International Journal of Applied Information Systems (IJAIS) – ISSN : 2249-0868
Foundation of Computer Science FCS, New York, USA
Volume 2– No.5, May 2012 – www.ijais.org

Competency Management in Engineering Institutions: an Expert System based Knowledge Management Perspective

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ABSTRACT
Competency is a key resource that all organizations possess. Proper channeling of organizational competencies leads to increased performance and better outcomes in order to meet the competitive edge.
A crucial feature of engineering institutions (EIs) is that they consist of many processes, each requiring the combination of various skills at different proficiency levels. A robust competency management (CM) system must reflect the need for competency development in the institution and cater to methods to achieve these.
This paper explores the need for CM in EIs and presents a conceptual framework for developing new competencies in the institution and refining the existing competencies for meeting the organizational goals. It focuses on enhancement of the competence of the human resource functions in the institutions through position fulfillment and career development mechanisms. It further proposes a layered architecture using Expert System for the implementation of the framework.
The framework is based on the competency domains of knowledge, research, administrative, interpersonal relations and behaviour (KRAIB). If adopted in EIs, the authors feel that the framework will lead to a better way to use the data on institutional competencies as a knowledge asset and apply it towards effective planning and actions for competency management.

Keywords
Competence, competency management, knowledge management, knowledge repository, expert systems

1. INTRODUCTION
The processes of engineering education are immensely demanding in terms of skills and competency. The growing number of institutions offering engineering courses and the increasing performance requirements of the stakeholders has increased competition and the need for better outcomes. In order to achieve this, the institutions need to perform better. Competency is a key resource that all institutions possess and proper channeling of the institutional competencies can help to achieve the performance requirements and meet the competitive edge.
A crucial feature of engineering institutions is that they consist of many functions and processes, each requiring the combination of various skills at different proficiency levels. This implies that people in the institutions need to possess and develop multiple competencies for personal and institutional survival. This paves the way to recognize the need for competency management in EIs. A robust competency management (CM) system must reflect the competency requirements in the organization and cater to methods to achieve these.
Competency management is becoming an area flourishing in importance and need in the current scenario. Organizations observe individuals as strategic assets. CM aims at integrating the competencies of individuals towards organization's business strategy and processes [3]. CM involves the identification and measurement of available competencies of all employees and enables additional competencies that may be required towards effective individual and organizational performance. It consists of capturing, evaluating, mapping, assigning and updating the competencies of any organization according to business plans It has the primary objective to define and continuously maintain competencies according to the objectives of the organization [2].
In educational institutions human resource alone greatly contributes towards the success of the institution. Engineering institutions formulated on the basis of the competency of their employees, particularly faculty can achieve the competitive edge. The institutions employ people possessing a variety of competencies with different proficiency levels. The question is what value is added to the services they deliver through the effective use of their competencies. The institutions have to precisely identify the required competencies based on institutional goals and job profiles and the gap that exists between the expected and available level of competencies. Based on the data, the institutions need to modulate themselves to design strategies in order to develop the missing competencies and adapt the existing competencies to the required proficiency levels.
The aim of this paper is to explore the competency management in engineering education from a knowledge management perspective in order to achieve easy integration of the competencies required in the academia and their mapping to academic processes. Comprehensive knowledge of the availability and requirement of the competencies is critical to the overall performance of the organization. Competency domains and core competencies of the people are the knowledge entities that need to be identified, captured, stored and mapped to the job profiles they are most suitable for. This process will result in application of the "right competencies to the right job", thereby contributing towards the overall growth of the institution.
The paper proposes a KRAIB (Knowledge, Research, Administration, Interpersonal relations and Behavioral) framework for the development and assessment of the institutional competencies towards the institutional goals. It demonstrates the integration of the related skills with processes to be available as a central resource for the internal and external stakeholders. The paper demonstrates a knowledge management implementation of the framework using expert systems in order to infer the competency

requirement of the institution and deployment of competencies to appropriate job profiles.

2. RELATED WORK

Significant work has been done in the field of competency management and competency modeling for achieving changes in educational and organizational perspectives.

Sno.	Authors	Nature of Work	Relevance for Proposed Work
1	[5]	Discussed the uses of competency management in terms of important skills and competencies, organizational culture, individual and organizational performance and evaluation processes	The understanding of the paper supported the importance of skills and competence and individual and organizational performance in organizations.
2	[13]	Applied a systems approach to organizational learning and human performance technology towards achieving organizational accomplishments.	The paper helped to establish the role of human performance towards achieving organizational goals
3	[9]	Introduced a novel, goal oriented competency model which is used to capture best practices used by professional engineers wishing to increase their personal worth, companies wishing to improve their performance and by academic institutions needing to obtain a better understanding of industry's expectations of new graduates.	The paper guided in the development of the competency management model with emphasis on career development and academic requirements.
4	[12]	Proposed an ontology based CommOn framework for developing operational knowledge based systems for competency management activities such as staff development and deployment, job analysis and economic evaluation.	The paper helped to develop a knowledge based competency management system to cater for employee development and job deployment.
5	[6]	Proposed an evaluation index system to give an overall evaluation of executives based on both subjective and objective information.	The paper helped to understand an indexing system for employee evaluation and this helped in mapping of competencies to work profiles in the current work
6	[10]	Applied an expert systems approach to develop human intellectual strategically and enable educational institutions to get the most benefit from their investments in both people and technology.	The paper helped to understand how an expert system approach can be applied to competency management
7	[7]	Focused on the advantages of human resources development process for the multinational and international businesses through a complex structure of interrelationship between strategic management, competency management, assessment and an overall quality	The paper supported the impact of competency management along with strategic management, assessment and overall quality management on the human resources development in organizations

		management.	
8	[11]	Developed an expert system for competency management and subsequent performance assessment in educational institutions.	The work helped as guide to use expert systems in development of competency management system for educational institutions.
9	[8]	Introduced an agent-based framework for the dynamic refinement of employees' competency profiles by analyzing and monitoring the collaborated activities in organizations.	The study of the paper helped to establish relationship between employee competency and organizational activities
10	[1]	Proposed a semantic web-based educational system within a social network system applied to the enterprise context in order to solve problems of managing employees' competencies and sharing employees' profiles across the organization in order to support competency finding.	The work helped in finding solution to competency management problems and competency finding across the institution.
11	[4]	Proposed a management method based on core competency ownership, where individuals are empowered to develop the organization's core competencies.	The paper helped to understand the role of competency management in the organizational development

The survey of the available research literature shows the lack of a knowledge management approach to competency management. The paper is a modest attempt to fill this gap in order to achieve the goals of competency usage, competency development and competency acquisition.

3. RESEARCH APPROACH AND FINDINGS

The research approach was qualitative in nature with a three-fold purpose : (1) identification of the generic competency domains required in engineering institutions; (2) identification of the core competencies in the competency domains and (3) roles performed by faculty in the EIs

The research literature related to competency management was studied extensively. It helped the authors to comprehend the need for competency management in educational institutions. Discussions with heads of institutions, section heads and senior faculty assisted in identifying the competency domains, core competencies and the faculty roles in EIs. This is illustrated in fig.1. Interviews with faculty were conducted to investigate their expectations from the institution and their needs for competency development. The discussions and interviews were carried out at personal level to visualize the functioning of engineering institutions and how CM implementation can affect them. Engineering colleges in the National Capital Region (NCR) of Delhi were considered as sample institutions.

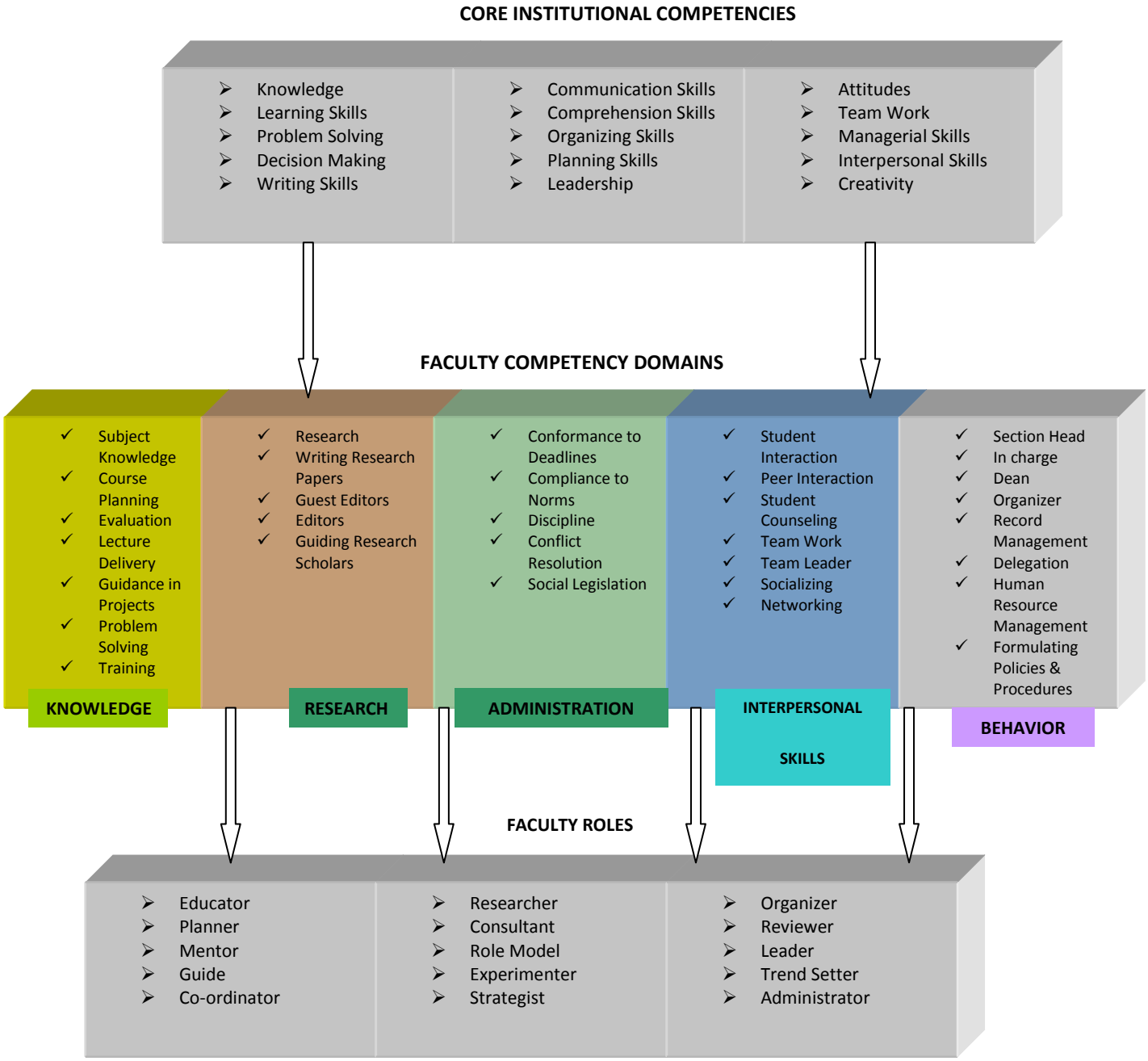

Fig. 1 : Core Institutional Competencies and Faculty Competency Domains

The study also helped to discover the multiple roles performed by faculty and the 1:1 (one to one) and 1: many (one to many) mapping of competencies to the competency domains. The implication is that a competency can be used to perform a single task or different tasks may require the same competency for their accomplishment. The importance of a competency in different competency domains and for different institutional functions will vary. This finding can be utilized by the institutions in cross functional job assignments (competency mapping) and in formulating strategies for recruitments, trainings and career development.

4. KRAIB (KNOWLEDGE, RESEARCH, ADMINISTRATION, INTERPERSONAL RELATIONS AND BEHAVIORAL) FRAMEWORK

Competency management in engineering institutions consists of the activities as follows :

1 Defining the right competencies based on the organizational goals, objectives, strategies and functional domains.

2 Evaluating the current competency level in the institution and identifying the missing competencies.
3 Developing the individuals for competencies that are missing through trainings, QIPs and developmental programmes.
4 Monitoring the performance of people for compliance to the identified competencies.

Based on the activities of competency management, the authors proposed a competency management life cycle (fig.2). It consists of four phases which aim at the continuous enhancement and development of the individual and organizational competencies.

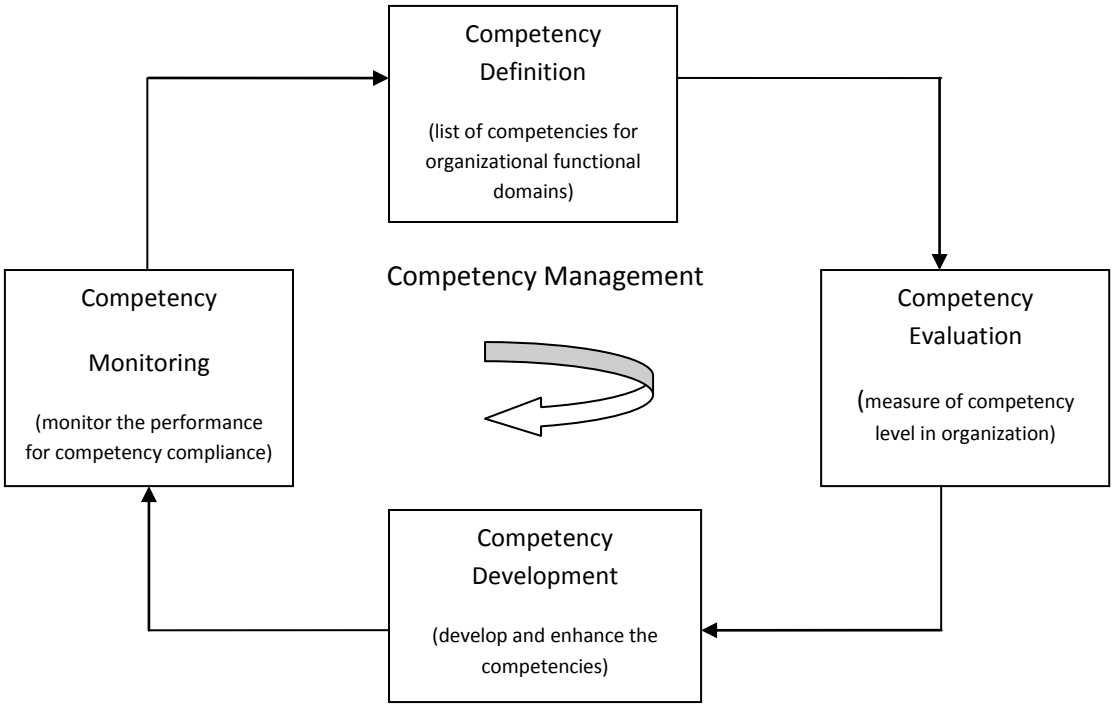

Figure 2 : Competency Management Life Cycle

The first phase of competency definition aims to provide the institution with an extensive list of the competencies required in order to perform the processes in accordance with the institutional strategies for meeting the goals and targets. The second phase is the competency evaluation phase which encompasses the assessment of the current state of competencies available in the institution and the level of each competency available. A competency gap analysis may be required at this stage to identify the difference in the available and the required competencies and the redundancy in the existing competency levels.

The identification of the missing and the redundant competencies will clearly contribute towards the next phase of development and enhancement of competencies in the institution. The third phase aims at activities towards fulfilling the existing gap in competencies. This includes providing for the missing competencies, enhancing the existing competencies to the required proficiency level and re-directing the redundant competencies to new directions. This can be achieved through recruitments, training and development programmes.

The competency monitoring phase ensures that the competencies developed and enhanced are maintained. A competency assessment mechanism comprising of feedback and evaluation can be adopted to achieve this. Feedback must be given at a regular basis and should lead to the required training, development and guidance. Evaluation is the outcome of feedback on performance at any point of time. It reinforces the need for additional competency development and refinement to perform a job.

Applying the competency management life cycle, the authors developed the KRAIB framework (fig.3) as the accomplishment of the tasks in any organization require one or more skills from the competency domains of KRAIB. The combination of these in the required proportions will facilitate the people to perform their jobs with proficiency.

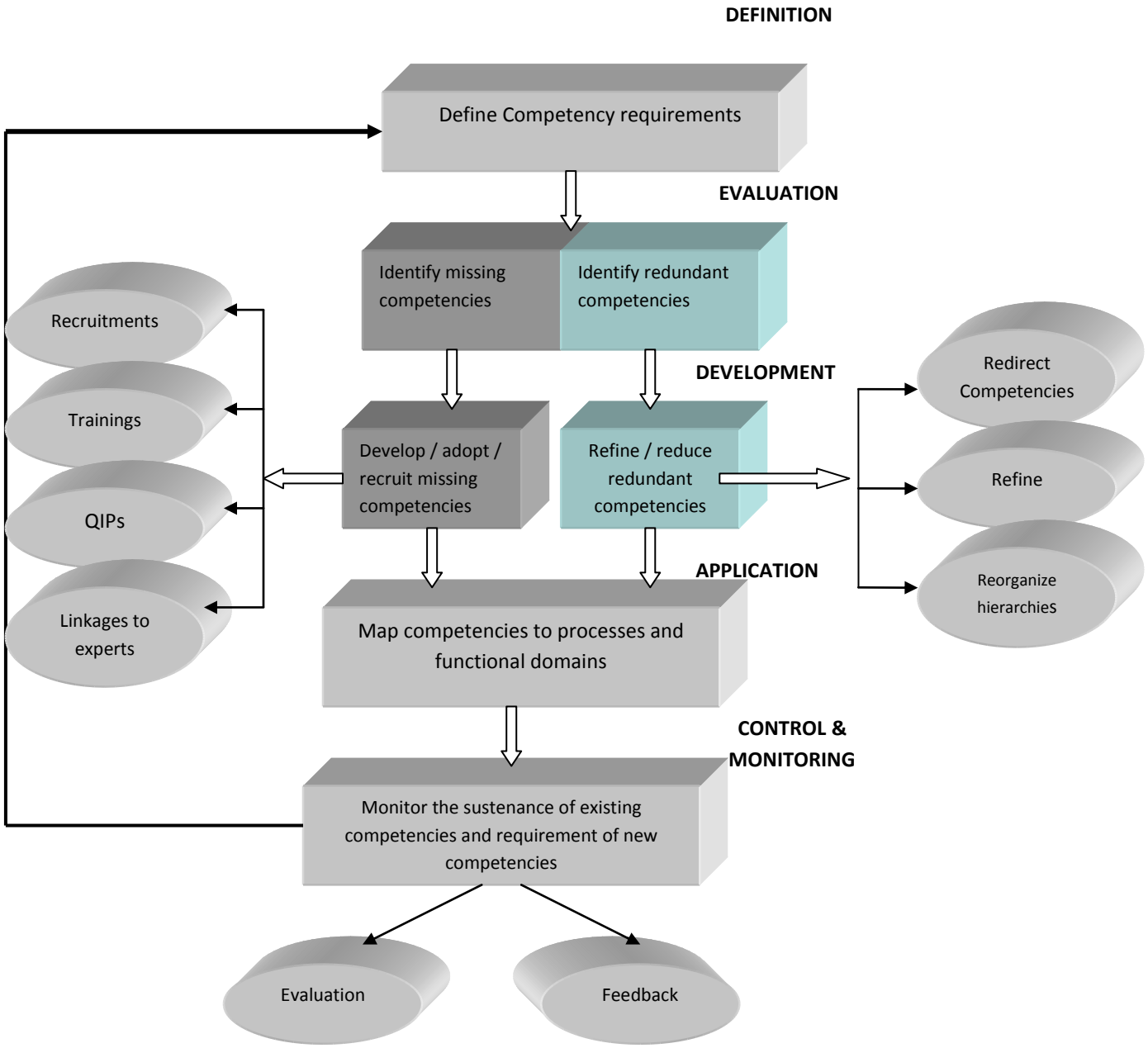

Fig. 3 : KRAIB Framework

Fig. 4 illustrates the competency storage ad mapping mechanisms of the KRAIB framework. The information on people, processes and competency are stored in a knowledge repository which is a structured collection of competencies mapped to the jobs they are required for and the people who possess these competencies. The competency knowledge repository is updated and maintained with the development of new competencies in the organization, recruitment of the employees and addition of new organizational functions and processes. This process enriches the repository with the competency knowledge of the organization. The mapping of the competencies to people and processes is a continuous process and facilitates the assignment of the right person to the right task.

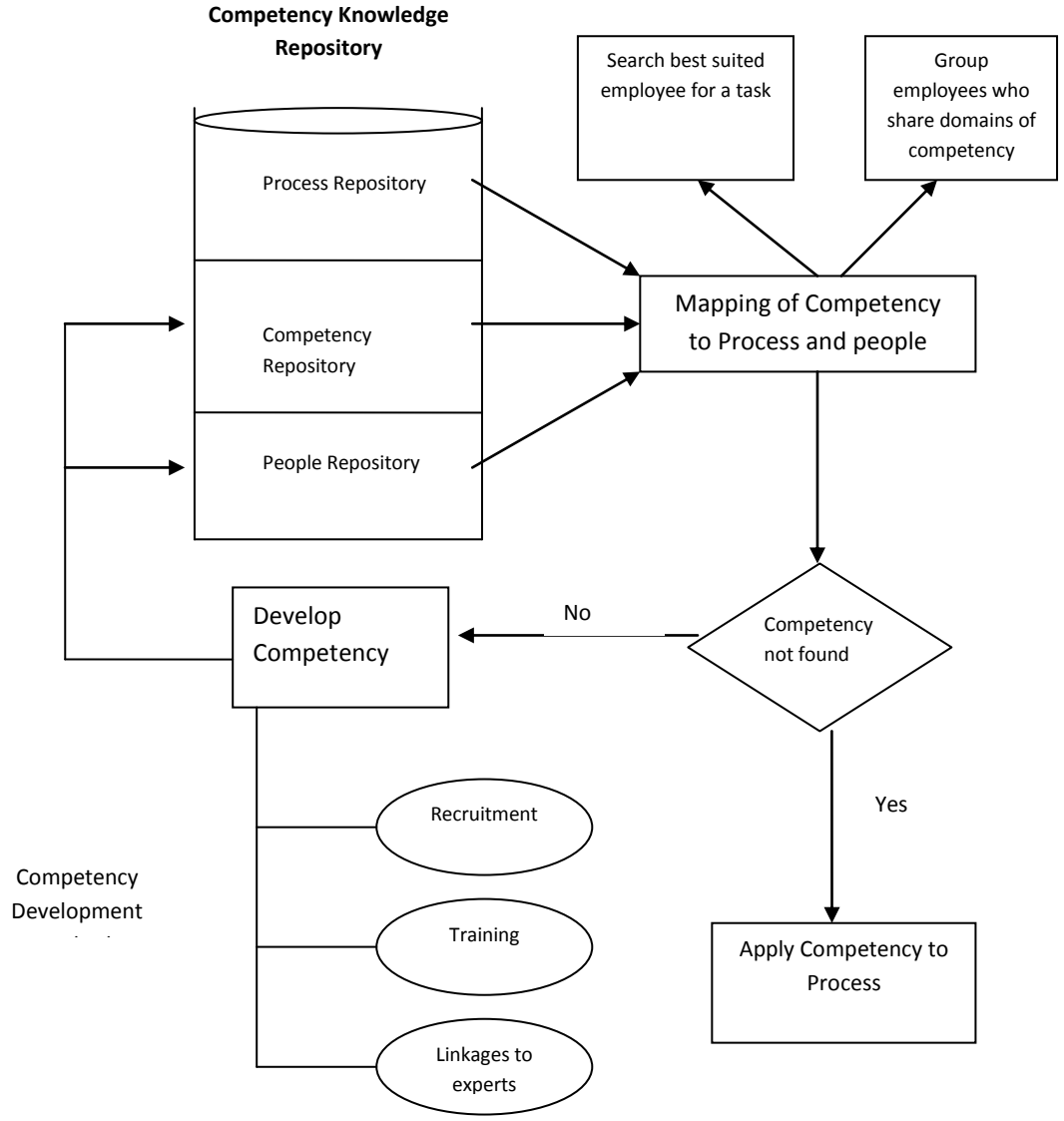

Fig. 4 : Competency mapping

5. IMPLEMENTATION OF THE FRAMEWORK

Fig. 5 shows an expert system based layered architecture for the KRAIB framework to facilitate the identification, storage, mapping and development of the institutional competencies.

The first layer depicts the knowledge identification and knowledge gathering process for the competency domains, functional activities and the required and available competencies. The knowledge gathering is achieved through the medium of people, study of documents and observation of processes. The second layer describes the storage of knowledge in a knowledge repository. The knowledge repository is organized and maintained by knowledge engineers and consists of information on people, processes and competencies and represents all the knowledge in the required domains.

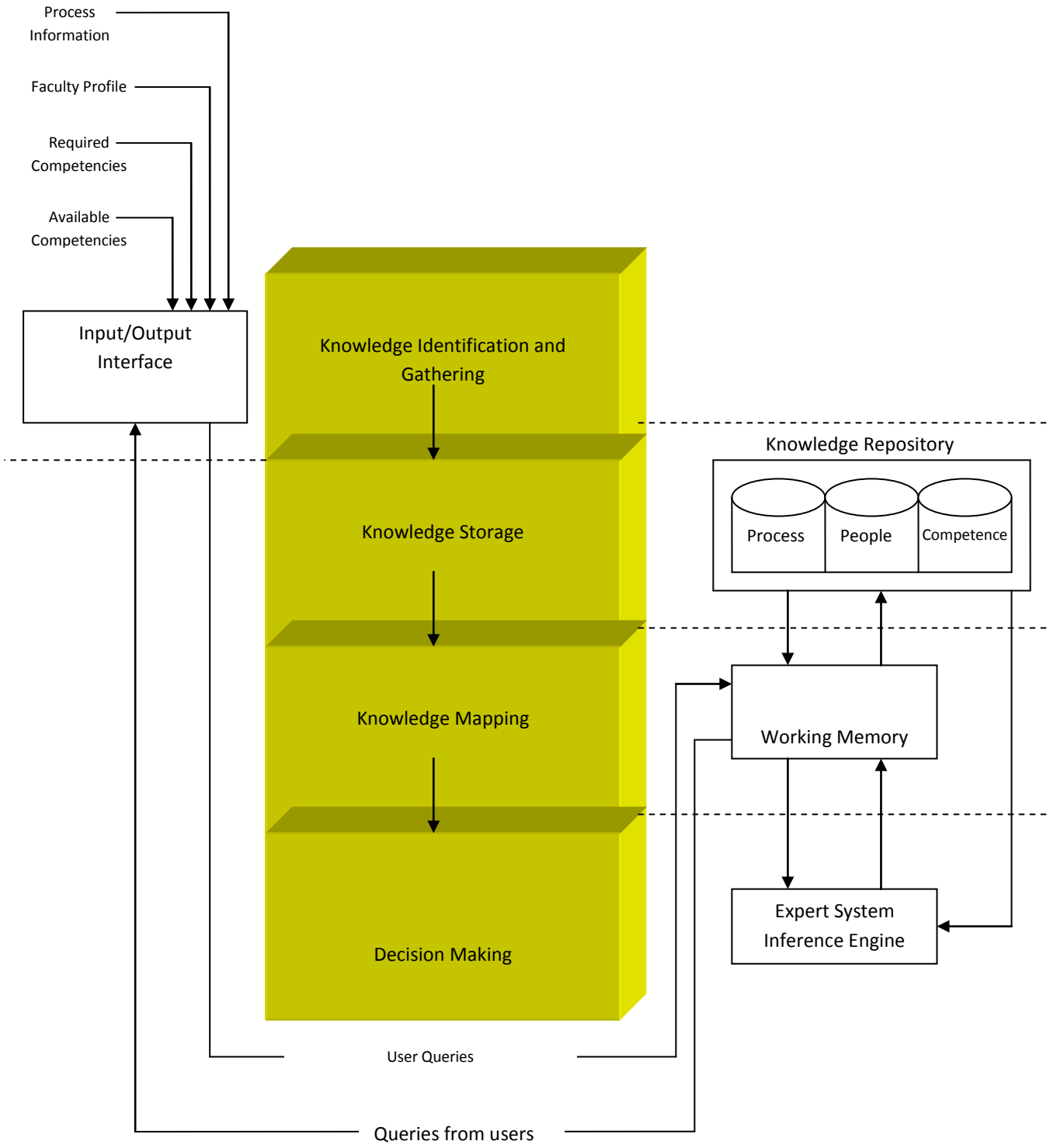

Fig.5 : Expert System Implementation

Additionally, the knowledge gathered in the first layer is filtered and structured to be represented in the repository in the form of rules and facts in the second layer. The third layer is the competency mapping layer for mapping the competencies to people and processes and performing a gap analysis to identify the missing competencies. The missing competencies and the competencies that require enhancement are identified. This is achieved by applying the facts and rules to the information in the knowledge repository. The fourth layer is the decision making layer using the expert system inference engine to derive the solutions for competency development and enhancement, competency monitoring and rewards and recognition, career planning, succession planning and institutional planning.

6. IMPLICATIONS

The implementation of the framework into IT based competency management system will offer multifold benefits.

6.1 Availability of knowledge on institutional competencies

- Assigning the right people to the right job
- Designing reward systems for the deserving employees
- Developing collaborative work culture
- Constructing performance evaluation system for employees.
- Transforming job profiles according to new strategies and projects

6.2 Availability of knowledge on competencies missing in the institution

- Recruiting the right people for the right job.
- Conducting training programmes for the development of existing employees.
- Implementing changes in strategies, projects and organizational hierarchy due to lack of critical competencies.
- Planning outsourcing of tasks due to missing competencies and competencies difficult to develop
- Communicating competency requirements to current employees for individual development
- Communicating competency requirement to job seekers

6.3 Availability of knowledge on competencies redundant in the organization

- Redirecting the competencies towards other jobs
- Reinforcing the critical competencies to higher levels through internal and external training programmes
- Reorganizing the organization by assigning employees to job profiles based on their competencies

7. CONCLUSION

The paradigm shift in engineering institutions from individual to cross functional and cross organizational perspectives has increased the demands on the competency of people involved. Competency is a benchmark of performance of the employees in EIs.

The proposed work aims to assess the institutional competencies and take strategic decisions towards competency deployment, competency development and rewards and recognition. The authors have discussed in depth a novel approach to competency management explicitly aligned with strategic business needs and oriented to long term future success. The concept has been integrated with expert systems approach for decision making and if implemented the architecture will yield benefits to define changes in the overall development of the institution and growth of the individual faculty. It will also promise fair appraisals and succession processes resulting in job satisfaction for all employees.

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