Chapter – 3

Research Contributions
CHAPTER- 3

RESEARCH CONTRIBUTIONS

This chapter presents the curriculum development process proposed by this researcher with detailed steps and requirements. A knowledge management framework for this identified process is proposed. The framework is validated by survey method through questionnaire and interviews with experts. Analysis of this survey is also presented.

3.1 MODEL PROCESS OF CURRICULUM DEVELOPMENT

It was noticed by the researcher that steps or phases in curriculum development process are similar to phases in Systems Development Life Cycle. This helped to define the phases in curriculum development on similar lines.

3.1.1 Systems Development Life Cycle

The appropriate curriculum development process was defined by this researcher by extracting best out of the various models and processes proposed earlier for curriculum development. The steps in the process were compared with phases in Systems Development Life Cycle (SDLC). Considerable similarities were noticed. Detailed requirements at each step in curriculum development were analysed by comparing with software development process.

Following is the description of SDLC phases which may be iterative, dependent on one another and undergone in sequence. After this description, similarities between SDLC and curriculum development process are listed followed by description of detailed steps in curriculum development process identified by this researcher.

Phases in SDLC (System Development Life Cycle) for Software Development:

1) Project planning, feasibility study: In this phase an abstract view of the intended project and its goals are determined. This phase also checks whether
the project is feasible. The feasibility study confirms whether the project should go ahead. If feasible, a project plan and budget estimates are prepared.

2) **Systems analysis, requirements definition:** The project goals are expanded into defined functions and operations. This phase also analyzes end-user information needs and defines the requirements for the system. Business needs of the organization are analyzed in detail. Changes to the business process may be thought of in this stage.

3) **Systems design:** This phase describes the operations and features of the system in detail. This may include process diagrams, business rules, screen layouts, pseudocode and other documentation. It also performs high level design estimating programs needed and their interaction, low-level design detailing the working of individual programs, interface design to show the appearance of interfaces and data design to list the required data. Thus at the end of this phase, the overall structure of the software is ready.

4) **Coding and Module Testing:** The real code (Computer Programs) is written for each module (or functionality) separately. Working of each module is tested separately.

5) **Integration and testing:** In this phase, all the modules of the system are brought together to undergo special testing, to check various types of errors and bugs. The interoperability among the components is also verified. All the individual modules are tested together as a complete system. The purpose of this testing is to ensure that interfaces among the modules work properly (integration testing), check whether the system is able to handle the expected volume of data (volume testing) and confirm whether the system does whatever is expected by the users (acceptance/beta testing).

6) **Acceptance, installation and deployment:** In this final stage of development, the software is put into use for working and runs actual business.

7) **Maintenance:** This phase continues for the rest of the software's life. It may undergo modifications, additions, corrections, betterment, performance tuning, changes in computing environment like operating system, database etc. Change may be required for various reasons like some unexpected input values into the system. These changes in the system for one operation may affect some other software operation. Hence the software should be designed initially in such a way that it is flexible to accommodate changes that may
occur in the post implementation period. This is perhaps most important step of all, requiring lot of efforts and goes on continuously. (Elias M. Awad, 1997)

These phases in SDLC were compared with curriculum development process and similarities between Phases of SDLC and Curriculum Development were identified as follows:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>SDLC</th>
<th>Curriculum Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preliminary Investigation and Feasibility Study</td>
<td>Problem Identification and Diagnosis of Need (Gap analysis)</td>
</tr>
<tr>
<td>2</td>
<td>Requirements Analysis</td>
<td>Planning of Resources, Formulation of Goals and Objectives</td>
</tr>
<tr>
<td>3</td>
<td>Systems Design</td>
<td>Selection of Content</td>
</tr>
<tr>
<td>4</td>
<td>Coding and Testing</td>
<td>Organisation of Content and description of methodologies to be used</td>
</tr>
<tr>
<td>5</td>
<td>Implementation</td>
<td>Implementation</td>
</tr>
<tr>
<td>6</td>
<td>Maintenance</td>
<td>Evaluation and Feedback</td>
</tr>
</tbody>
</table>

Table 3.1: Similarities between Phases of SDLC and Curriculum Development

3.1.2 A Model of the Curriculum Development Process

Curriculum development is a continuous process. The Phases in curriculum development process life cycle were identified by this researcher as follows:
Fig. 3.1: Stakeholders and steps in curriculum development process

Phases in Curriculum Development with details of steps (Seema A. Tarnekar, 2012):

1) **Gap Analysis**:
   a) **Problem Identification**: This phase will identify and characterize the problem in the concerned area i.e. find whether curriculum is up-to the mark or meets the expectations. Advice from teachers, curriculum or subject experts, professionals, and other stakeholders from educational community may give insights to these problems.
   b) **Diagnosis of need**: Know the target audience, what they need and whether it is feasible to include. This phase is similar to feasibility study of project in SDLC.

2) **Planning of resources**:
   Once it is decided that the curriculum has to be developed or revised, it may require committees or teams to be constituted. Curriculum development is a project and a concerned person can act as project manager to handle the responsibility of co-ordination among the team members. The tasks can include:
   - Planning and organizing the resources required and address constraints if any, for the curriculum development.
- Formation of curriculum committees and define their roles for curriculum planning and development.
- Select team members for writing team, teachers’ panel, advisory group etc. Selection should be based on expertise in concerned subject or learning area, teaching or professional experience and curriculum development expertise. A selection procedure should be devised to select the members.
- Plan and state the individual responsibilities of persons involved.

3) **Establishing Goals and Objectives:**
   This phase involves defining goals, the end results to be achieved in broader sense. Objectives are in more details, should be specific and measurable. Clearly communicate the purpose and give guidelines for the choice of curriculum content. Identify suitable learning methods to accomplish the objectives. (e.g. lecture, discussion, case study, lab etc.). This phase is similar to Analysis phase of SDLC.

4) **Selection and organization of content:**
   This is the major task. The teams will identify the educational strategies to achieve the curricular objectives. This will involve addressing contents, methods and the means by which the objectives are achieved.

   Content selection needs to be done in such a way that there is appropriate balance of subject knowledge (core and optional), practice skills and the development of the student as a learner with ability to detail and context. This phase is similar to Design phase of SDLC.

   The key questions to be addressed in this context are:
   1. Which concepts, applications or interpretations, must or should be included in order to achieve the intended learning outcomes?
   2. What knowledge, context in the discipline and skills should the student possess by the end of particular topic?
3. How to provide appropriate balance in the contents in context with breadth and depth of topics, knowledge and skills to be delivered, processes and values to be inculcated in the students?

4. How should the contents be organized so that they can be learnt in the time available?

A broad outline of curriculum document need to be developed first, based on the above questions.

Selection of contents should be based on study of current requirements of the concerned discipline and professional skills required, expectations of the recruiters etc. The sources and nature of this study will vary depending on the nature of discipline. For example, Cheryl L. Noll, et al (2002) have identified through their study the skills required for different types of Information Systems professionals which will help to design different curricula for three categories of IS professionals namely Programming, Analyst and User support area where some skills are common to all the three areas. They have proposed inputs in the form of expected skills for future, technology advances, other information systems curricula and position announcements. The stakeholders listed as sources of inputs are recruiters, advisory boards, state government, accrediting bodies, graduating seniors and recent alumni.

**Organization of content:**

Once contents are selected, they need to be organized based on two aspects, scope and sequence. Scope of content is dependent on time available to deliver and the balance between breadth and depth of topics. Integration is also important in sequencing the contents. Students usually learn faster when they are able to relate new contents to their prior knowledge. Similarly they tend to learn more when they find real world applications linked to what they are learning.

In sequencing the curriculum contents, put more complex ideas later after building a foundation of knowledge and skills. Other way is start with a
complex idea and piece by piece reveal how the complexity can be understood by building the knowledge around it.

Contents should be followed by teaching, learning and assessment methods that will be used to deliver the contents and assess the learning outcomes. The selection of teaching, learning and assessment methods for different components of the content will depend on the type of contents to be imparted to the students. They can be majorly classified as knowledge, skills and attitudes. The approaches used to deliver, learn and assess each of these type of contents will involve different methodologies. For example, different types of skills like communication skills, problem solving skills, thinking and creativity skills, numeracy skills, literacy skills will need different methodologies for teaching / learning and will have to be assessed in different ways.

The resources like books, journals, web resources also need to be mentioned along with practical resources required if any. Practical resources may include equipments and material in the laboratories in case of scientific subjects, hardware and software resources in case of IT curricula.

The draft curriculum thus prepared should be reviewed from various academic, professional and subject experts in the domain. Approval for the draft curriculum should be taken from the concerned authorities.

5) Preparing for Implementation :
This phase will consist of :

- Conducting sessions by the curriculum development team or associated persons to brief about the curriculum, the intentions behind and to give directions for implementation
- Determination of implementation schedules considering the requirements and available resources
- Preparation of teaching and study materials and providing learning opportunities or training for teachers if required
• Providing earlier work samples if any, to illustrate achievement standards and evaluation
• Preparation of question banks, case studies, practical exercises etc. as applicable

6) **Evaluation and Feedback:**

This phase involves preparing the plan to evaluate the usefulness and effectiveness of the curriculum. It may require

• Teachers and Institute authorities assess the feasibility of the implementation of curriculum being taught.
• There should be periodic review after curriculum implementation to determine whether a curriculum requires revision with respect to a part of contents or any method of teaching/learning or assessment.
• Regular review or practice to compare the practices against practices elsewhere
• Regular reports to the concerned Committee on relevant solutions to address the issues.

This phase equivalent to maintenance phase of SDLC is very crucial in case of Curriculum Development as the decision and inputs for any minor changes or later curriculum revision will be acquired in this phase. Feedbacks from various stakeholders need to be taken, maintained and analysed. All the efforts taken, sources, experiences, lessons learned, decisions and situations causing them during this phase need to be recorded for further use. This will provide information about continuous quality improvement.

Evaluation is designed to highlight any gaps in the current content and reveal areas which may need modification or further development. This step involves examining existing materials in detail, and gathering data from students about their experiences taking the modules.

These phases may be overlapping at different stages.
The data, information and knowledge required for the various tasks in each of the above phase were estimated. Based on this, a KM framework for curriculum development process was designed which is presented in the next section.

### 3.2 PROPOSED KNOWLEDGE MANAGEMENT FRAMEWORK

Dictionary meaning of a framework is “Broad overview, outline, or skeleton of interlinked items which supports a particular approach to a specific objective, and serves as a guide that can be modified as required by adding or deleting items” (web: Business Directory, 2014). It is also defined as “A framework is a standardized set of concepts, practices and criteria for dealing with a common type of problem, which can be used as a reference to help approach and resolve new problems of a similar nature”. (Nilesh Jain, 2015)

The difference between a framework and model is that a model is something used to represent or explain the operation and mechanism of something else while a framework is used to give an overall picture of the possible courses of action or to bring a preferred approach to a thought or idea. In research context, framework gives overall structure of the project whereas model explores the specific methodology of the research.

In context of software development, “a framework is a set of prefabricated software building blocks that programmers can use, extend or customize for specific computing solutions” (Amatriain X., 2004). In context with object oriented analysis, “a framework is a set of classes that embodies an abstract design for solutions to a family of problems” (Ralph Johnson et al, 1988). It is also summarized as “A framework is the reusable design of a system or a part of a system expressed as a set of abstract classes and the way the instances of those classes collaborate”, in the context of object oriented analysis. With such frameworks, application developers don't have to start from scratch when they write an application in that domain. Since they provide a well-designed and tested infrastructure, it is easy to add new components and integrate them without affecting much the existing components of the framework. (Amatriain X., 2004)
According to Jim Booth (web: James Booth, 2014), the responsibilities that a software development framework should handle are management of Menu, Forms, security, communications and data access. On similar lines we can say that the issues that a KM framework should handle are: knowledge capture, knowledge acquisition, knowledge storage, knowledge distribution or sharing and application or use of knowledge. Important steps in a software development framework are identifying the problem, knowing the requirements and determining the scope. In a KM framework the equivalent steps can be: identifying the sources of knowledge, identifying the useful knowledge required for the process or application under consideration and the ways of applying this knowledge for betterment of the process.

In general, frameworks are abstract applications in a particular domain, which can be customized for individual applications. It can be designed from structural or functional point of view. If a framework is illustrated, examples make framework easy to understand.

The proposed framework in the present study is designed from functional point of view in the sense that it guides the ways in which the various functionalities in curriculum development process can be achieved using KM. Since the framework is generic, it can be customized for curriculum development for particular course or programme and is illustrated also.

As stated by Jim Booth (web: James Booth), qualities of a good framework for software development (object oriented) are simplicity, clarity, boundary limitations and expandability. The structure of the framework should easily reflect how it works. This simplicity can be accomplished by giving clear and consistent interfaces to the components of the framework. For clarity, the framework should be such that the user should be able to apply the framework, without knowing details about exactly how the various functionalities are achieved. These functionalities must be encapsulated. A framework should not violate its boundaries. A framework should be focused on its responsibilities to meet its requirements only. It provides the skeleton to build the functionalities. It is the responsibility of the person using the framework, to achieve
the functionalities. Expansion of the framework, by adding new classes or subclasses to the existing classes should be easy.

Before developing a KM system, the organization must build a framework to help planning of the process. Hence a KM framework is vital for the organizations to implement KM system. It will form the basis as guidelines for the KM system and will help to avoid errors and give benefits by saving time, efforts and cost involved in building the system. A KM framework should address the issues in three major components of a KM system i.e. knowledge acquisition, sharing and utilization.

Based on understanding of various curriculum development models, model curricula of many programmes, systems approach to problem solving and study of various KM concepts, existing KM systems or frameworks, the present researcher could identify components of a good knowledge management system for curriculum development. The researcher has designed a framework for this knowledge management system.

First version of the framework which was assessed through pilot survey was found technical or IT based and experts from non IT background were not able to understand purpose of some components. Hence after pilot survey another framework was developed more application oriented i.e. more based on requirements of curriculum development process and having less technical orientation. This second version of the framework was proposed as knowledge management framework for curriculum development and put to validation by academic experts. The first version was then modified and proposed as framework for implementation of the knowledge management system for curriculum development.

The knowledge management framework for curriculum development process is described below (Seema A. Tanekar, 2014):

The Framework ‘A’ (Fig. 3.2) represents sources of knowledge, knowledge or information acquired from various resources, various operations for converting knowledge into proper form for its storage in respective knowledge repositories. Other six diagrams, frameworks B1 to B6 (Fig. 3.3 to 3.8) represent actions, purposes, and generated reports in each phase of curriculum development process.
Fig. 3.2: Framework ‘A’: Abstract view of the KM Framework for Curriculum Development

Justification of requirement / usefulness of the various components

The framework ‘A’ includes representation of all the conversions of knowledge between tacit and explicit forms i.e. tacit to tacit (socialization), tacit to explicit (externalization), explicit to tacit (internalization), explicit to explicit (combination). Socialization is represented in the form of discussion boards, meetings, brainstorming sessions among curriculum developers, various types of experts and teachers. Externalization is taking place when tacit knowledge extracted from various sources is stored into repositories in explicit form or knowledge received through discussions is documented. When this tacit knowledge stored in repositories is retrieved and applied in the form of actions in various phases of curriculum development process, it is internalization. Combination will take place when explicit knowledge received in the form of documents like feedbacks from stakeholders, subject material etc. are converted into other explicit form after analyzing, summarizing etc.

The probable sources of knowledge for this knowledge management system will be as follows:
1) Teachers and Subject Experts: They can provide knowledge about latest advancements, research, books, journals, web resources, trends and technologies in their respective domains. They are also important stakeholders to give feedback about curriculum and suggestions for improvements. Teachers can give feedback about implementation of curriculum (problems faced, usefulness, students’ performance and comfort with the curriculum, etc.)

2) Curriculum Developers and Academic Experts: They can help in framing curriculum development process of the institution in tune with the institutional goals. Academic experts will be helpful in suggesting effective teaching, learning and assessment methods. Academic experts can be within or outside the institution.

3) Professional Experts: Professional experts like recruiters, professional practitioners or consultants, entrepreneurs etc. can be involved in curriculum development to make use of their experience to know professional and latest requirements of the market.

4) All kinds of experts and teachers should share their knowledge (socialization) through collaboration tools, meetings, discussion boards, brainstorming sessions etc.

5) External Sources: Curricula of other institutions will be acquired from various sources external to the organization like universities, web resources, printed brochures etc.

6) Statutory Councils / Accrediting bodies: Various governing bodies like universities, accrediting bodies, academic bodies, government, management may have provided guidelines, rules and regulations or constraints about curriculum. For example, a constraint like making inclusion of certain course or module mandatory or providing model curricula, guidelines about student evaluations etc. must be brought into notice of the curriculum developer depending on context.

7) Stakeholders: The sources of feedback about curriculum and its implementation are stakeholders like teachers, students, employers, experts, alumni. This feedback will help to decide about curriculum revision or modifications in methods of teaching, learning, assessments of learning outcomes etc.
8) Teachers can give feedback about their experiences while implementing curricula like problems occurred if any and solutions used/suggested, students performances etc. Student feedbacks can be about usefulness of the curriculum, skills achieved, ease of learning etc. Alumni feedback can be taken in context with effectiveness of current curricula with respect to current professional requirements, way of implementation etc. Academic experts will give feedback about the teaching, learning and assessment methodologies, general nature of curriculum etc. Subject experts will give feedback about the composition of contents of the curriculum it terms of coverage of fundamental concepts, latest research and technologies available in the domain, resources in the form of books, journals, web resources etc. Professional experts (i.e. employers, consultants / practitioners, entrepreneurs can provide feedback about whether the curriculum is satisfying professional (industry or market) expectations, skills required etc.

After receiving information/knowledge from above mentioned sources, it will be converted to proper form and stored in knowledge repositories by performing various operations on it as follows. This will make it convenient for storage and efficient for retrieval and application.

<table>
<thead>
<tr>
<th>Operation / Technique</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filtering</td>
<td>Remove irrelevant information</td>
</tr>
<tr>
<td>Summarizing</td>
<td>Summarize descriptive reports, documents</td>
</tr>
<tr>
<td>Analysis</td>
<td>Statistical analysis e.g. analysis of feedbacks</td>
</tr>
<tr>
<td>Documentation</td>
<td>Documentation of the knowledge received through discussions</td>
</tr>
<tr>
<td>Taxonomy</td>
<td>To classify knowledge properly to support retrieval</td>
</tr>
<tr>
<td>Ontology</td>
<td>To add context to the knowledge so that retrieval is efficient</td>
</tr>
<tr>
<td>Externalization</td>
<td>Convert tacit knowledge into explicit to store easily</td>
</tr>
<tr>
<td>Combination</td>
<td>Converting explicit knowledge into other suitable explicit form</td>
</tr>
<tr>
<td>Creating metadata</td>
<td>Data about data - to describe what is stored in repositories</td>
</tr>
</tbody>
</table>

Table 3.2: Operations to convert data/information/knowledge into proper form
Knowledge Repositories

Various types of repositories suggested will be useful in building curricula as follows:

**Modularized Subject Material:** Subject-wise material updated frequently with additions in research, technological advancements, professional trends and accessible in small pieces as per required context, supported by concept maps, will be very helpful in selecting topics for the contents of curriculum. Searching on keywords, synonyms, context will lead to efficient retrieval.

**References of web resources, books, journals:** Index of reference material or sources available outside the system in the form of websites, books, journals, white papers etc. will help in accessing this material. The portal should provide corresponding links and access to internet to seek web information.

**Curricula:** Current and past curricula of other institutions can be stored classified and indexed on different criteria like level-wise (UG/PG etc), discipline-wise, in chronological order etc. This will support navigation and retrieval as per user requirements in efficient manner.

**Modularised Contents:** If present and past curricula of the institution are maintained in hierarchical manner to represent broad topics divided into smaller topics at lower levels, even the smallest piece of content can be added, removed, modified, retrieved and used to combine with other topics at any level of hierarchy to design other curricula and interdisciplinary curricula.

**Profiles of Experts:** This option should guide the curriculum developer about whom to approach for seeking advice or expertise during the curriculum design. It should provide way to contact academic experts, professional experts, subject experts and provide information about their domains, experience, contact details etc. Corporate relationships, guest speakers will be useful in finding current trends and professional requirements in related field.

**Assessment Methodologies:** Various ways of assessing learning outcomes can be made available in the repositories along with the context in which they were / can be used and their effectiveness or experiences in the past. This will help in suggesting
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effective and innovative assessment methodologies suitable for testing particular skills. New methodologies should be continuously get added as suggested by teachers with their experiences while implementing, suggested by academic experts based on their experience and research, suggested by professional experts as they will be in tune with the professional expectations from the students.

**Question Banks:** In addition to questions based on theoretical concepts covered in the curriculum, they will include field work assignments, practical assignments, problem statements useful for surveys, research, projects etc. These will be helpful for teachers during implementation of curriculum. But these banks should be used as guidelines to get new ideas and should not restrict the scope of the curriculum.

The assessment methods and question banks can be categorized depending on whether they will be used to assess knowledge, skills or attitudes of students.

**Teaching / Learning Methodologies:** If various methodologies in context with the nature of topics to be covered are available in the repositories, they will serve as guidelines to suggest suitable methods in the curriculum.

**Documents, Reports, Files and Databases:** Documents for guidelines by various statutory councils and accrediting bodies, institutional policies, vision mission, goals, institutional procedures etc. Reports on previous student evaluations, performances, placements, expectations of knowledge/skills by recruiters, previous research for curriculum development etc. should be continuously added and updated in the repository. Files and databases consisting of experts’ information, professional contacts, guest speakers, academicians, recruiters, alumni, teachers and other stakeholders will help to review communications with them and contact whenever required.

**Profiles of Expert and Knowledge Maps:** Details of various experts with information about their domains, experience, contact details etc. will guide the curriculum developer about whom to approach for seeking advice or expertise during the curriculum design. It should provide way to contact academic experts, professional experts, subject experts. Corporate relationships, guest speakers will be
useful in finding current trends and professional requirements in related field. Knowledge maps in the repositories will help in finding experts and expertise. Knowledge maps will guide the user about steps in processes or experts to be contacted at various stages in curriculum development.

**Concept Maps:** Concept maps are used to represent various key concepts in a subject and ideas in the domain and their dependencies (other related concepts). These are useful in deciding depth (details) of topics to be included in the curriculum depending on the level of the course.

**Analysed Stakeholders Feedbacks:** Analysis of feedbacks about curricula from different stakeholders like students, alumni, faculty, employers, professionals, experts should be maintained. This will help to evaluate the curriculum and decide about further revisions or introduction of new curricula.

**Cases with lessons learned:** Experiences while designing and implementing curriculum e.g. problems occurred and the solutions suggested/used can be maintained in the repositories so that they can be useful in handling similar situations.

The above knowledge stored in the repositories will be retrieved and applied depending on the requirement by curriculum developer in various phases of curriculum development process as follows:

I. **Gap Analysis**

To analyse the gap between existing curriculum of the institution and curricula of other institutions or expectations by stakeholders, the knowledge management system will help in following ways:

The system will search and provide curricula of similar courses or subjects and give results of comparison with them in the form of common contents and other contents by using text comparisons with contexts (ontology) and using data mining tools.

The system will retrieve the profiles of appropriate experts suitable for the programme, subject for which curriculum is being designed and considering the
requirements requested by the curriculum developer. The classification of experts in efficient manner i.e. the underlying taxonomy will make the search effective. The professional needs, latest developments in the domain, suitable teaching, learning and assessment methods can then be discussed with the concerned experts suggested by the system to find out whether the existing curricula satisfy the expected requirements.

### Phase I: Gap Analysis

![Framework 'B1' for Phase I](image)

Professional experts will guide about whether the current curricula fulfill the latest market needs or professional expectations with reference to recruitment, entrepreneurship, research etc.

Subject experts will verify whether the fundamental concepts and other details, latest developments in the domain are covered in proper proportion and the resources like books, journals, web resources are suitable to give the required domain knowledge.

Academic experts are the academicians who will guide about the general nature of the curriculum- language, comprehensiveness, suitability of teaching, learning and assessment methodologies to achieve the learning outcomes etc.
These profiles of the experts are categorized into three types to make the retrieval more specific to the requirement while designing the curriculum.

Stakeholders’ feedback plays an important role in decision for revising existing curriculum or introducing new curriculum. The system will retrieve feedbacks about the programme or course under consideration which can be interpreted by the concerned authorities. Lessons learnt if any in context with the curriculum under consideration will be retrieved by the system to consider previous experiences associated with the curriculum.

Outcome of this phase will be in the form of various reports or documents as follows

1) Report on comparison of the curricula: This will consist of similarities or common contents in the curriculum under consideration and other curricula of the same/similar subject or programme. Other parts of contents which have appeared frequently in other curricula of the same/similar subject or programme. This can be generated by the KM system using text mining. This will give an insight about to what extent the existing curriculum under consideration is covering the aspects covered in other curricula (competitors’ curricula or benchmarking curricula).

2) Assessment of professional needs: This will consist of expectation of the industry in context with the concerned course, their coverage in the concerned curriculum, extent of additional requirements and their feasibility of coverage into existing curriculum.

3) List of contents requirement: After assessing suggestions of all kinds of experts and comparison with other curricula, the list of contents expected in the curriculum will be prepared by the curriculum developer.

4) List of resources required: If any changes in the curriculum or new curriculum is suggested, additional resources requirement e.g. equipments, hardware, software, study material (books, journals) etc. should be estimated and complete list of resources should be prepared. This will help in estimating the feasibility and cost of resources.

5) Changes in teaching/learning methodologies required if any.

6) Changes in assessment methods required if any.

II. Planning of Resources

Once it is decided to design the curriculum, the system will help in planning of resources in the form of human and study material resources. Various experts will constitute human resources while books, journals, documents, web resources will constitute study material resources for preparation of curriculum. The system will help in this phase in following ways:

The system will retrieve the profiles of appropriate experts suitable for the programme or subject for which curriculum is being designed so that teams or committees of experts for framing the curriculum can be prepared after checking the availability of the experts.

The system will provide references of web resources, books, journals, documents required as reference material for the subject for which curriculum is being prepared. The experts’ teams will then select suitable resources and specify details containing which resources will be useful for which part.

The system will notify applicable rules and guidelines by statutory councils, management etc. in context with the programme / course for which curriculum is being prepared. The curriculum developer will specify constraints if any by these bodies in the given context.

Fig 3.4: Framework ‘B2’ for Phase II
Outcome of this phase will be in the form of various reports or documents as follows:

1) Formation of teams/committees: Depending on the need and scope of work at the institutional level, teams of experts can be formed to work on different components of the curriculum.

2) Allocation of responsibilities: Responsibilities can be allocated on team or individual basis depending on scope of work.

3) List of resources available and required: This can be documented from list of resources selected by the experts as above and documenting the available resources with details.

III. Establishing Goals and Objectives

To decide goals and objectives of the programme or course, the knowledge management system will help in following ways:

The system will retrieve Institutional vision, mission, goals and objectives stored in the documents from the repository so that the concerned team or curriculum developer can set goals at the programme level in accordance with institutional goals.

The system will also search and retrieve goals and objectives of other similar programmes from the repository and also present result of comparisons using text mining giving frequently occurred objectives.

To establish goals and objectives at the subject (course) level, the system will present objectives and learning outcomes of similar curricula and result of their comparisons by effective searching and data mining techniques.

The system will present latest research and technologies introduced in concerned discipline from the subject material and references stored in the repositories.

The system will also recommend suitable experts who can then be contacted to give their opinions by analyzing goals and objectives of other curricula and latest research.

Verbs helpful in framing objectives and learning outcomes can be stored in the system based on Bloom’s Taxonomy (web: Austin College, 2016).
classifies learning objectives in six categories or levels of learning viz. knowledge, comprehension, application, analysis, synthesis, evaluation. The purpose of listing these verbs in classified manner is to assist in using more specific verbs to describe student learning of particular category. For example, to specify the objective of acquiring knowledge about concepts etc., the suitable verbs can be know, define, identify etc. Thus the learning outcome can be framed in a sentence like student should be able to ‘know’ or able to ‘define’ a particular concept etc.

If the course requires any pre-requisites or co-requisites, it will be decided at this stage by discussing with the experts.

![Diagram of Framework 'B3' for Phase III](image)

**Fig 3.5: Framework ‘B3’ for Phase III**

Outcome of this phase will be in the form of various reports or documents as follows:

1) Formation of goals of the programme (if applicable): If new program or revision of existing program is being done, its goals and objectives will be listed.

2) Objectives and learning outcomes of course: If curriculum of a subject is being prepared, the objectives and learning outcomes will be listed.

3) Establishment of feasibility of achieving and measuring learning outcomes: Along with learning outcomes, ways to measure the achievement of learning outcomes should also be listed in this phase.

4) Description of pre-requisites if any: In case of curriculum of a subject (course), if any pre-requisites are expected they will be documented so that while deciding the further contents of the curriculum they will be assumed as covered earlier.
IV. Selection and organization of contents

The knowledge management system will help in detailing the actual contents to be delivered in following ways:

The system will search and retrieve subject material specific to the subject under consideration and its objectives, in the form of latest research, technological advancements, professional trends, major topics in the subject etc. This information can be used to decide fundamental concepts to be covered and broad topics pertaining to each objective.

As the system will be maintaining concept maps for showing different concepts/topics in the subject, the system will suggest subtopics related to the major topics. Depending on the level of the students or course (e.g. Undergraduate, postgraduate), depth of topics to be covered and time available to cover, subtopics can be selected. The system will also give statistical analysis of frequency of occurrence of particular topics or subtopics in similar curricula of other institutions or programmes and time allotted for coverage therein, using statistical tools or data mining. While deciding topics and subtopics, the curriculum developer can think on topics occurring more frequently and common time allocated.

The system will suggest suitable experts in the subject domain. Brainstorming sessions can be held among experts to achieve consensus on topics and subtopics to be included in the curriculum.

Teaching/learning, assessment methods, question banks retrieved from the repositories, discussion with academic and professional experts and teachers’ opinions about teaching/learning assessment methods in the form of feedback from previous experiences can be used to decide teaching, learning, assessment methods to implement the curriculum.

The system will help in selecting the textbooks and other reference material to be prescribed in the curriculum by giving statistical measures on highly referenced material in various other curricula.
Outcome of this phase will be in the form of various reports or documents as follows:

1) Listing of major topics, subtopics belonging to each major topic and time allocation: These are the actual contents to be delivered through the curriculum.

2) Description of teaching/learning and assessment methodologies, resources, reference material: These are the components of curriculum which will help to achieve the objectives of curriculum and measure the learning outcomes formally.

3) Draft Curriculum consisting of items above: By combining all these components along with the objectives framed in the previous stage, a draft curriculum is ready which can then be given for further review to some other experts and/or teachers and then be finalized.

V. Preparing for Implementation

The knowledge management system will help in preparing for delivering the contents of the curriculum to some extent in following ways:
The system stores subject material and concept maps in the repositories which can be used to prepare teaching material or study material. The system will retrieve references of web resources, books journals in context with the subject under consideration which can be used to get those resources to prepare the teaching material.

The system will retrieve various types of question banks including field work assignments, practical assignments, surveys, research, projects etc. and assessment methods which will be useful in deciding the measures of learning outcomes and will be mentioned in curriculum document.

Outcome of this phase will be in the form of various reports or documents as follows: Teaching material / Study material: This will form as a base document for teacher to implement the curriculum i.e. delivering the contents.

Measures of learning outcomes: Depending upon the types of assessment methods suitable for measuring learning outcomes of the curriculum, lists of assignments, case studies, surveys, field work, projects, experiments/practical assignments will be documented as a part of the curriculum.

VI. Evaluation and Feedback
The knowledge management system will help in evaluating the curriculum and maintaining feedbacks from different stakeholders in following ways:
As the system will provide Goals, objectives, learning outcomes and guidelines to measure learning outcomes for the course which can then be checked whether they are achieved against the actual performances after implementation of the curriculum. The system will store and provide feedbacks from various stakeholders about the curriculum which can then be discussed with various experts, teachers on the basis of performances, achievements and employment of the students.

**Fig 3.8: Framework ‘B6’ for Phase VI**

Outcome of this phase will be in the form of various reports or documents as follows:

1) Analysed feedbacks from stakeholders and Suggestions for improvements:
   The feedbacks received about the curriculum will be analysed by the experts and again stored in the system repositories along with suggestions for improvements so that they are useful in the future also.

2) Lessons learnt: Different experiences during design and implementation of curriculum along with problems occurred and solutions used will be stored in the repositories along with previous experiences stored.

3) The two reports mentioned above will act as input to the first phase ‘Gap Analysis’ to see whether existing curriculum should be revised or new curriculum should be introduced. Thus curriculum development is a continuous process.
3.3 VALIDATION OF THE FRAMEWORK

After developing the knowledge management framework, in order to quantify the support of experts to this framework, it was decided to design a questionnaire for experts. It was also thought that for qualitative assessment of the framework, discussion with experts is necessary, for which interviews would be the suitable means.

Thus, the above mentioned framework was evaluated through experts’ opinions through interviews and questionnaire. Experts were senior persons from academics having experience in curriculum development process. The forty four respondents who responded, included Heads of Departments and Deans of various disciplines, Professors, Associate Professors from various institutions/Universities. The experts were selected using Snowball Sampling method. Initially, few Heads of Departments/Deans/Senior professors from some Universities were contacted. They were asked to give references of other experts whom they think would be suitable to give suggestions about this framework. When these experts referenced by previous experts were contacted, their response and involvement or interest shown in understanding and commenting on the framework was satisfactory. Some experts contacted without any such reference did not respond. The reason may be time and efforts required to understand the framework and then respond accordingly. It was also difficult to identify such highly qualified experts having necessary experience and interest in curriculum development. Because of this experience, the researcher used snowball sampling where respondents are located through referral networks. (Donald R. Cooper, 2012)

Face to face interviews with the experts were conducted to discuss about the validity, usefulness or effectiveness of the framework and seek suggestions if any, to improve the framework. The nature of the interviews was semi-structured. Questions related to validity of the components with respect to their purpose were structured, whereas open discussions were held in order to seek their suggestions, practical feasibility, problems and solutions in implementing the framework etc. Accordingly some of their suggestions suitable for the framework were incorporated. For example, suggestions like the concept of ‘Theme Paper’ for each course or subject which will
serve as background or reference document for developing curriculum for that course, various statistical measures useful for deciding contents of curriculum, maintaining global standards or benchmarking curricula along with addressing local/societal needs and strengths, maintaining proportion of core, optional, theoretical, practical contents etc. were incorporated. The interviews with experts helped in developing more insights to the issues involved in curriculum.

The questionnaire is given in Appendix A. There were 15 questions in the questionnaire for validating the framework. Out of these, first three questions were based on abstract view of the framework, and next twelve questions consisted of two questions for each sub-framework representing phases in curriculum development. For each question a five point Linkert scale (0 to 4) was used to ask the importance of the subcomponents in each component of the framework. The first question A1 was designed to validate the nature of knowledge repositories proposed. Importance of each repository was asked. Question A2 was designed to validate sources of knowledge identified. Sources of knowledge were listed along with their purpose to ask suitability for acquiring specified knowledge. Purpose of question A3 was to evaluate techniques suggested for converting knowledge into proper form in order to store into the repositories. Meaning and purpose of each technique was mentioned. Question A4 was an open ended question to request for general comments and suggestions if any.

Purpose of questions B1 to B6, each containing two sub-questions a and b, was to validate the six sub-frameworks for six phases of curriculum development process. In the part a of each question, weightage (0 to 4), to the sub-component related to the ‘knowledge-action’ pair i.e. ‘knowledge provided by the system and action taken on it’, was asked. In the part b, respondents were asked to evaluate the sub-component related to ‘outcome of these actions’. Thus outcome of each phase was evaluated.

Respondents were asked to give importance of different components in the framework on a five point scale 0 to 4, where a '0' stands for nil importance and a '4' represents absolute importance. These points correspond to the importance of the corresponding component as
Research Contributions

0 : Not required, 1 : Slightly important, 2 : Moderately important, 3 : Very important, 4 : Is a must

In this section, the analysis of responses received through the questionnaire is discussed. I determine ‘Importance Quotient’ of a component as the total of percentage responses for values ‘4’, and ‘3’. The behaviour of responses is also presented in the form of graphs showing percentage of respondents and importance given by them for various components as follows:

A. The Comprehensive Knowledge Management Framework (Abstract View)

It is an abstract view of the whole framework. For detailed view of use of knowledge management in each phase of curriculum development, there are six detailed frameworks corresponding to the six phases of the curriculum development process.

A1. Nature of Knowledge Repositories

All the repositories mentioned were supported to considerable extent as ‘Is a must’ i.e. ‘4’ or ‘Very important’ i.e. ‘3’ (together above 71% with greater contribution of ‘4’ as seen from the graph) except repository of ‘Question Banks’ scored 62% and repository of ‘Documents, reports, files, databases’ scored 52% (each for total of 3 and 4). (Fig. 3.9)

![Fig. 3.9: Responses to Nature of Knowledge Repositories](image-url)
Through discussion with the experts, it was realized that some of them were not in favor of having question banks because that constraints the students perception that they confine their domain of study to the question banks. This researcher suggests that question banks can be maintained as a part of teaching material so that teachers can get help for assessment of learners and some assignments from the question banks can be selected for including in the curriculum as ways of evaluation of certain learning outcomes as applicable.

It was observed that the repository named ‘Documents, reports, files, databases’ was given less importance by some experts who are not much familiar with IT aspects of the nature of repositories. This researcher suggests that this can be named as ‘Miscellaneous documents, reports, files, databases’ as other repositories may also contain knowledge in the form of various documents, reports, files and databases.

<table>
<thead>
<tr>
<th>Component</th>
<th>Importance Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching / Learning methodologies</td>
<td>93.75%</td>
</tr>
<tr>
<td>Modularized Subject Material</td>
<td>90.63%</td>
</tr>
<tr>
<td>References of web resources, books, journals</td>
<td>90.63%</td>
</tr>
<tr>
<td>Concept Maps for subject topics</td>
<td>87.50%</td>
</tr>
<tr>
<td>Modularized contents</td>
<td>81.25%</td>
</tr>
<tr>
<td>Assessment methodologies</td>
<td>80.65%</td>
</tr>
<tr>
<td>Profiles of Experts, Knowledge maps</td>
<td>77.42%</td>
</tr>
<tr>
<td>Cases with lessons learnt</td>
<td>76.67%</td>
</tr>
<tr>
<td>Analysed Stakeholders’ Feedbacks</td>
<td>74.19%</td>
</tr>
<tr>
<td>Curricula of various institutions</td>
<td>71.88%</td>
</tr>
<tr>
<td>Question banks</td>
<td>62.50%</td>
</tr>
<tr>
<td>Documents, reports, files, databases</td>
<td>51.61%</td>
</tr>
</tbody>
</table>

Table 3.3: Importance Quotient for Nature of Knowledge Repositories

A2. Sources of knowledge

For the component ‘Sources of knowledge’ the responses behavior was as follows:
All the sources of knowledge have received the importance as ‘Is a must’ i.e. ‘4’ or ‘Very important’ i.e. ‘3’ (together above 75%) with greater contribution of ‘4’ as seen from the graph. ‘Teachers and subject experts’ as sources of knowledge have received 100% responses as ‘4’ (78%) and ‘3’ (22%). ‘External sources’ of knowledge has received only 22% responses as ‘Is a must’ (Fig. 3.10). During discussion with experts and comments on this, it was noticed that respondents were expecting details or classification of external sources be mentioned. In some cases there was no clarity in understanding the meaning of external sources.

**Fig. 3.10: Responses to Sources of Knowledge**

<table>
<thead>
<tr>
<th>Component</th>
<th>Importance Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers, Subject experts</td>
<td>100.00%</td>
</tr>
<tr>
<td>Curriculum Developers, Teachers, Academic, Subject and Professional experts</td>
<td>96.88%</td>
</tr>
<tr>
<td>Curriculum Developers, Academic experts</td>
<td>93.75%</td>
</tr>
<tr>
<td>Professional experts</td>
<td>84.38%</td>
</tr>
<tr>
<td>Stakeholders (Teachers, students, alumni, experts, employers)</td>
<td>81.25%</td>
</tr>
<tr>
<td>Statutory Councils</td>
<td>78.13%</td>
</tr>
<tr>
<td>External sources</td>
<td>75.00%</td>
</tr>
</tbody>
</table>

**Table 3.4: Importance Quotient for Sources of Knowledge**
A3. Techniques to convert knowledge into proper form

For this component, the responses behavior was as follows:
All the techniques listed for converting the knowledge extracted from the sources have received the ratings of higher importance as ‘Is a must’ or ‘Very important’ (together above 75%) with greater contribution of ‘Is a Must’ as seen from the graph (Fig. 3.11). The application of these techniques is necessary because they include tools and techniques for knowledge capturing, knowledge representation and storage. The respondents were expected to have slight familiarity with some terminologies related to knowledge management like metadata, externalization, internalization, combination, socialization. These terms were explained to the respondents during interviews or when the questionnaires filled up in person from them. It was observed that few responses have ratings on lower importance because of non-familiarity of these technical terms. This researcher suggests all these operations as necessary in order to make the knowledge efficient for storage, retrieval and application. Depending on the type of knowledge, particular technique will be applied to represent it in a way to make it more useful and efficient to retrieve or to apply whenever required. The purpose of each of these techniques is given in the previous section 3 i.e. ‘Proposed Framework and justification of components’.

Fig. 3.11: Responses to Techniques to convert knowledge into proper form
<table>
<thead>
<tr>
<th>Component</th>
<th>Importance Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis</td>
<td>90.63%</td>
</tr>
<tr>
<td>Filtering</td>
<td>87.50%</td>
</tr>
<tr>
<td>Taxonomy</td>
<td>87.50%</td>
</tr>
<tr>
<td>Creating metadata</td>
<td>87.50%</td>
</tr>
<tr>
<td>Externalization</td>
<td>78.13%</td>
</tr>
<tr>
<td>Combination</td>
<td>78.13%</td>
</tr>
<tr>
<td>Summarizing</td>
<td>77.42%</td>
</tr>
<tr>
<td>Documentation</td>
<td>75.00%</td>
</tr>
<tr>
<td>Ontology</td>
<td>75.00%</td>
</tr>
</tbody>
</table>

Table 3.5: Importance Quotient for Techniques to convert knowledge into proper form

B. Knowledge Management Framework for phases in curriculum development process

Framework for each Phase (out of the six phases) of the curriculum development process is divided into two major components (with each having its own subcomponents)

a) Knowledge retrieved from the system and action to be taken on it:
   Importance was asked for each subcomponent as a pair of i) Knowledge provided by the system and ii) action to be taken on it. While labeling the graph, the subcomponents are named in terms of knowledge provided by the system (without mentioning action to be taken), to avoid big labels.

b) Outcome of the phase in the form of various reports: Importance of each outcome was asked.

Phase - I
For Framework for Phase I of the curriculum development process i.e. Gap Analysis, responses for knowledge provided by the system were as follows:
Fig. 3.12: Responses to subcomponents of Phase I

All subcomponents have received the importance as ‘Is a must’ i.e. ‘4’ or ‘Very important’ i.e. ‘3’ (together above 80%) with greater contribution of ‘4’ as seen from the graph. Profiles of academic experts which will be used to contact them to discuss and analyze teaching/learning and assessment methods for their effectiveness has received 100% responses as ‘4’ (58%) and ‘3’ (42%) i.e. no responses for low or nil importance (Fig. 3.12). Few respondents said that it is not essential to refer to curricula of other institutions.

<table>
<thead>
<tr>
<th>Knowledge Provided by the KM system</th>
<th>Action</th>
<th>Importance Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profiles of Academic Experts</td>
<td>Discuss and analyze teaching/learning and assessment methods for effectiveness</td>
<td>100.00%</td>
</tr>
<tr>
<td>Profiles of Subject Experts</td>
<td>Discuss and gather current developments in the domain</td>
<td>96.77%</td>
</tr>
<tr>
<td>Profiles of Professional Experts</td>
<td>Discuss to elicit professional needs (to be fulfilled by the course)</td>
<td>90.32%</td>
</tr>
<tr>
<td>Analysis of stakeholders’ feedbacks, lessons learnt</td>
<td>Interpretation of feedbacks and suggestions for improvements</td>
<td>83.87%</td>
</tr>
<tr>
<td>Similar curricula</td>
<td>Analysis and Comparison with current curricula</td>
<td>80.65%</td>
</tr>
</tbody>
</table>

Table 3.6: Importance Quotient for knowledge provided and actions in Phase I
All the reports mentioned as outcome of Phase I received the importance as ‘4’ or ‘3’ (together above 80%) with greater contribution of ‘4’ as seen from the graph below (Fig. 3.13). None of the reports received a ‘0’ importance from any respondent.

Fig. 3.13: Responses to Outcomes of Phase I

<table>
<thead>
<tr>
<th>Output</th>
<th>Importance Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of content requirement</td>
<td>96.77%</td>
</tr>
<tr>
<td>Assessment of professional needs</td>
<td>93.55%</td>
</tr>
<tr>
<td>Changes in teaching/learning methodologies required if any</td>
<td>90.32%</td>
</tr>
<tr>
<td>List of resources required</td>
<td>87.10%</td>
</tr>
<tr>
<td>Generation of comparison report of curricula</td>
<td>86.67%</td>
</tr>
<tr>
<td>Report of interpretation of feedbacks</td>
<td>80.65%</td>
</tr>
<tr>
<td>Changes in assessment methods required if any</td>
<td>80.00%</td>
</tr>
</tbody>
</table>

Table 3.7: Importance Quotient for Outcomes of Phase I

Phase - II

For Framework for Phase II of the curriculum development process i.e. Planning of Resources, responses for knowledge provided by the system were as follows:
Fig. 3.14: Responses to subcomponents of Phase II

The subcomponent ‘Rules and guidelines by statutory councils, management etc.’ received the importance as ‘Is a must’ i.e. ‘4’ or ‘Very important’ i.e. ‘3’ (together above 74%) whereas the other two subcomponents have received the importance as ‘Is a must’ i.e. ‘4’ or ‘Very important’ i.e. ‘3’ (together above 90%) with greater contribution of ‘4’ as seen from the graph. During discussions some respondents commented that guidelines by various bodies are not essential, we can set curriculum as per our requirements. No component has received ‘0’ importance (Fig. 3.14).

<table>
<thead>
<tr>
<th>Knowledge Provided by the KM system</th>
<th>Action</th>
<th>Importance Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profiles of experts in context with the discipline</td>
<td>Confirmation of availability of experts</td>
<td>90.63%</td>
</tr>
<tr>
<td>References of web resources, books, journals, documents</td>
<td>Specification of resources</td>
<td>90.63%</td>
</tr>
<tr>
<td>Rules and guidelines by statutory councils, management etc.</td>
<td>Specification of constraints / limitations if any</td>
<td>74.19%</td>
</tr>
</tbody>
</table>

Table 3.8: Importance Quotient for knowledge provided and actions in Phase II

All the reports mentioned as outcome of Phase II received the importance as ‘4’ or ‘3’ (together above 87%) with greater contribution of ‘4’ as seen from the graph below. None of the reports received a ‘0’ importance from any respondent (Fig. 3.15).
Research Contributions

Fig. 3.15: Responses to Outcomes of of Phase II

<table>
<thead>
<tr>
<th>Output</th>
<th>Importance Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formation of teams/committees</td>
<td>96.88%</td>
</tr>
<tr>
<td>Allocation of responsibilities</td>
<td>87.50%</td>
</tr>
<tr>
<td>List of resources available and required</td>
<td>87.50%</td>
</tr>
</tbody>
</table>

Table 3.9: Importance Quotient for Outcomes of Phase II

Phase - III

For Framework for Phase III of the curriculum development process i.e. Establishing Goals and Objectives, responses for knowledge provided by the system were as follows:

Fig. 3.16: Responses to subcomponents of Phase III
Table 3.10: Importance Quotient for knowledge provided and actions in Phase III

All subcomponents have received the importance as ‘Is a must’ i.e. ‘4’ or ‘Very important’ i.e. ‘3’ (together above 87%) with greater contribution of ‘4’ as seen from the graph. Objectives and learning outcomes of similar curricula, Profiles of experts, Latest research and technologies introduced in concerned discipline which will be used in analysis of objectives of similar curricula and local needs, seeking experts’ opinions, decision about prerequisites has received 100% responses as ‘4’ (69%) and ‘3’ (31%) i.e. no responses for low or nil importance (Fig. 3.16).

All the reports mentioned as outcome of Phase III received the importance as ‘4’ or ‘3’ (together above 80%) with greater contribution of ‘4’ as seen from the graph below (Fig. 3.17).
Fig. 3.17: Responses to outcomes of Phase III

<table>
<thead>
<tr>
<th>Output</th>
<th>Importance Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives and learning outcomes of course</td>
<td>96.88%</td>
</tr>
<tr>
<td>Establishment of feasibility of achieving and measuring learning outcomes</td>
<td>96.88%</td>
</tr>
<tr>
<td>Formation of goals of the programme (if applicable)</td>
<td>93.75%</td>
</tr>
<tr>
<td>Description of pre-requisites if any</td>
<td>72.41%</td>
</tr>
</tbody>
</table>

Table 3.11: Importance Quotient for Outcomes of Phase II

Phase - IV

For Framework for Phase IV of the curriculum development process i.e. Selection and organization of contents, responses for knowledge provided by the system were as follows:

Fig. 3.18: Responses to subcomponents of Phase IV
### Table 3.12: Importance Quotient for knowledge provided and actions in Phase IV

<table>
<thead>
<tr>
<th>Knowledge Provided by the KM system</th>
<th>Action</th>
<th>Importance Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject material related to each objective</td>
<td>Cover fundamental topics, see pre-requisites if any, select broad topics for each objective</td>
<td>96.88%</td>
</tr>
<tr>
<td>Teaching/learning, assessment methods, question banks, profiles of academic and professional experts</td>
<td>Decide teaching/ learning and assessment methods based on previous experiences and experts and teachers opinions</td>
<td>90.63%</td>
</tr>
<tr>
<td>References of web resources, books, journals, new editions of books and statistical measures on highly referenced material in various curricula</td>
<td>Selection of textbooks and reference material</td>
<td>90.63%</td>
</tr>
<tr>
<td>Concept maps for the subject, Statistical measures on occurrence of topics and time allotted in various curricula</td>
<td>Decide breadth and depth of topics and time to be allocated</td>
<td>83.87%</td>
</tr>
<tr>
<td>Profiles of subject experts, professional experts</td>
<td>Achieve consensus to finalise topics and subtopics through brainstorming among experts</td>
<td>83.87%</td>
</tr>
</tbody>
</table>

All subcomponents have received the importance as ‘Is a must’ i.e. ‘4’ or ‘Very important’ i.e. ‘3’ (together above 83%) with greater contribution of ‘4’ as seen from the graph (Fig. 3.18).

All the reports mentioned as outcome of Phase IV received the importance as ‘4’ or ‘3’ (together above 80%) with greater contribution of ‘4’ as seen from the graph below (Fig. 3.19). There are no responses for nil importance.
Research Contributions

Fig. 3.19: Responses to outcomes of Phase IV

<table>
<thead>
<tr>
<th>Output</th>
<th>Importance Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of teaching/learning and assessment methodologies, resources, reference material</td>
<td>96.67%</td>
</tr>
<tr>
<td>Listing of major topics, subtopics belonging to each major topic and time allocation</td>
<td>93.55%</td>
</tr>
<tr>
<td>Draft Curriculum consisting of items above</td>
<td>80.65%</td>
</tr>
</tbody>
</table>

Table 3.13: Importance Quotient for Outcomes of Phase IV

Phase - V

For Framework for Phase V of the curriculum development process i.e. Preparing for Implementation, responses for knowledge provided by the system were as follows:

<table>
<thead>
<tr>
<th>Knowledge Provided by the KM system</th>
<th>Action</th>
<th>Importance Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject material and concept maps</td>
<td>Preparation of study material</td>
<td>96.88%</td>
</tr>
<tr>
<td>References of web resources, books, journals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retrieval of learning outcomes, assessment methods, question banks</td>
<td>Preparing for assessment of learning outcomes</td>
<td>87.10%</td>
</tr>
</tbody>
</table>

Table 3.14: Importance Quotient for knowledge provided and actions in Phase V
All subcomponents have received the importance as ‘Is a must’ i.e. ‘4’ or ‘Very important’ i.e. ‘3’ (together above 87%) with greater contribution of ‘4’ as seen from the graph (Fig. 3.20). There are no responses for nil importance.

All the reports mentioned as outcome of Phase V received the importance as ‘4’ or ‘3’ (together above 87%) with greater contribution of ‘4’ as seen from the graph (Fig. 3.21). There are no responses for low or nil importance.
**Output**

| Study / teaching material                       | 95.00% |
| Assignments, case studies                      | 87.10% |
| Question banks for surveys, field work, projects |       |
| List of experiments/practical assignments      |       |

**Table 3.15: Importance Quotient for Outcomes of Phase V**

**Phase - VI**

For Framework for Phase VI of the curriculum development process i.e. Preparing for Implementation, responses for knowledge provided by the system were as follows:

<table>
<thead>
<tr>
<th>Knowledge Provided by the KM system</th>
<th>Action</th>
<th>Importance Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>profiles professional, academic and subject experts</td>
<td>Discussion with experts and faculty about performance, achievements, employment of students</td>
<td>100.00%</td>
</tr>
<tr>
<td>Goals, objectives, learning outcomes and guidelines to measure learning outcomes. Feedbacks from stakeholders</td>
<td>Receiving feedbacks and analysing with reference to achievement of goals, objectives and learning outcomes</td>
<td>93.55%</td>
</tr>
</tbody>
</table>

**Table 3.16: Importance Quotient for knowledge provided and actions in Phase VI**
All subcomponents have received the importance as ‘Is a must’ i.e. ‘4’ or ‘Very important’ i.e. ‘3’ (together above 94%) with greater contribution of ‘4’ as seen from the graph (Fig. 3.22). There are no responses for nil or low importance.

All the reports mentioned as outcome of Phase VI received the importance as ‘4’ or ‘3’ (together above 90%) with greater contribution of ‘4’ as seen from the graph (Fig. 3.23). There are no responses for low or nil importance.

### Table 3.17: Importance Quotient for Outcomes of Phase VI

<table>
<thead>
<tr>
<th>Output</th>
<th>Importance Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysed feedbacks from stakeholders</td>
<td>96.67%</td>
</tr>
<tr>
<td>Suggestions for improvements</td>
<td></td>
</tr>
<tr>
<td>Lessons learnt</td>
<td>90.32%</td>
</tr>
</tbody>
</table>

In the next chapter, demonstration of the framework is discussed. It also details IT specific aspects for the implementation of framework through realization of the framework as an IT application.