Chapter-VI

A) Rule based Expert System

Rule based system for Quality Assessment and Enhancement for Higher Education Institutes.

This chapter deals with how knowledge acquired is represented in the form of a ‘Rule Base’. Thus this chapter is devoted towards framing rules and developing a rule base, which facilitates in application of knowledge by the system to take decisions.

5.0 Rule based Expert system Design and rule Validation

To evaluate the Institutes it is important to administer the various inputs of quality parameters in this case we have taken quality parameters identified by NAAC and they are widely accepted by the higher educational Institutes throughout country as measure of quality. By the term “quality” we intend the potential of an Institute to cater to its stakeholders like students, employers, parents and society at large. The rule based system assist evaluators; IQAC heads in obtaining question item through subsequent screens provided the system automatically detects parameters of quality and provides the help with advice how to enter all valid information. It validates upper and lower limits in each criterion.

Rule based systems are generally composed of an inferential engine, a knowledge-base and a user interface. The quality parameters are classified on the basis of the seven criteria and sub criteria with key assessment indicators. Weight ages are assigned to each key indicator.

A rule based system is a system whose knowledge base is expressed under the form of production rules. Rule-based system has been employed in
many applications for decision making. Such systems can also be used for classification. The production rules can be inferred directly from the expertise or obtained through machine learning methods. In general, the rules are in the following form:

\[
\text{IF } \text{<antecedent conditions> } \\
\text{THEN } \text{<consequent conditions> }
\]

The antecedent conditions define the values or the value intervals for one or more input attributes. The consequent conditions define the values or the value intervals for one or more output attributes. In the case of classification, the consequent conditions determine if a given entity belongs to a class. In rule based system it is often necessary to deal with uncertainty.
5.1 Primary Level System Analysis and Design

Fig-5.0

Source: - Model Designed by Researcher.

Notes from interviews and Secondary Data of Institutes IQAC

List of Decision parameters

Quality parameters

Rules Listing

1) Grade “A” Very Good (Score 3-4)
2) Grade “B” Good (Score 2-3)
3) Grade “C” satisfactory (1-2)
4) Grade “D” Not satisfactory (Less than 1)
The Fig 5.0 is given to get the idea about how the system will have its flow of the information till the grade of the Institute is displayed. The Existing System is studied in the 1\textsuperscript{st} phase with logical design at 2\textsuperscript{nd} stage. The 3\textsuperscript{rd} stage creates the new logical design using quality parameters. At 4\textsuperscript{th} stage rules are written and at 5\textsuperscript{th} stage the expert system is development. The output is given by the expert system in the form of Letter grade A, B, C or D with explanation for the same. Also the score from 0- 4 is displayed by the system calculated by the rules stored in the knowledgebase.

5.2 Knowledge-based systems in HEI

Knowledge based systems are artificial intelligent tools working in a narrow domain to provide intelligent decisions with justification. Knowledge is acquired and represented using various knowledge representation techniques rules, frames and scripts. The basic advantages offered by such system are documentation of knowledge, intelligent decision support, self learning, reasoning and explanation.

“Knowledge-based systems are systems based on the methods and techniques of Artificial Intelligence. Their core components are:

- knowledge base
- acquisition mechanisms
- inference mechanisms

While for some author’s expert systems, case-based reasoning systems and neural networks are all particular types of knowledge-based systems, there are others who consider that neural networks are different, and exclude it from this category.

KBS is a frequently used abbreviation for knowledge-based system.
Knowledge base

A knowledge base is a special kind of database for knowledge management. A knowledge base provides a means for information to be collected, organized, shared, searched and utilized.

Knowledge bases are essentially closed or open information repositories and can be categorized under three main headings:

- **Machine-readable knowledge bases** store knowledge in a computer-readable form, usually for the purpose of having automated deductive reasoning applied to them. They contain a set of data, often in the form of rules that describe the knowledge in a logically consistent manner. An ontology can define the structure of stored data - what types of entities are recorded and what their relationships are. Logical operators, such as and (conjunction), or (disjunction), material implication and negation may be used to build it up from simpler pieces of information. Consequently, classical deduction can be used to reason about the knowledge in the knowledge base. Some machine-readable knowledge bases are used with artificial intelligence, for example as part of an expert system that focuses on a domain like prescription drugs or customs law. Such knowledge bases are also used by the semantic web.

- **Human-readable knowledge bases** are designed to allow people to retrieve and use the knowledge they contain. They are commonly used to complement a help desk or for sharing information among employees within an organization. They might store troubleshooting information, articles, white papers, user manuals, knowledge tags, or answers to frequently asked questions. Typically, a search engine is
used to locate information in the system, or users may browse through a classification scheme.

A text based system that can include groups of documents including hyperlinks between them is known as **Hypertext Systems**. Hypertext systems support the decision process by relieving the user of the significant effort it takes to relate and remember things." Knowledge bases can exist on both computers and mobile phones in a hypertext format.

- **Knowledge base analysis and design** (also known as KBAD) is an approach that allows people to conduct analysis and design in a way that result in a knowledge base, which can later be used to make informative decisions. This approach was first implemented by Dr. Steven H. Dam.

**Knowledge acquisition**

**Knowledge acquisition** is a method of learning, first proposed by Aristotle in his seminal work "Organon". Aristotle proposed that the mind at birth is a blank slate, or tabula rasa. As a blank slate it contains no knowledge of the objective, empirical universe, or of itself.

"Knowing subject" is often the description of a mind with acquired knowledge; Therefore, a human mind cannot be a "knowing subject" until it has "acquired knowledge". "Acquired" in this sense can be either an adjective, as in "that which has been acquired"; or a verb, as in the act of acquisition.
**Inference engine**

In computer science, and specifically the branches of knowledge engineering and artificial intelligence, an **inference engine** is a computer program that tries to derive answers from a knowledge base. It is the "brain" that expert systems use to reason about the information in the knowledge base for the ultimate purpose of formulating new conclusions. Inference engines are considered to be a special case of reasoning engines, which can use more general methods of reasoning.

**Fig – 5.1 Knowledge based system.**

![Knowledge based system diagram](image)

**Source: - Artificial Intelligence Principals and Techniques**

The above figure shows various parts of the Expert System and its flow from the user to Knowledge engineering.
5.3 Design of Expert System for using NAAC Quality parameters

Accreditation Process

In order to design the expert system researcher has used the NAAC evaluation process which is based on seven assessment criteria through 36 criterions-wise key aspects. Each key aspect of a criterion is further differentiated into number of assessment indicators which can be used as guideline to capture the micro-level quality pointers and can be used by peers team members. The key aspect quality profiles are aggregated for aiming at the criterion-wise profiles and the cumulative institutional profile.

Grading by NAAC

Institutions are graded for each Key Aspect under four categorizes, viz., A, B, C, and D, denoting very good, good, satisfactory and unsatisfactory levels respectively. The summated score for all key aspects under a criterion is then calculated with the appropriate weightage applied to it and the GPA is worked out for the criterion. The cumulative GPA (CGPA), which gives the final assessment outcome, is then calculated from the seven GPAs pertaining to the seven criteria, after applying the prescribed weight age to each criterion.

Advantages of CGPA

- letter grades converted to numerical grade points (overall score in cumulative grade point average)
- Qualitative measurements converted to grade points
- Wider scope for normalizing the scores
- Extreme biases (if any) could be minimized
• A one point difference between two letter grades, with 50 or 100 points assigned between two successive letter grades results in appreciable fine-turning of the process.

• Relative evaluation would be more exact, due to a reduction in variations and standard deviations

• Inter–peer team variations are substantially reduced

• With scarce scope for adjustment at any stage, the peer team judgement would be more accurate.

• Changing the grading pattern from the earlier 9-point scale to the new three letter grades, viz, A, B, C′ for accredited institutions and “D” for those which are not accredited.

• Shifting the institutional overall scoring pattern from the earlier percentage to the cumulative grade point average (CGPA) system on a 4-point scale

5.4 The Criteria for quality evaluation and its weightage are as follows

Table -5.1 Criteria wise weightages

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Criteria</th>
<th>Weightage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Curricular Aspect</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>Teaching Learning and Evaluation</td>
<td>450</td>
</tr>
<tr>
<td>3</td>
<td>Research Consultancy and Extension</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>Infrastructure and Learning Resources</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>Student Support and Progression</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>Governance and Leadership</td>
<td>150</td>
</tr>
<tr>
<td>7</td>
<td>Innovative Practices</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1000</td>
</tr>
</tbody>
</table>

Table No. -5.2

Sub criteria Teaching Learning and Evaluation :-

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Key Aspect</th>
<th>Weightage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Admission Process and Student Profile</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Catering to Diverse Needs</td>
<td>45</td>
</tr>
<tr>
<td>3</td>
<td>Teaching Learning Process</td>
<td>270</td>
</tr>
<tr>
<td>4</td>
<td>Teacher Quality</td>
<td>65</td>
</tr>
<tr>
<td>5</td>
<td>Evaluation Process and Reforms</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>Best Practices in Teaching Learning and Evaluation</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>450</strong></td>
</tr>
</tbody>
</table>


All other criteria have sub criteria and they are stored in knowledgebase of the expert system.

5.4 Sample Rules for Displaying Grade

Introduction:

The basic idea of using rule is to codify tacit knowledge of teaching and learning in the form of premise-action pairs. The basic idea is to present knowledge in the form of premise-action pairs. IF-THEN structure of the rule is represented by premise and action clauses. The action clauses consist of a statement or a series statement separated by AND or commas and is executed if the premise is true. The main aim of preparation of rule is to calculate the teaching and learning process.

Rule based systems are generally composed of an inferential engine, a knowledge-base and a user interface. The items are classified on the basis of the values of some parameters calculated on test outcomes. A rule based system is a system whose knowledge base is expressed under the form of production rules. Rule-based system has been employed in many
applications for decision making. Such systems can also be used for classification. The production rules can be inferred directly from the expertise or obtained through machine learning methods. In general, the rules are in the following form:

**Conditions are connected using AND logical operator.**

1. **Rule based system for producing “A” grade and Good Remark for the Higher Education Institute**
   
   IF Curricular Aspects = Very good
   
   AND the Teaching Learning and Evaluation = Very good
   
   AND the Research Consultancy and Extension = Very good
   
   AND Infrastructure and learning resources = Very Good
   
   AND Students Support and Progression = Very Good
   
   AND the Governance and the leadership = Very Good
   
   AND Innovative Practices = Very Good
   
   THEN “A” grade is given (“Very Good” Letter Grade to the Institute is awarded)

   The Institute is in “A” Grade.

2. **Rule based system for producing “B” grade and Good Remark for the Higher Education Institute**
   
   IF Curricular Aspects = Very good
   
   AND the Teaching Learning and Evaluation = Good
   
   AND the Research Consultancy and Extension = Good
AND Infrastructure and learning resources = Very Good
AND Students Support and Progression = Very Good
AND the Governance and the leadership = Good
AND Innovative Practices = Very Good

THEN “B” grade is given (Good The Institute is in “B” Grade.

The Institute is in “B” Grade.

3. Rule based system for producing “C” grade and Satisfactory
Remark for the Higher Education Institute
IF Curricular Aspects = Good
AND the Teaching Learning and Evaluation= Satisfactory
AND the Research Consultancy and Extension = Satisfactory
AND Infrastructure and learning resources = Good
AND Students Support and Progression = Good
AND the Governance and the leadership = Good
AND Innovative Practices = Good

THEN “C” grade is given (Satisfactory Letter Grade to the Institute)

The Institute is in “C” Grade.

4. Rule based system for producing “D” grade and Unsatisfactory
Remark for the Higher Education Institute
IF Curricular Aspects = Satisfactory
AND the Teaching Learning and Evaluation=Unsatisfactory
AND the Research Consultancy and Extension = Unsatisfactory
AND Infrastructure and learning resources = Satisfactory

AND Students Support and Progression = Satisfactory

AND the Governance and the leadership = Unsatisfactory

AND Innovative Practices = Unsatisfactory

THEN “D” grade is given (Unsatisfactory Letter Grade to the Institute)

The Institute is in “D” Grade

5.5 Table Design for ESQAA

The system has following tables to store the various key aspects of the quality.

Table No - 5.3

Key Indicators sample table from Criteria teaching learning and Evaluation criteria stored in Knowledge base.

<table>
<thead>
<tr>
<th>MAIN_MASTER_DETAIL_SUBDETAIL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wide Publicity and Transparency in the Admission Process</td>
<td></td>
</tr>
<tr>
<td>Assess the students learning level after admission and conduct appropriate remedial courses</td>
<td></td>
</tr>
<tr>
<td>The Teaching program schedule and methodologies are planned and organized in advance</td>
<td></td>
</tr>
<tr>
<td>Percentage of teachers with Ph.D. qualification</td>
<td></td>
</tr>
<tr>
<td>Provisions for continuous evaluation and monitoring students progress</td>
<td></td>
</tr>
<tr>
<td>Curriculum design in aligned with the institutional goals and objectives</td>
<td></td>
</tr>
<tr>
<td>Institution offers a number of program options leading to different degrees, diplomas and Certificates (UG/PG/ PG Diploma/Diploma Certificate)</td>
<td></td>
</tr>
<tr>
<td>Feedback from students</td>
<td></td>
</tr>
<tr>
<td>Frequency of Curriculum revision</td>
<td></td>
</tr>
</tbody>
</table>
Best practices in curricular design and development academic flexibility / feedback on curriculum/curricular update or any other quality initiative the institution practices

Institute facilitates faculty to undertake research by providing research funds (seed money)

Significant faculty involvement in research

Publicize the expertise available for consultancy services

Promotion of extension activities

Collaborations Institution Level/Local

Best Practices in Promotion of Research and Publication output/Consultancy/Extension activities /Collaborations/ or any other quality initiative the institution practices

(Physical facilities ): The Institution provides necessary facilities for class rooms (furniture and fixtures)

Maintenance of Infrastructure: Has a maintain budget for the physical facilities through existing / mobilized resources.

Library as a learning resource : Number of titles of books in the library

**Source:** - Extracted from System Design

**Table No. -5.4 Grade Scales and Grade points stored in knowledge base**

<table>
<thead>
<tr>
<th>SCORE</th>
<th>GRADE</th>
<th>DESCRIPTION</th>
<th>GRADE_POINT_FROM</th>
<th>GRADE_POINT_UP_TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>VERY GOOD</td>
<td>76</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>GOOD</td>
<td>51</td>
<td>75</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>SATISFACTORY</td>
<td>26</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>D</td>
<td>UNSATISFACTORY</td>
<td>0</td>
<td>25</td>
</tr>
</tbody>
</table>

**Source:** - Extracted from System Design
Table No. -5.5 Class Master

<table>
<thead>
<tr>
<th>Pk_Class</th>
<th>Class_Desc</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>University</td>
</tr>
<tr>
<td>2</td>
<td>Affiliated Colleges</td>
</tr>
<tr>
<td>3</td>
<td>Colleges</td>
</tr>
</tbody>
</table>

Source: - Extracted from System Design

Table No. -5.6 Main Master

<table>
<thead>
<tr>
<th>FK_CLASS</th>
<th>PK_SR_NO</th>
<th>DESCRIPTION</th>
<th>GRADE_P OINT</th>
<th>TOTAL_ASPECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>Curricular Aspect (Test)</td>
<td>50</td>
<td>5.00</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>Teaching Learning and Evaluation</td>
<td>450</td>
<td>6.00</td>
</tr>
<tr>
<td>1</td>
<td>300</td>
<td>Research Consultancy and Extension</td>
<td>100</td>
<td>10.00</td>
</tr>
<tr>
<td>1</td>
<td>400</td>
<td>Infrastructure and Learning Resources</td>
<td>100</td>
<td>10.00</td>
</tr>
<tr>
<td>1</td>
<td>500</td>
<td>Student Support and Progression</td>
<td>100</td>
<td>10.00</td>
</tr>
<tr>
<td>1</td>
<td>600</td>
<td>Governance and Leadership</td>
<td>150</td>
<td>10.00</td>
</tr>
<tr>
<td>1</td>
<td>700</td>
<td>Innovative Practices</td>
<td>50</td>
<td>10.00</td>
</tr>
</tbody>
</table>

Source: - Extracted from System Design

Conclusion: –

In this Chapter the researcher has given the rules for displaying the grades of the Institutes. The Tables prepared for storing various quality parameters suggested by NAAC. The Grade is calculated using the 4 scale and the remark is given to explain why the Institute has got that particular grade and score (CGPA).

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