CHAPTER - 4

CONCEPTUAL FRAME, DERIVATION OF HYPOTHESES & CRITERIA FOR EVALUATION.

The chapter aims at developing a suitable model for studying the extent of use of Information technology in S&T libraries of Delhi. The conceptual frame & Criteria for the evaluation of growth and development of IT in S&T libraries is basically developed on the basis of the review of the literature. This chapter gives a brief illustration about: Conceptual frame of study, derivation of hypothesis, the Model Criteria, Management Functions in an S&T Library, Matrix for Library Activities, levels of Management, Elements of Management Information, System design, Components of IT based Libraries, IT-based Information Systems (IS) Development Life Cycle.

4.1 Assumptions:

The basis assumption in this study is "that the extent of Information Technology use is determined by a set of organizational and personal variables". This assumption is based on the Social Engineering approach as described by Rice(1963), Marrow, et al. (1967), and .al. (1967), and Trist, et.,al. (1963). These authors contented that in an Organization there is an interaction between the two major factors; a) Technology, and b) the Organization and its Members. In planning or changing one factor has an effect on the other one. To study the use of IT in the given library systems the organizational factors and the Perception of the library managers about IT use are taken in to consideration.

The following information related to the Information Technologies are to be explored in the given S&T libraries:

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The Organizational study & perceptual study of the libraries of the S&T libraries of Delhi state are to be undertaken.

4.2. Variables

The important concepts (Variables) found to be associated with the use of IT are given as below:

A. Independent Variables

   i) Organizational Characteristics:
      Goal, Activities, Resources, Structures, Policies, Rules, Training,
      Culture, Management etc.

   ii) Communication Behavior:
      Communication Pattern, Information Seeking behavior, Linkages, etc.

B. Dependent Variables:

   1) Extent of information technology use. The change is measured here by comparing the differences between the systems. Differential exposure and intake of modern library services and practices leads to differential change in S&T libraries. With this basic premise of different aspects of change in the library services and practices are considered in this study as are likely to be the result of adoption of new technology - Computer Technology, Communication Technology, & Optical /Video (CD-ROM) technology that enable the acquisition, representation, storage, transmission, and use of information in S&T libraries.

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4.3. The Basic Frame of the Study:

The first objective of the study i.e. Status of use Information Technology (IT) was met by using two methods of research: a). Historical Method b) Survey Method. The following sources of information were used:

i) Literature related to the Information systems and its application in academic libraries,

ii) Reports and documents related to the organizations under study.

iii) Inquiry from the concerned library managers.

The Tools employed were :

i) Literature Survey

ii) Study of documents and other records

iii) Survey of the individual Organizations

On the basis of Literature Survey a criteria of evaluation for the Organizational Resource study was designed. The data was collected through two instruments: i) Organizational Questionnaire, and b) Data collection sheet. The data was analyzed by using descriptive statistics. The second objective of the study was concerning with the Organizational culture of the Library managers about the use of Computer-based system in S&T libraries. These factors were conceived: i) as associated with the actor (respondents), and ii) influenced by specific situation in which they were observed. Since the solution of the problem were in the present, therefore, the survey method of research was used to study and to minimize the bias.

Four Hypothesis were derived using the literature review and various models of related past study. The following methods were followed to conduct the Survey method of research:

a) Identification and specification of problems

b) Conceptual frame and formulation of Hypothesis

c) Design of instrument

d) Collection of data

e) Analysis of data
4.4 Derivation of Null Hypothesis:

In the light of the objective of the study following hypotheses were derived:

**Null Hypothesis 1:**

There is no significant difference between those library managers who are involved in computerization and those who are not involved as regards their perception of IT use in S&T libraries.

**Null Hypothesis 2:**

There is no significant difference between library managers who are encouraged by various professional bodies and those who are not encouraged as regards their perception of IT use in S&T libraries.

**Null Hypothesis 3:**

There is no significant difference between male and female library managers as regards their perception of IT use in S&T libraries.

**Null Hypothesis 4:**

There is no significant difference between those library managers who have knowledge of computers and those who do not have as regards their perception of IT use in S&T libraries.
The conceptual framework discussed earlier has been used for designing the questionnaire. (Appendix B). The structured questions were designed so as to assist in computer-based statistical processing of collected research data. The protested questionnaire which has been used for data collection included the following aspects:

a) Top Management's Interest in IT use
b) Planning of IT
c) Perception towards Technology use in libraries
d) Manpower Planning and Training
e) Library managers interest & awareness for IT application in library.

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ii) Reports and documents related to the organizations under study.
iii) Inquiry from the concerned library managers.

4.5. Model Criteria

The model provides a uniform framework for S&T library managers to assist them in the development and implementation of Computer based Information System. Wassermann (1980) stated that a method for information system development should be based upon a small number of underlying concepts.

- **Modularisation** - The problem solving notion of "divided and conquer" permit one to subdivided a difficult problem in to sub problem and then to subdivide those problems repeatedly until the resulting problems become intellectually manageable.

- **Abstraction**: The psychological notion of the abstraction permits one to concentrates on a problem at some level of generalization with out regard to irrelevant low level details.

- **Written and Oral Communication**: Communication of knowledge and concepts among all of the persons involved in the designed and development of an information system is
critical; this information must be represented in such a way that it can be effectively communicated.

- Commitment of development organization to software engineering - the environment in which the development organization works has a strong impact on the ease of communication, the quality of the final product that can be developed, and the productivity of the developers.

- Availability of appropriate tools - tools are manor component of an environment and must be usable and well integrated with one another.

- Phases approach to software quality - the quality of the product is determined from the start. Failure to identify the problem or the user needs will result in a poor specification, which will be reflected in an inadequate system, requiring extensive medications and enhancements that lead to uncontrollable maintenance costs and user dissatisfaction. This reason, above all, provides the best justification for use of a systematic methodology for information systems design.

4.6 Conceptual Framework:

To understand the extent of use of IT in S&T libraries there is a need to review of the available theoretical framework. There are a number of conceptual framework which are commonly adopted for studies of area of IT application, extent of their use, growth and development etc. The Nolan's six stage model is adopted for this purpose. The suitability of the model is explored in 4.6.1 as below:

4.6.1. Nolan's Stage Hypothesis:

Richard L. Nolan, a professor at the Harvard Business School, suggested a "Stage Hypothesis" in 1974. This model explained the growth of Computer based System function in any organization on a four stage continuum. In 1979, Nolan revised the model a six stage growth hypothesis.
Nolan's Four Stage Model:

In 1974, Richard L. Nolan suggested a model, popularly known as "Stage Growth Model", meant for understanding the different stages of EDP growth. A depicted in the model, an organization goes through identifiable stages as it computerizes. This model goes through identifiable stages as it computerizes. This model finds its application everywhere in computerized processing. This model could prove to be useful to organisations thinking of buying a computer as well as to those who have been using computers for years, decades or so. To help EDP manager communicate with the management and to develop an understanding of computerization among the organizational cadres, this model provides a theoretical framework. As discusses in this model, there are four different stages in the growth of all computerization facilities, each with distinctive applications, regards and managerial problems. When plotted, these stages could be drawn in the form of an S-curve. Nolan described three components of EDP growth process:

- A growth in computer application.
- A growth in the specialization of EDP personnel
- A growth in management techniques and organization.

The four stages of IT-based System growth are discussed by Nolan as follows:

Stage I. Initiation: It could be seen from Fig.4.1, that the moment the first computer is installed in an organization in an organization, the organization is more concerned about the cost saving applications. Issues like long term impact of computer on personnel organization or its strategy, are normally ignored. the emphasis is laid on recruiting personnel with specialization for efficiency of computer applications. Ample amount of freedom is granted to the EDP department with loose budget the lack of controls. The system is installed under the department where it is first used, and usually in the accounting department. The interjection of high-technology into an organization also results in an anxiety generated from fear of job displacement and organizational threats. The management is needed to plug this issue with properly dissected communications.

Stage II. Expansion: With the excess capacities procured at the time of initiation and a general impatience for advanced applications, the EDP function "takes off". There is a steep rise in the EDP budget for hardware, software and personnel. This is also termed as a
period of "contagious, unplanned growth". The applications of EDP proliferate into almost all areas of business activity. Personnel employed are people with specialization to develop variety of applications. The hierarchical position of the EDP manager is hiked up in the organization and the personnel spreads all over the organization. The management is still not exercising full control and the application development does not follow much standards.

Top management is usually attracted to the usefulness of computerization ignoring all its side-effects. This stage often ends up in crisis when top management becomes aware of the explosive growth of the EDP activity and its budgets. At this point, the top management realizes the necessity to undertake resource allocation and coordinate any further growth in the area.

Peculiar during this stage are exponential budget growth rate, cost overruns, exploding demands of the users, euphoric urge of the EDP personnel to excel and evolution of an informal structure among computer personnel. The relationship between computer personnel and users also takes an informal shape. Development of middle level managers in this stage becomes very crucial since a balance between organizational needs and professional interest is hard to achieve.

Stage III. Normalization: During this stage, formalization of reporting systems takes place with the top management becoming more and more concerned about the cost, resource control and centralized effort. The establishment of a chargeour system as well as the elaborate and cumbersome quality control measures are peculiar to this stage. The management emphasizes higher priority to control rather than the new application development. The personnel specialize in control and quality assurance in addition to their earlier acquired skills. Settings of steering in addition to their earlier acquired skills. Setting of steering committees, and centralization of efforts and a tendency towards systems programming gets a higher priority. These are backed by strong budgetary (pg.50) planning for hardware and new application. Controls are exercised to contain a run-away budget. Priorities are set up formally to justify budgets and documentation is standardized, Project control and quality control guidelines are also established.

During this stage a separate "System development division" is usually created and the top management direction is necessitated in the resource allocation. Also, this is the time
when the system analysis function should be reorganized to have systems analysts spread throughout the organization to ensure that the user needs are met adequately.

**Stage IV. Maturity:** After crossing stage-3, the IT based system resource is mature enough to generate continuing economic benefits to the organization. The function starts developing data base oriented application, mainly to supply the top management with division support systems. Also, on-line real time systems with on-line inquiry facility form a part of the development package. The specialization of personnel shifts to data base technology and data communication technology. At this stage, the organization starts preparing 3-5 year corporate EDP plans for further growth. EDP is considered a separate functional area with its own pre-assesses budget. Management control systems are refined and data base policies are introduced.

The System manager is heavily involved in planning for future and enjoys a very respectable position in the organizational hierarchy. The communication at this stage between system manager and top managements as well as between system department and users becomes very crucial. To avoid conflict, the steering committee may play an important role in the determining project priorities, policies and changes within the system department.

**Nolan's Six Stage Model:** In 1979, Nolan revised his conceptual model by adding two more stages to his four stage theory. It was in the wake of the sea change which took place in the mission and function of corporate computing activities. This scheme, as mentioned by him supersedes the earlier model for growth of corporate System function. The stages proposed by Nolan in his revised Model are:

- **Initiation**
- **Contagion**
- **Control**
- **Integration**
- **Data Administration**
- **Maturity**

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In this model he has emphasized on management of data resource after stage-3 and management of compute resource up to stage-3 and management of computer resource up to stage-3. This calls for restructuring of data processing organization as well as installing new management techniques. The transition point in fig. For Growth Process, as given below indicates the shift of emphasis from computer resource management to data resource management.

**Growth Process:**

<table>
<thead>
<tr>
<th>Application Portfolio</th>
<th>Functional Cost &amp; reduction applications</th>
<th>Proliferation</th>
<th>Upgrade documentation &amp; restructuring of existing applications</th>
<th>Retrofitting existing applications using IT.</th>
<th>Organization integration of applications</th>
<th>Application integrations mirroring Information flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization</td>
<td>Specialization of technological learning</td>
<td>User oriented programs</td>
<td>Middle Management</td>
<td>Established computer utility and user account teams</td>
<td>Data Administration</td>
<td>Data resource management</td>
</tr>
<tr>
<td>Data processing Planning &amp; control</td>
<td>Lax</td>
<td>More Lax</td>
<td>Formalized planning &amp; control</td>
<td>Tailored planning &amp; Control System</td>
<td>Shared data &amp; common systems</td>
<td>Data resource Strategic planning</td>
</tr>
<tr>
<td>User Awareness</td>
<td>Hands Off</td>
<td>Superficially enthusiastic</td>
<td>Arbitrary accountability</td>
<td>Accountability learning</td>
<td>Effectively accountability</td>
<td>Acceptance of joint user &amp; data processing responsibility</td>
</tr>
<tr>
<td>Level of Data Processing expenditures</td>
<td>Stage I Initiations</td>
<td>Stage II Contagion</td>
<td>Stage III Control</td>
<td>Stage IV Integration</td>
<td>Stage V Data Administration</td>
<td>Stage VI Maturity</td>
</tr>
</tbody>
</table>

As it could be seen from Fig. Above, Nolan has suggested numerous growth processes, which are indicative of stage growth of a system. Important among these are application portfolio; data processing organization; data processing planning and control; and level of user awareness. Nolan also discusses about the application which may not be feasible or economical to automate at every level of management as well as at every stage of growth.
The data base and data communication technologies are introduced into the organization at the close of stage-3. In addition, the computer organization reaches a point where high quality services are reliably provided to the users. In stage-4 the users are provided on-line interactive terminals, pushing the system budget at the same rate as in stage-2.

Nolan has considered identification of the EDP growth stage important from planning and controlling point of view and has given benchmarks of six stages for identifying the growth stage of system in any organization.

In the first level benchmarks, the growth stage is considered to be a function of growth rate of system expenditure and its comparison with growth rate of sales as well as of technology being used. In the second level of benchmarks, the growth stages are identified on the basis of growth processes. There are possibilities of any organization having different applications in different stage or any organizations being in the same stage of growth.

Nolan has given the following guidelines to manage system growth successfully:

- Recognize the fundamental organizational transition from computer management to data resource management.
- Recognize the importance of the enabling technologies.
- Identify the stages of the computers operating units to help keep data processing activities on track.
- Develop a multi-level strategy and plan.
- Make the steering committee work.

Janice C. Burn has applied this model successfully in 125 organizations of Hongkong.

a) The organizations are found to be distributed over full range of Nolan's Stage Growth Model.

b) There is a noticeable variation between various sectors with regard to stage growth. Government sector was found to be most sophisticated user with only 14 per cent of the users in the earlier stages of growth and more than 60 percent of them in stage-4.

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c) There was a strong correlation between performance return and percentage of investment in information processing activity. She concludes that in some organizations the 6th stage has already reached and in other organizations, it may never reach.

As observed by Dickson, most of the U.S. organizations crossed the control stage by mid-1970's. Many firms, have integrated applications and have become oriented towards data base technology, however, some of them are still towards the tail of control stage.

**Suitability of the Model:** This model can be used both for diagnosing the current stage of growth of EDP activities as well as for planning changes to control the future direction of Computerized Systems activities. This model has been accepted by many practitioners as a high value tool, and is treated as one of the classics in the field. The consulting firm of Nolan & Norton Inc. have carried out more than 200 studies based on this model. Nolan's stage hypothesis could be put on a number of used as a conceptual framework. It can be used for finding out the stage for growth which the organization is experiencing.

However, some of the researchers have also found the stage growth model not being supported by the actual data collected from the organizations. As observed by them, the research evidence does not support the contingency relationship between stages and features associated with the growth processes at each stage. But Gordon Davis passes this inadequacy on to the lack of proper research design, non-availability or insufficiency of data. King and Kremr described the Nolan model as an evolutionist which can describe the logic, direction and estimation of the change.

In this study the Nolan stage Growth model is taken as conceptual model to understand the status of use of IT application in S&T libraries.

### 4.7. CRITERIA FOR EVALUATION:

As mentioned in chapter 1 the S&T library is having all the characteristics of a Model Organization where IT use was found most successful. Their managers are also perform the managerial functions, head their library, have some authority, are responsible to get the work done from the staff, and watch the interest of the staff working in that organization. The
Primary task of the management is to take decision in the direction of achieving set goals and coordinating the efforts put in by various category of staff. The library is also having all the five classical functions of managers suggested by Henary Fayol's for a model business organization. The are:

1. Planning what is to be done
2. Organizing the appropriate structure to accomplish the plan
3. Staffing the organization with appropriate personal and coordinating their activities.
4. Directing the staff towards the accomplishment of the plans.
5. Controlling the activities so that the objective can be made.

Following Criteria is developed for the evaluation of system functions in a library. This is based on the Management functions used in Computer-based system in IIT Delhi Library Systems.

System: A university Library system as a whole
Sub-systems: i) Users services ii) Administrative Services, iii) Systems Services

Following are the main administrative services in an academic / University Institution Library:
• Serial,
• Acquisition
• Circulation
• Technical Processing
• Main Services
• Account Maintenance

Each Administrative Services Module is having a) Operational Procedures, b) Management Procedures.

Following are the activities common to all the Procedures:
4.8. Matrix for Library Activities

In an academic library a set of records and reports had been in vogue since its inception. For example: for maintenance of records, various registers are prescribed and for flow of information from grassroots levels to the top, different reporting performance are in practice. In addition, some more information to monitor the library program activities are also needed in different forms and returns. It should be possible to reduce the overall number of forms, and the number of times an element of information must be transcribed from one form to another, by considering the information requirement of the whole system and consciously designing forms to exploit the time sequence of library processing and the possible interconnection of one activity with another. Much of the information required for one operation is also required in other operations, and MIS is the other name of Records, Reports, and Returns. It takes in to account the systems approach both in the collection and the use of data.

4.9. Elements of S&T Library Information system:

Environmental information
academic plan
profile of library
higher education trends
IT developments
publishing trends
political factors

Library and Information Systems Plan
function and objectives
services
activities
priorities
criteria for evaluation

Financial Information
inflation factors
staff costs/distribution
budget control
buildings
equipment

Performance Indicator
external comparisons
units costs
service delivery times
space utilization
stock turnover
cataloguing throughout/backlogs
speed of supply

Statistics
number of items purchased
number of enquiries handled
number of online searches
use of library
opening hours

User satisfaction
consumer group information
complaints
staff-student committees
questionnaires
surveys of use
knowledge of services
perception
market research

Staff morale
Sickness rates
recruitment success
training time
4.10. System Design:

The Information is the data that has been processed and is meaningful to a user. This follows that some data has to be collected from internal and external sources, stored, processed, retrieved and transmitted to its various users through some systems.

As shown in Figure 4.1 the System is a set of components that operate together to achieve a common purpose. The main components of this system are:

a) The People such as users - i) different levels of managers who need different type of information for their decision making; and ii) Data processing management which includes Database administrator and all the technical personnel such as programmer, system designers etc. who help in maintaining system and providing needed information.

b) The Procedures - includes the standards and necessary manuals used to access or request new reports, common communication format, procedures, instructions, rules, regulations etc. which facilitate the use of the system; and

c) The Equipment's - includes Hardware components, Peripherals, Software components, Database, Data dictionary, networking and system model. These components work together to select, classify, store, analyze, retrieve, and process data to reduce uncertainty in decision making by yielding information to managers at the time they can most effectively use it.

4.11. Components of IT-based Information System in S&T Libraries:

As shown in the Figure 4.3 the basic components of a Computer-based MIS are given below:

1. The users: The users of the are all the different levels of decision makers of the academic libraries.

2. Inputs: Inputs provides the basic raw data to for information systems to operate. All data which has some bearing on its functioning should be recorded. The input data used to produce information originate from internal and external sources. In ternal sources consist of individuals and department, units, located within the organization. The sources furnishes facts on regular and planed basis. External information is generated from the data outside the organization.

3. Outputs: The basic purpose of any Information system is to generate information which are found useful by its users in discharge of their responsibility: The outputs can be
either prescribed in terms of its contents, structure and frequency. To provide the quality information the systems found relevant to the library environment includes:

4. **Communicational Channels:** The output may be received through the single PC or more than one PC or Terminals connected through Network.

5. **Procedures:** Include all the user manuals designed to facilitate the utilization and user manuals designed to facilitate the utilization and interaction of the user with the system the standard, data security measurements. The purpose of the procedures is to maintain standards, data security, and provide the user with the necessary on-line construction to facilitate environment. That is, this environment enable the user of the system to work with enough instruction to produce the complexity of the system.

6. **Data Processing Management:** Normally, data processing management includes all the technical and operation personnel to support the development of a in a data base environment. One of the first responsibilities of top management is to establish the data base administrator. The data base administrator can be one person or more. The main data base administrator function is to be responsible for the standardization and coordination of the institutional data resources. Basically this group is in charge of management and control of the data resources of the institution.

7. **File or Database:** Files or database are used for storing data about entities or things of interest to the users of information. The database should be regularly updated to reflect the changes of in the status of the concerned entity. In a computer-based systems the important components are the Hardware, Software and Peripherals.

8. **Data Dictionary (DD):**

This represents the depository of information about the institutional data elements. The DD represents an invaluable tool for the data base administrator as it permits control and management of the data resources by the use of a common, centralized and standardized depository of information concerning the institutional data. This DD can be a manual one. However the current development in DD technology indicate that more and powerful software packages are becoming available to assist the development of automated DD development of efforts (Ross, 1981).

9. **Decision Model Software:** Basically, the institutional data base development effort must be able to produce the institutional information requirements for general administrative computing and management requirements. However, the university library must require the
utilization of very specialized management decisions models and the must integrate decision models software as part of the basic components.

4.12. IT-based Information System (IS) Development Life Cycle:

There are very few comprehensive methodologies or frameworks specially designed for developing IT-based IS in academic libraries. Atwood (1977) suggested the following steps

1. Systems analysis
2. Feasibility study
3. System design
4. Equipment selection
5. Programming
6. Conversion
7. Documentation
8. Implementation of the design.

Some of the early methodologies were intended for the systems professionals (Bingham & Davis, 1972; Hussain, 1975; Kindred, 1973).

The methodology used for developing and implementing computer-based systems affects its acceptance and use by the users. Experience and research has shown that greater the participation and involvement of end users in the computer-based systems development and implementation process, greater is the likelihood of its being accepted and used by the users.

The popular computer-based systems development methodologies in use are: a) the traditional methodology for computer-based systems development which is more popular in use is known as the System Development Life Cycle (SDLC). The more modern approach which is also gradually increasing in use is known as Prototype Methodology.

In System Development Life Cycle (SDLC) methodology the following main steps are generally adopted.
1. Definition stage: Initiation and proposal definition; Feasibility assessment; conceptual and logical design.

2. Development stage: Physical systems design; physical file/database design; processing logic/program development; testing; procedure development and documentation.

3. Installation and operation stage: Changeover/conversion; operation; maintenance; post audit and evaluation.

Prototyping Approach to development of Information systems (IS) is an evolutionary design method particularly suitable in situations where requirement are difficult to specify in advance or when requirements are changed significantly during development period itself. It is based on the proposition that users can express their information needs, what they require or don't require more easily and correctly about an existing information system. In this approach:

a) the systems designers identifies user's initial, basic requirements.

b) a prototype system is used which may not have all the desired requirements or feature in all respects.

c) user uses the prototype in actual practice and gives feed back to the systems designer about the inadequacy about the prototype system.

d) the system designer revises the prototype system according to the requirements of the users. The feedback / enhancement cycle is repeated until a satisfactory system has been developed.

Although use of prototype methodology results in more useful system, it is not easy to implement as it requires users/ administrators and system designers to work together closely and continuously during the development of the systems.