software development environment containing the basic components of expert systems. The core components of expert systems are the knowledge base and the reasoning engine.

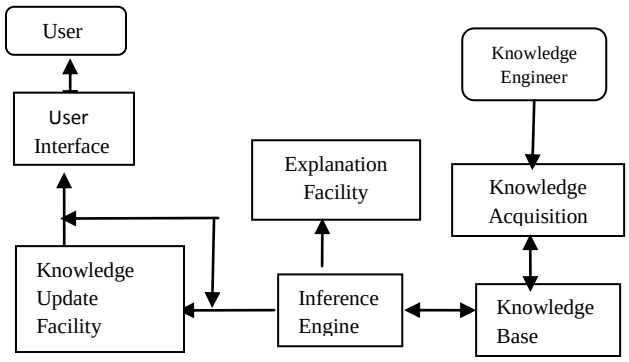


Fig.1: Architecture of Expert System

Knowledge Base: The knowledge base contains the knowledge necessary for understanding, formulating and for solving problems. It is a warehouse of the domain specific knowledge captured from the human expert via the knowledge acquisition module. To represent the knowledge production rules, frames, logic, semantic net etc. is used. The knowledge base of expert system contains both factual and heuristic knowledge. Factual knowledge is that knowledge of the task domain that is widely shared, typically found in textbooks or journals. Heuristic knowledge is the less rigorous, more experiential, more judgmental knowledge of performance, rarely discussed, and is largely individualistic. It is the knowledge of good practice, good judgment, and plausible reasoning in the field.

Inference Engine: Inference Engine is a brain of expert system. It uses the control structure (rule interpreter) and provides methodology for reasoning. It acts as an interpreter which analyzes and processes the rules. It is used to perform the task of matching antecedents from the responses given by the users and firing rules. The major task of inference engine is to trace its way through a forest of rules to arrive at a conclusion. Here two approaches are used i.e. forward chaining and backward chaining.

Knowledge Acquisition: Knowledge acquisition is the accumulation, transfer and transformation of problem-solving expertise from experts and/or documented knowledge sources to a computer program for constructing or expanding the knowledge base. It is a subsystem which helps experts to build knowledge bases. For knowledge acquisition, techniques used are protocol analysis, interviews, and observation.

Explanation Facility: It is a subsystem that explains the system's actions. The explanation can range from how the final or intermediate solutions were arrived at to justifying the need for additional data. Here user would like to ask the basic questions why and how and serves as a tutor in sharing the system's knowledge with the user.

User interface: It is a means of communication with the user. It provides facilities such as menus, graphical interface etc. to make the dialog user friendly. Responsibility of user interface is to convert the rules from its internal representation (which user may not understand) to the user understandable form.

To build the expert system is known as Knowledge Engineering. Personnel involved in expert system development are domain expert, user, knowledge engineer and system maintenance personnel. Domain expert has special knowledge, judgment, experience and methods to give advice and solve problems. It provides knowledge about task performance. Knowledge engineer is involved in the development of the inference engine, structure of the knowledge base and user interface. The expert and knowledge engineer should anticipate user's need while designing an expert system [2] [6].

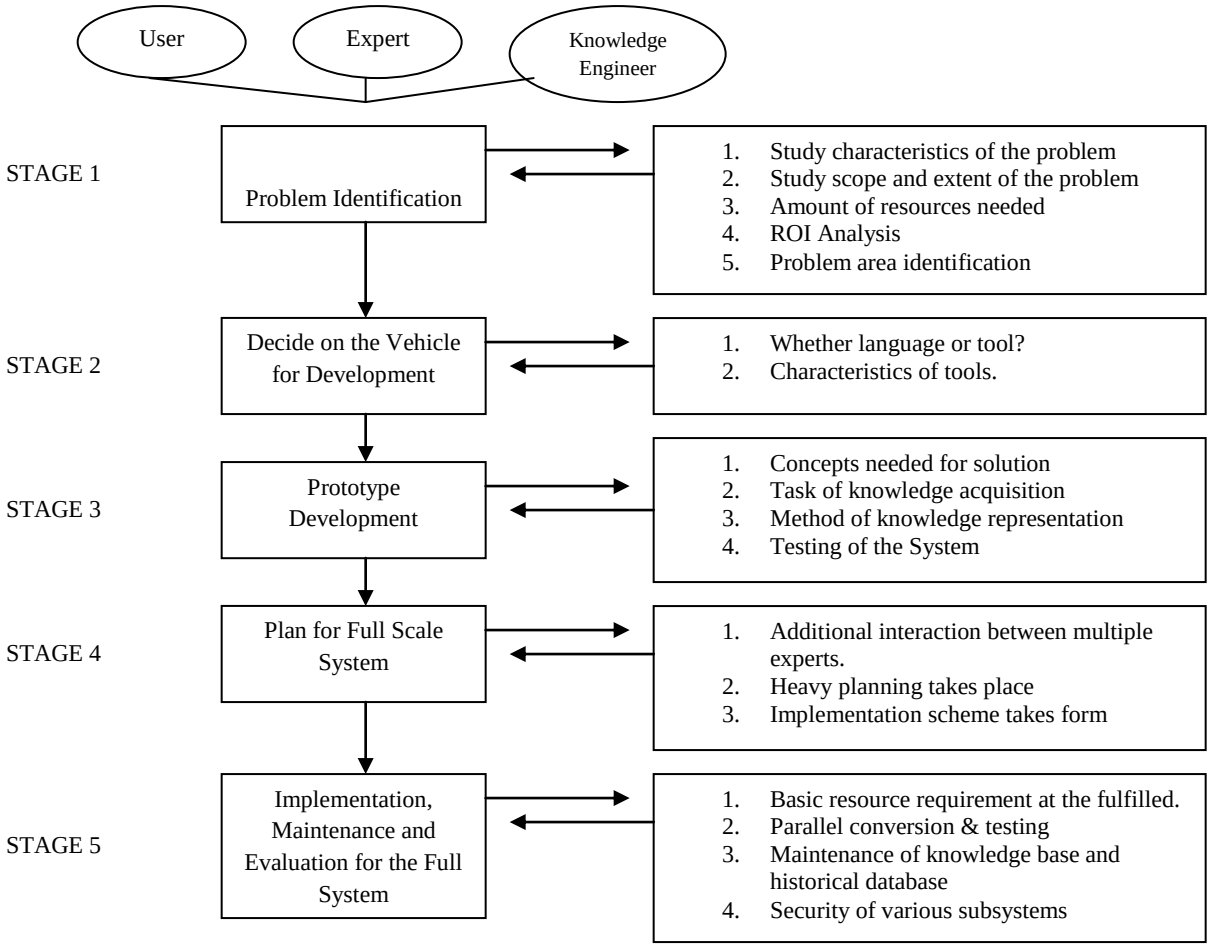


Fig.2: Expert System Life Cycle

There are five major stages in the development· of an expert system. Each stage has its own unique features and a correlation with other stages.

Stage 1: Identification of the problem
In this stage, the expert and the knowledge engineer interact to identify the problem. The major points discussed before for the characteristics of the problem are studied. The scope and the extent are pondered. The amount of resources needed, e.g. men, computing resources, finance etc. are identified. The return-of-investment analysis is done. Areas in the problem which can give much trouble are identified and a conceptual solution for that problem and the overall specification is made.

Stage 2: Decision about the mode of development
Once the problem is identified, the immediate step would be to decide on the vehicle for development. The knowledge engineer can develop the system from scratch using a programming language like PROLOG or LISP or any conventional language or adopt a shell for development. In this stage, various shells and tools are identified and analyzed for the suitability. Those tools whose features fit the characteristics of the problem are analyzed in detail.

Stage 3: Development of a prototype
Before developing a prototype, the following are the prerequisite activities:

- Decide on what concepts are needed to produce the solution. One important factor to be decided here is the level of knowledge (granularity). Starting with coarse granularity, the system development proceeds towards fine granularity.
- After this, the task of knowledge acquisition begins. The knowledge engineer and the domain expert interact frequently and the domain-specific knowledge is extracted.
- Once the knowledge is acquired, the knowledge engineer decides on the method of representation. In the identification phase, a conceptual picture of knowledge representation would have emerged. In this stage, that view is either enforced or modified.
- When the knowledge representation scheme and the knowledge is available, a prototype constructed. This prototype undergoes the process of testing for various problems and revision of the prototype takes place.

By this process, knowledge of fine granularity emerges and this is effectively coded in the knowledge base.

Stage 4: Planning for a full-scale system
The success of the prototype provides the needs impetus for the full-scale system. In prototype construction, the area in the problem which can be implemented with relative ease is first chosen. In the full-scale implementation, sub-system development is assigned (l group leader and schedules are drawn. Use of Gantt chart, PERT or CPM techniques are welcome.

Stage 5: Final implementation, maintenance and evolution
This is the final life cycle stage of an expert system. The full scale system developed is implemented at the site. The basic resource requirements at the site are fulfilled and parallel conversion and testing techniques are adopted. The final system undergoes rigorous testing and later handed over to the user.

Maintenance of the system implies tuning of the knowledge base because knowledge, the environment and types of problems that arrive are never static. The historical database has to be maintained and the minor modifications made on inference engine have to be kept track off. Maintenance engulfs security also.

Evaluation is a difficult task for any AI programs. As mentioned previously, solutions for AI problems are only satisfactory. Since the yardstick for evaluation is not available, it is difficult to evaluate. However, utmost what one can do is to supply a set of problems to the system and a human export and .compare the results. When this method was adopted for the system MYCIN, it surpassed human experts.

4. OVERVIEW OF ORGANIZATION

Birla Corporation Limited has number of plants, out of which, two at Satna (M.P.) - Satna Cement Works & Birla Vikas Cement, Chanderia (Rajastan) - Birla Cement Works & Chanderia Cement Works, and Durgapur (W.B) – Durgapur Cement Works & Durga Hitech Cement and one at Raebareli (U.P). They manufacture varieties of cement like Ordinary Portland Cement (OPC), 43 & 53 grades, Portland Pozzolana Cement (PPC), Fly Ash - based PPC, Low Alkali Portland Cement, Portland Slag Cement, Low Heat Cement and Sulphate Resistant Cement. The total employees in the plant are found around 5200 of various categories. The system developed is used to maintain attendance record for the same. [1]

5. PROPOSED KNOWLEDGE-BASED EXPERT SYSTEM FOR ACRS

The main objective of Attendance Capturing & Recording System (ACRS) is to ensure that the attendance (i.e. presence or absence) of employees is accurately recorded and reported for computation of payable days, overtime hours, festival allowances and payable ESI contributions etc.

Fig. 2: Knowledge-based System for ACRS

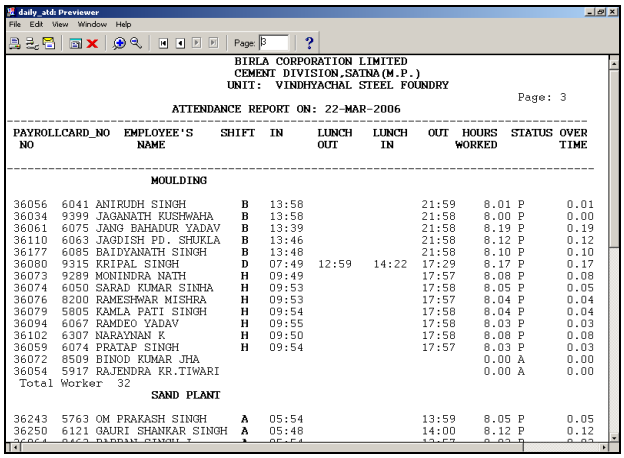
An efficient employee Attendance Recording system makes for a smoother-running organization. The ACRS can contribute to an organization's overall harmony and efficiency. This automated system saves time for managers and employees, improving their productivity. By eliminating manual record keeping, it reduces errors, avoiding disputes. ARS integrates a company's accrual policies and consistent awarding of employee attendance. The primary goals of ACRS are to:

1. Establish an efficient workflow process for attendance authorization.
2. Integrate time and leave data with HR, payroll and ERP systems or to APIs for electronic processing.
3. Ensure accurate and consistent implementation of pay and leave policies.
4. Quickly and simply request leave or other scheduled absences.
5. Receive automatic notification of leave balances, as well as available vacation and personal time, sick days and other leave benefits.

The proposed system has several advantages like worker's individual information is stored separately, searching of particular information became faster, Generation of various reports made review process easy, facilities of full database backup and central control of user, well-defined authorization and security levels etc.

5.1 Reporting from the Proposed System

The reports which are used by top management are generated from the above MIS like Monthly Attendance, Card Replacement, Sick Report, and Monthly Voucher Correction which are submitted to HR Manager and he takes proper decisions related with Attendance Capturing & Recording.



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BIRLA CORPORATION LIMITED
CEMENT DIVISION,SATNA(M.P.)
UNIT: VINDHYACHAL STEEL FOUNDRY

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ATTENDANCE REPORT ON: 22-MAR-2006

PAYROLLCARD_NO	EMPLOYEE'S NAME	SHIFT	IN	LUNCH OUT	LUNCH IN	OUT	HOURS WORKED	STATUS	OVER TIME
	MOULDING								
36056	6041 ANIRUDH SINGH	B	13:58			21:59	8.01	P	0.01
36034	9399 JAGANATH KUSHWAHA	B	13:58			21:58	8.00	P	0.00
36061	6075 JANG BAHADUR YADAV	B	13:39			21:58	8.19	P	0.19
36110	6063 JAGDISH PD. SHUKLA	B	13:46			21:58	8.12	P	0.12
36177	6085 BAIDYANATH SINGH	B	13:48			21:58	8.10	P	0.10
36080	9315 KRIPAL SINGH	D	07:49	12:59	14:22	17:29	8.17	P	0.17
36073	9289 MONINDRA NATH	H	09:49			17:57	8.08	P	0.08
36074	6050 SARAD KUMAR SINHA	H	09:53			17:58	8.05	P	0.05
36076	8200 RAMESHWAR MISHRA	H	09:53			17:57	8.04	P	0.04
36079	5805 KAMLA PATI SINGH	H	09:54			17:58	8.04	P	0.04
36094	6067 RAMDEO YADAV	H	09:55			17:58	8.03	P	0.03
36102	6307 NARAYNAN K	H	09:50			17:58	8.08	P	0.08
36059	6074 PRATAP SINGH	H	09:54			17:57	8.03	P	0.03
36072	8509 BINOD KUMAR JHA						0.00	A	0.00
36054	5917 RAJENDRA KR.TIWARI						0.00	A	0.00
Total Worker 32									
	SAND PLANT								
36243	5763 OM PRAKASH SINGH	A	05:54			13:59	8.05	P	0.05
36250	6121 GAURI SHANKAR SINGH	A	05:48			14:00	8.12	P	0.12

Fig. 3: Daily Attendance Report

6. CONCLUSION

Expert systems provide consistent answers for repetitive decisions, processes and tasks and holds significant level of information. The purpose of expert system is not to replace human experts, but to make their knowledge and experience more widely available and permit non-experts to work better. For the success of the expert system proper management of expert system, development and deployment is required. Success factor of an expert system depends on the problem to be solved which must be qualitative and narrow in aspect. It is observed that domain experts not always able to explain their logic and reasoning. Also an expert system cannot respond creatively like a human expert in unusual circumstances and can automatically modify its knowledge base, or adjust existing rules or add new ones. The knowledge engineer is still responsible for revising and maintaining the system.

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