Chapter 3

CONCEPTION PHASE

"On the other hand, the concept owes its meaning and its justification exclusively to the sense impressions which we associate with it."

-Albert Einstein
Chapter 3

CONCEPTION PHASE

3.1 INTRODUCTION TO CONCEPTION PHASE OF A PROJECT

In the conception phase of a project, a project work is identified, its meaning is elaborated, its objectives are defined and its boundaries are depicted clearly. Every project in any organizational environment will start from conception phase, however, the activities may differ in different organizations, but with the same objective to have clear concept of the problem and the project to take up. Projects always begin with a problem. The early stages of developing the outline of the problem and the project serve to ensure that the objectives of the project are clear by providing an understanding of what is to be done. This includes understanding user’s problem and the requirements to solve the problem, feasibility and chances of success to take up the project and also preparation and obtaining approval of the project proposal and finally developing the detailed definition and scope of the project. All these activities can be treated as sub-systems in the conception phase of a project and they are described below.

In view of the above, the different activities in the conception phase of a project are:

- Selection of project
- Concept of project
- Feasibility of project
- Approval of project proposal
- Scope of project.

When all the above activities are performed in a perfect manner, the next important phase of project, that is, the planning phase will be handled effectively by embedding clear vision and direction to execute the project.
A verbal model, named as 'SeCFAS', has been developed by integrating all the five activities of the conception phase of a project and is graphically shown in the figure, Fig. 3.1.

Figure 3.1. SeCFAS model of the conception phase of a project

3.2 SELECTION OF PROJECT

Selection of the project is very important and is the first step in the project life cycle. It may be a problem to solve, a product to develop, or a service to perform and also it may be a new system or modifying/extending the old system. Project selection is the process of evaluating the pros and cons of taking up a project. The selection of a right project for future investment is a crucial decision for the long-term survival of the parent organization. Project selection is merely making a commitment for the future.

Meredith and Mantel (2003) reported different factors that influence the selection of a project. They are production, financial, marketing, personnel, and administrative and miscellaneous factors. The production factors include facility and equipment requirements,
availability of raw materials, etc. The marketing factors include consumer acceptance, probable market share of output, estimated life of output, impact on current product line, etc. The financial factors include profitability, cash requirements, impact on cash flows, size of investment required, etc. The personnel factors include training requirements, labour skill requirements, availability of required labour skills, level of resistance from current workforce, impact on working conditions, inter- and intra-group communication requirements, etc. Administrative and miscellaneous factors include meeting government safety and environmental standards, impact on information system, impact on image with customers, suppliers, and competitors, patents and trade secret protection, managerial capacity to direct and control new process, etc.

From the surveys performed, it was observed in APTS that usually a state government organization requests the services of APTS to study its system and recommend IT solutions to automate their activities or solve their workflow problems. Then the technical people of APTS will go to the concerned department and they study the existing system, its problems and make recommendations to improve the workflow performance. After conducting a few meetings among the team members and also with users, a document containing the details of approximate cost, duration, etc. of the project will be prepared and submitted to the user organization along with relevant recommendations, based on the availability of funds and financial condition of the user organization to go for computerization or other IT services. When the organization is convinced and agrees to the proposal of APTS, APTS evaluates its own capabilities like facilities, enough labour, skills and technologies, etc. to take up and develop the project using its own resources or to sub-contract the work to external developers.

In the case of NHCL and other private organizations, they approach different customer organizations, both public and private sectors, enquire about their problems and requirements, study and analyse them and submit proposals. For this, the developers will do prior analysis to ensure that they have sufficient financial reserves or options and other

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* A state government organization may be either a state government department or a directorate or a corporation.
required resources to take up such project, if awarded. If they need extra human and non-human resources to take up the project, as they are private organizations, they can hire additional resources at any time easily and quickly, either independently or through some potential suppliers, for example, for human resources they can get from human resources (HR) consultants. But in Government organizations, a lot of procedures and policies will be followed and such actions of getting resources cannot be taken so fast and easily as in private organizations. In addition, the staff in the private organizations is highly motivated to learn and practice other additional technologies, and upgrade their skills and knowledge to meet any challenges demanded by new projects.

From the above discussions, eleven salient variables have been identified which form and influence within the sub-system of 'selection of project' and the list is given in Table 3.2.

<table>
<thead>
<tr>
<th>Salient variables</th>
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<tbody>
<tr>
<td>1. Demand and Value</td>
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<tr>
<td>2. Financial prospectus</td>
</tr>
<tr>
<td>3. Cost of the project</td>
</tr>
<tr>
<td>4. Organizational strengths</td>
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<tr>
<td>5. Skilled people</td>
</tr>
<tr>
<td>6. Suitable technologies</td>
</tr>
<tr>
<td>7. Facilities</td>
</tr>
<tr>
<td>8. Financial reserves</td>
</tr>
</tbody>
</table>

3.2.1. Basic SD feedback loops in the sub-system of 'Selection of project'

The causal links connecting different variables and the different basic feedback loops formed by them in the activity of selection of a project are shown in the figure, Fig. 3.2.1.

(a) Financial prospectus ensures that the revenue, profits, and other benefits expected from the proposed project exceed the cost of the project for its development and operation. When there is market demand/value or customer demand for a product or service, the project will have good financial prospectus and hence the selection process of the project will be made
easy. In brief, the market demand/value improves the financial prospectus for a product or service and both improvements show the change in selection of the project in the same direction. Hence the causal links connecting ‘Demand and Value’ with the two variables, namely, ‘Financial prospectus’ and ‘Selection of project’ have been treated as positive (+) links and the causal link connecting ‘Financial prospectus’ with ‘Selection of project’ treated as a positive link. The feedback loop formed by all these three positive causal links will become a positive (+) feedback loop.

(b) When the cost of the project is high, the financial prospectus will be less. Hence the causal link connecting the variable, ‘Cost of the project’ to the variable, ‘Financial prospectus’ is treated as a negative (-) link. The cost of the project also shows negative effect on the selection of the project. This is due to the fact that when the cost of the project looks high, the development firms rethink about the prospectus of the project and delays the decision of selecting the project. Hence the causal link between the two variables, namely, ‘Cost of the project’ and ‘Selection of project’ will be a negative one. The feedback loop formed by these two negative causal links and one positive link connecting the variables, ‘Financial prospectus’ and ‘Selection of project’ will become a positive feedback loop as per the terminology of SD methodology explained in Chapter 2 of this work, that is, when the number of negative causal links is even, the feedback loop will be positive.

Fig. 3.2.1. SD feedback loops in the system of ‘Selection of a project’
3.2.2. Causal loop model of the system of ‘Selection of project’

Apart from the variables included in the feedback loops explained earlier, the variable ‘Organizational strengths’ also influences the activity of selection of project. To do a project, an organization should have enough strengths in the form of sufficient skilled people, technologies, facilities (working environment) and financial reserves. Any pitfall in such strengths reduces the chances of selecting a project. The causal links connecting the four variables that improve the strengths of an organization with the variable ‘Organizational strengths’ have been represented as positive links. The causal link between the two variables, namely, ‘Organizational strengths’ and ‘Selection of project’ has been treated as a positive link. The integrated diagram, i.e., the causal loop diagram thus developed with all the respective causal links and the two feedback loops of the sub-system of selection of project is shown in the figure, Fig. 3.2.2

![Causal loop model of 'Selection of project'](image-url)
3.3 CONCEPT OF PROJECT

Once a problem is selected, its concept and idea will be elaborated and framed to formulate it as a project work describing the major requirements of the user, activities to be performed and goals to be met. After getting clear picture of concept of the project, the feasibility of the project whether to take it up or not will be studied. The concept of the project includes understanding the user’s business and their flow of information and then understanding their needs. The concept of the project should highlight the user’s major requirements along with the main objective of the project. Concept development of the project needs some clarity in the functional, technical and information requirements of the project and also business objectives involved in taking up the project. Any misunderstandings in these issues may lead to adverse decay and vagueness in the concept development of the project and this ultimately spoils further activities.

In APTS and most of the other private organizations surveyed, it was observed that the technical people and marketing people as well visit the user organizations as many times as possible to get a clear idea about the problems the organizations are facing and immediate solutions required to implement and thereby the objectives of the total project. The frequent visits are meant to remove any ambiguity in their understanding of the existing system of the user organizations. The problem(s) to be solved and the project to be developed are compared with the business objectives of those development firms. Finally, the objectives of the project are oriented towards meeting the user requirements and this needs clear understanding of the requirements of the user organizations, because any misunderstanding will spoil the concept of the project and thereby weaken the chances to progress further.

Therefore, the concept development of a project is influenced by the following salient variables:

- Selection of good problem
- Clear business objectives
- Clarity in user requirements
- Misunderstandings
The improvement in any or all of the variables, namely, 'Selection of good problem', 'Clear business objectives' and 'Clarity in user requirements' will improve the development of concept of the project and hence the causal links connecting these variables with the variable 'Concept of project' have been treated as positive links. The causal link connecting the variables, 'Misunderstandings' and 'Concept of project' has been assigned negative sign, because increase in misunderstandings about the project will reduce the development of concept of the project.

The system dynamics influence diagram for the concept development activity is given in the figure, Fig. 3.3.

**Fig.3.3. SD influence diagram for 'Concept of project'**

3.4 FEASIBILITY OF PROJECT

After development of firm concept, the next step is to decide whether the project is worth doing or not. For this, a feasibility study needs to be done to clarify whether the project is viable both financially and functionally or not. Feasibility study means examination of possible options, identification of potential issues, determination of critical success factors and also an attempt to give real definition of the project keeping in view of the assessment of project elements like time, cost, resources, skills, supply considerations, scope and quality.
The feasibility study of a project basically ensures how the benefits of the project will justify the costs. The study will be accompanied by analysing different issues and problems and weighing different options in the background of user requirements, time, cost, resources, skills, scope and quality. All the possible solutions to satisfy the requirements of the user are considered and estimation of a approximate cost for each solution will be attempted. Then cost and benefit analysis will be carried out to decide how much will be the benefit from the cost of the project. After satisfactory feasibility study, the concept of the project will be improved and elaborated further paving a way for good analysis of what the system will do for the user, how it will fit into user's environment and how it will benefit the developer or supplier. The concept development of the project is the base and direction for the feasibility study. If the project team wants to develop a product to be released in the market, feasibility study should cover the additional factor, market conditions. Management support will also play an important role by encouraging the project team to explore the things related to project. Feasibility study should also take into account the acceptable risk level involved in taking up the proposed project. Acceptable risk level of a project is the maximum risk that the organization is prepared to sustain with it while handling the project. If the acceptable risk level is very low, the feasibility of taking up the project will become questionable and leads to cease further study.

Simister (2000) listed three factors to be addressed in the feasibility study; they are - market conditions, supply considerations, and financial prospectus. He states that if there is a limited portfolio of potential buyers, or the market is volatile, or demand is price-sensitive, the project is vulnerable to many adverse circumstances over which the project manager has little influence. Feasibility study should assess the cost, quality, and availability of capital equipment, raw materials and labour. Study of financial prospects should analyse the profitability of the project by applying economic evaluation techniques.

According to McManus and Harper (2003), the feasibility of an IT project can be evaluated in terms of four major categories - organizational feasibility (how well a proposed information system supports the objectives of the organization's strategic plan for information systems), economic feasibility (whether cost savings, increased revenue,
increased profits, reductions in required investment, and other benefits exceed the cost of developing and operating a proposed system), technical feasibility (whether reliable hardware and software capable of meeting the needs of a proposed system can be acquired or developed by the business firm within the required time), and operating feasibility (the willingness and ability of the management, employees, customers, suppliers, and so on to operate, use, and support a proposed system).

In APTS, there was a special division for feasibility studies. The technical people of this division, after visiting the user organization and after clearly understanding the user's problems and needs, develops a report on the feasibility whether the organization can go for IT solution which requires some investment. They also take into account the financial position of the organization and carry out cost/benefit analysis, which is based on rough estimation of cost and time of the proposed project and the services and benefits of the user organization from it.

In NHCL, there is a separate marketing division and the people in that division go around the customer organizations, study the media and the demand and value of a product or service in the market and perform feasibility analysis with the project managers of different development groups in NHCL.

Before taking up the work or proceeding to any other project, the development organization should assess their organizational strengths in terms of needful basic facilities, skilled people, required technologies, financial reserves, etc. When the project is treated as a viable one to benefit both parties, the feasibility of taking up the work as a project will be improved.

In APTS, the accounts department is very strong and active and can show the updated financial picture of the organization at any time. NHCL is having a sister organization, a financial consultancy, which enables NHCL to assess their financial status and look at options to get advance payments, if necessary.
Due to the revolutionary steps taken up by APTS in 1997 to automate the workflow of the Andhra Pradesh State Government departments, Directorates and Corporations, etc. by computerizing their offices, there was a flood of different projects relating to development of different software applications, supply of different hardware equipment and software, etc. to various government organizations. That urgency was due to the vision developed by the Government to link all the essential services of government departments with all the mandals in the A.P. State through Wide Area Networking (WAN), so as to take all those services to the access of a common man. Since all these works demanded speedy actions, the life of the software projects was made as short as possible and reasonable. The shortened life cycle of a project made every responding supplier/developer to think and analyse again and again cautiously and only then offer their services. When any vendor offered services means the vendor has analysed the feasibility to take up the project even though the project has a shortened life cycle. All these vendors were supposed to be aware of the risks of delays, defects, huge initial investment on hiring the resources, etc. due to the speedy project works to be performed. Those organizations which had overcome these risks with a foresight succeeded in the race and very few organizations struggled and out of them one or two firms terminated the project work without completing it (a rare case).

NHCL also took many challenges by continuously developing and uploading new content modules into their website, swcaliber.com, an online software skills testing software, based on the top demand and value for those modules in the market. Of course, there were risks of error-flow in the content due to speedy processes; but by forecasting that situation with the shortened life projects, remedial actions were planned and taken to make the system as much error-free as possible.

From the above discussion, the salient variables that influence the sub-system of 'Feasibility of project' have been identified and listed in Table 3.4.
3.4. List of salient variables in the system of 'Feasibility of project'

<table>
<thead>
<tr>
<th>Salient variables</th>
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<tbody>
<tr>
<td>1. Viability rate</td>
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<tr>
<td>2. Concept development</td>
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<tr>
<td>3. Demand and Value</td>
</tr>
<tr>
<td>4. Financial prospectus</td>
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<tr>
<td>5. Cost of the project</td>
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<tr>
<td>6. Shortened life cycle of the project</td>
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<td>7. Acceptable risk level</td>
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<tr>
<td>8. Support to organizational objectives and policies</td>
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<td>9. Organizational strengths</td>
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<tr>
<td>10. Skilled people</td>
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<tr>
<td>11. Suitable technologies</td>
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<td>12. Facilities</td>
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<tr>
<td>13. Financial reserves</td>
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</tbody>
</table>

3.4.1. Basic SD feedback loops in the system of 'Feasibility of project'

(a) As in the case of the system of selection of project, demand and value of a project in the market will have good financial prospectus for the development organization and the project will become more viable. Hence all the three causal links connecting the three salient variables, namely, 'Demand and Value', 'Financial prospectus' and 'Viability rate' have been treated as positive (+) links. All these causal links form a positive (+) feedback loop.

(b) Increase in the cost of project shows negative influence on both financial prospectus and the viability of the project. Hence the causal links connecting the variable, 'Cost of the project' to 'Financial prospectus' and 'Viability rate' have been treated as negative (-) ones. The causal link between 'Financial prospectus' and 'Viability rate' is positive. The feedback loop formed by these three causal links connecting financial prospectus, cost of the project and feasibility of project will be a positive feedback loop.
(c) Some projects will have shorter life cycle due to urgency or due to other reasons. To develop such projects, the organizations have to mobilise additional resources and start completing the project within that short time. This may sometimes demand hiring outside resources (both human and non-human) and allotting overtime duties to the staff. All these efforts increase the cost of the project to be borne by the organization itself and ultimately dilute the viability in taking up such project. Hence, the causal link connecting the variable, ‘Shortened life cycle’ to ‘Cost of the project’ has been shown as positive, and that to ‘Viability rate’ shown as negative link. The causal link between the two variables, ‘Cost of the project’ and ‘Viability rate’ is a negative link. The loop formed by these three causal links will become a positive feedback loop due to the presence of even (two) number of negative links.

(d) The shortening of life cycle of a project will add further risk to the project, that is, lowering the acceptable risk level of the project. The shortening of life cycle also reduces the chances of taking up the project, because of the rush and pressure involved therein. Hence the causal links connecting the variable, ‘Shortened life cycle’ to the two variables, ‘Acceptable risk level’ and the ‘Viability rate’ have been represented as negative (-) links. When the acceptable risk level is more, there will be more chances to take up the project, i.e., improvement of viability in the project. Hence the causal link connecting ‘Acceptable risk level’ to ‘Viability rate’ is positive (+). The three causal links connecting the three variables, namely, shortened life cycle, acceptable risk level and the viability rate form a positive feedback loop due to the presence of even (two) number of negative causal links.

(e) When the cost of the project is high, there may be cost overruns, which will add further risk to the project. This leads to lowering the acceptable risk level of the project. Hence the causal link between ‘Cost of the project’ and the ‘Acceptable risk level’ has been shown as negative link. The feedback loop formed by the three causal links connecting the variables, namely, shortened life cycle, cost of the project and acceptable risk level will be a positive loop due to the presence of even (two) number of negative links.

All the five feedback loops of the system of ‘Feasibility of project’ are shown in the figure, Fig. 3.4.1.
3.4.2. Causal loop model of the system of ‘Feasibility of project’

Viability in a project encourages taking it up, that is, viability rate in a project increases the feasibility of taking it up. The feasibility of taking up a project makes it viable. Hence the causal link between the two variables, ‘Feasibility of project’ and ‘Viability rate’ has been treated as a positive link. The development of concept for a project will give a clear understanding whether the project is a viable and feasible one or not, because concept gives a clear picture of the user’s requirements. Hence the influence of concept development improves the rate of viability of the project and the causal link between the variables
'Concept development' and 'Viability rate' will be a positive link. Similarly, the organizational strengths made up of skilled people, suitable technologies, facilities and financial reserves, will play a major role to improve the viability of a project. Hence the causal link connecting organizational strengths to viability rate has been represented as a positive link. The more the project supports the objectives and policies of the organization, the more will be its viability. So, the causal link connecting the variable, 'Support to organizational objectives and policies' to 'Viability rate' has been treated as positive link.

All the above explained positive causal links and the six feedback loops already explained will form the integrated causal loop diagram for the system of 'Feasibility of project' and is shown in the figure, Fig. 3.4.2.
3.4.3. Stock and flow model of the system of ‘Feasibility of project’

The variable, ‘Viability rate’ has been treated as a rate variable and the variable, ‘Feasibility of project’ treated as a stock (or level) variable. Viability rate fills the level of feasibility of project. These two variables along with other variables having causal links among themselves and also to the variable ‘Viability rate’ form the stock and flow model for the system of feasibility of project. The model is given in the figure, Fig. 3.4.3.

![Stock and Flow model of ‘Feasibility of project’](image)

3.4.4. Modeling equations for the system of ‘Feasibility of project’

The modeling equations for the system of feasibility of project are given in Table 3.4.4. The equations have been fed to the stock and flow model and the model has been simulated. For the purpose of modeling and simulation, the total duration of the project has been assumed as one year (12 months), of which a duration of first three months has been assumed as time for formulating conception of the project. Out of the assumed total duration of 3 months for the
conception phase, the duration for the feasibility has been assumed as one month. Hence for the feasibility study of the project, the final time has been taken as 1 month with initial time as zero. For simulation purpose, the time step has been chosen as 0.0625 month.

The project has been assumed to have a shortened life cycle of about 10%, that is, 0.1 of the total project time. The project is supposed to have good demand and value in the market and hence the value 1 has been chosen. Hence the equilibrium (normal) values of the two variables, ‘Shortened life cycle’ and ‘Demand and Value’ have been assumed as 1 and 0.1 respectively. Each of the six variables, namely, ‘Concept development’, ‘Facilities’, ‘Financial reserves’, ‘Skilled people’, ‘Suitable technologies’ and ‘Support to organizational objectives and policies’ has been assigned an initial value of 1, by assuming that all the above things are existing in the organization for the project.

Facilities, financial reserves, skilled people and availability of technologies suitable for the project make up the strengths of an organization and hence the variable ‘Organizational strengths’ has been equated to the sum of the four variables, ‘Facilities’, ‘Financial reserves’, ‘Skilled people’, and ‘Suitable technologies’.

For clear understanding of the simulation process, it has been assumed that in the absence of shortened life cycle of the project, the cost of the project is 100000, which can be treated as Rs. 1,00,000. Based on this assumption and also the fact that the shortened life cycle imposes extra costs on the project, the modeling equation for ‘Cost of the project’ has been written as $100000 \times (1 + \text{Shortened life cycle})$.

The variable, ‘Acceptable risk level’ has been equated to the reciprocal of the product of shortened life cycle and the logarithmic value of cost of the project. ‘Financial prospectus’ is equated to the ratio of ‘Demand and Value’ and the logarithmic value of cost of the project. Based on the type of influence of various variables on the variable ‘Viability rate’, a long modeling expression has been framed for it, as given by the equation (13) in Table 3.4. The variable ‘Feasibility of project’ has been equated to the integration of viability rate starting with nil (0) value.
### Table 3.4.4. SD modeling equations of the system of 'Feasibility of project'

<table>
<thead>
<tr>
<th>Equation</th>
<th>Description</th>
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<tbody>
<tr>
<td>(i) INITIAL TIME = 0</td>
<td>(The initial time for the simulation).</td>
</tr>
<tr>
<td>(ii) FINAL TIME = 1</td>
<td>(The final time for the simulation).</td>
</tr>
<tr>
<td>(iii) TIME STEP = 0.0625</td>
<td>(The time step for the simulation).</td>
</tr>
<tr>
<td>(iv) SAVEPER = TIME STEP</td>
<td>(The frequency with which output is stored).</td>
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<tr>
<td>(1) Shortened life cycle = 0.1</td>
<td></td>
</tr>
<tr>
<td>(2) Demand and Value = 1</td>
<td></td>
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<tr>
<td>(3) Concept development = 1</td>
<td></td>
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<tr>
<td>(4) Facilities = 1</td>
<td></td>
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<tr>
<td>(5) Financial reserves = 1</td>
<td></td>
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<tr>
<td>(6) Skilled people = 1</td>
<td></td>
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<tr>
<td>(7) Suitable technologies = 1</td>
<td></td>
</tr>
<tr>
<td>(8) Support to organizational objectives and policies = 1</td>
<td></td>
</tr>
<tr>
<td>(9) Organizational strengths = Facilities + Financial reserves + Skilled people + Suitable technologies</td>
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<tr>
<td>(10) Cost of the project = 100000*(1+Shortened life cycle).</td>
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<tr>
<td>(11) Acceptable risk level = 1/(LN(Cost of the project)*Shortened life cycle).</td>
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<tr>
<td>(12) Financial prospectus = Demand and Value/LN(Cost of the project).</td>
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</tr>
<tr>
<td>(13) Viability rate = ( Support to organizational objectives and policies + 3<em>Concept development + 2</em>Financial prospectus + 4<em>Organizational strengths)</em>(Demand and Value + Acceptable risk level)/(Shortened life cycle * LN(Cost of the project)) + Feasibility of project.</td>
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</tr>
<tr>
<td>(14) Feasibility of project = INTEG (Viability rate, 0).</td>
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</table>
3.4.5. Simulation results of the system of 'Feasibility of project'

The stock and flow model of the feasibility of project has been simulated and it resulted in the improvement of the viability rate of the project and hence its feasibility. The graphs of the patterns of behaviour of feasibility of the project and its viability rate have been generated and it is observed that both patterns have an exponential growth. The two patterns of growth behaviour are shown in the figure, Fig. 3.4.5. The final value of the viability rate is close to 80, whereas that of feasibility of project is close to 50. The result that the feasibility of a project is at a value of 50 may be treated as a situation having equal chances whether to take up the project or not. The factors that improve the pattern of growth behaviour in the feasibility of project can be found from the sensitivity analysis of the stock and flow model.

*Fig. 3.4.5. Patterns of growth behaviour in the system of 'Feasibility of project'*

![Graph showing patterns of growth behaviour in the system of 'Feasibility of project']
3.4.6. Sensitivity analysis results of the system of ‘Feasibility of project’
The stock and flow model has been undergone automatic simulations by changing the values of different parameters, namely the four elements of organizational strengths – skilled people, suitable technologies, facilities, and financial reserves along with other parameters, namely, concept development, support to organizational objectives and policies, demand and value of the project, and also shortened life cycle of the project. This sensitivity analysis has been performed to study the subsequent changes in the rate of viability of project and also the feasibility of taking up the project. The results are shown in the figures, Fig. 3.4.6. (i), (ii) and (iii). In each figure, graph II (blue coloured curve) represents the result of sensitivity analysis (by changing the value(s) of one or more variables), whereas graph I (red coloured curve) represents the simulation result with initial values (initial simulation run).

(i) When the value of each of the four variables, namely, ‘Skilled people’, ‘Suitable technologies’, ‘Facilities’ and ‘Financial reserves’ composing the variable ‘Organizational strengths’ is increased simultaneously from the initial value of 1 to 2, that is doubled, a considerable growth is observed in the behaviour of two variables, ‘Feasibility of project’ and ‘Viability rate’. Feasibility of project approached closely to 100, whereas ‘Viability rate’ crossed a value of 150.

This result can be validated by the fact that a project can be taken up if the organization is having very good strengths in terms of resources, finance and infrastructure. From the surveys, it has also been observed that those software companies, who have started up projects without having the above strengths, failed to complete those projects and some companies even closed their activities, by diverting to other businesses.

To be benefited from the IT boom during the period from 1998 to 2000, several new software companies entered the IT market by establishing attractive front offices, but without acquiring proper skilled people. The firms with skilled people, but without financial reserves also tested their luck. But the ultimate result in majority of cases is simply a ‘failure’. This observation is validating the above sensitivity analysis result.
(ii) When the value of each of the three variables, namely, 'Demand and Value', 'Support to organizational objectives and policies' and 'Concept development' is increased simultaneously from 1 to 1.2, some more growth is observed in the behaviour of the two variables, 'Feasibility of project' and 'Viability rate', the former one reaching a value of 60 and the latter one reaching 100 respectively.

The above result can be interpreted as: When a project has good demand and value and if it supports well the objectives and policies of the organization with a good concept development and clear understanding, chances will be improved to take up the project. This is validating the usual experience of the organizations that depend on the projects.
(iii) When the value of the variable, 'Shortened life cycle' is increased from its initial value of 0.1 to 0.15, a lot of decay is observed in the growth behaviour of the two variables, viability rate and feasibility of project. The feasibility of project dropped down from 50 to 30, whereas the viability rate dropped from 80 to about 50.

The above result is validating the fact that when the project life cycle is reduced (or shortened) from some optimum value due to urgency or under-estimation, the feasibility of the project will be drastically reduced leading the organization to rethink whether to take up the project or not. This is a usual experience observed in some software organizations that take up the project without thinking about the feasible time duration to complete it. In some IT organizations being controlled by external policies, the same thing has been observed in many cases and the projects were heavily delayed.
From the three different sensitivity analysis results of the system of 'Feasibility of project', it has been observed that the parameter, namely, 'Shortened life cycle' of the project is showing high influence on the viability rate and feasibility of project and the influence of other parameters is normal. The shortened duration of a project will make the developers to rethink about taking up the project and thereby reducing the feasibility of project.

3.5 APPROVAL OF PROJECT PROPOSAL

After completing the feasibility study satisfactorily and after being convinced with the requirements and objectives of the project and the capabilities of the organization and the project team, the project team prepares a project proposal describing the aim and objectives of the project, functional and technical specifications, needs of the project in terms of budget, time, resources, etc. In the case of in-house projects, the project proposal is submitted to the
senior management of the parent organization, whereas in the case of external projects, the project team has to participate in open or closed bidding competition by submitting the project proposal as per the rules and regulations prescribed therein. The proposal should be clear and convincing with the objectives and outcome of the project and also competitive to get approval.

In the case of in-house project proposals, the project team submits the proposal to the senior/top management of the parent organization. The preparation and process of submitting the in-house project proposal is relatively easier job when compared to the external proposals. For the external project proposals, the project team usually faces competition, sometimes high, from the other development firms. It may happen to participate in tender bid competition, wherein systematic and strict procedures and rules will be applied from the start of preparation of proposals, their submission and evaluation along with several contractual and legal issues. In the case of external proposals, the project team represents the parent organization by submitting the proposal, participating in the competition, negotiating with the customer organization, etc.

The project proposal should detail the project cost, schedule of cost, schedule of activities of the project and outline the steps that the project team will take to produce the required product or service. The proposal has three purposes — first, it contains the project team’s first estimate of the cost and delivery date of the project, second, for an external project, it is a formal legal document that outlines the project team’s intent to provide the required services, third, it is a sales tool (Rakos 1990). There will be high chances to get the approval to go ahead with the project work, if the project proposal is clear, relevant, objective, innovative, convincing, attractive and competitive. Of course, there will be some other important external activities like presentation, demonstration and negotiations that are linked with the proposal and handled by the project team itself to convince the users to get their approval. Even though the proposal has all the strengths, the project manager may fail to get the approval if the team fails to present or demonstrate the objectives or prototype of the project properly and negotiate different things from time to time.
In APTS, the proposals received from different software developers, hardware and computer stationery suppliers will be scrutinized in the direction of the supplier's clear understanding and expression of the requirements of the user and the innovativeness/creativity/distinction shown in the proposal about the product/service. When more than one potential developer or supplier compete, then APTS looks into the flexibility in negotiations of service and cost.

In view of the above discussions, the major factors that influence the approval of the project proposal are as follows:

- Strengths (clear, relevant, objective, innovative, convincing, and attractive attributes) of the proposal
- Clear business objectives
- Presentation/demonstration skills of the project team
- Negotiation skills of the project team.

All the above factors positively influence the chances for approval of the project. Hence the causal links connecting these four salient variables to the variable 'Chances for approval of the proposal' can be represented as positive links. The system dynamics influence diagram for the system of 'Approval of project proposal' has been developed by integrating the four causal links and is shown in the figure, Fig. 3.5.

*Fig. 3.5. SD influence diagram for 'Approval of project proposal'*
3.6 SCOPE OF PROJECT

After getting the approval to go ahead with the project, the actual project work starts. This needs to have strong base describing all the tasks, functions, activities and objectives to be performed in a detailed way to fulfill all the requirements of the project. Scope of the project is a statement that says what to do and what not to be done. Scope of the project is the foundation for any project and every further activity in the project development and management depends upon it throughout the life cycle of project and project management. The project plan will be designed as a layer on the scope of the project and guides the project manager to proceed by performing important tasks like budgeting and estimating the resources, scheduling the project tasks, resource allocation, monitoring and controlling the project and improving quality.

As a part of scope of the project, the problem of the project needs to be defined in detail narrating different activities to be performed to meet all the requirements and objectives of the project. The detailed definition of the project leads to a clear picture of the scope with clear boundaries of the project. The scope acquires its shape and size from the system study and analysis wherein the current system of the user and their requirements are described in detail. In addition, the user(s) should cooperate and actively participate in developing the scope of the project by supplying required information. Any misunderstandings in collection of information may fire at any moment and lead to serious damage to the project. Hence, there should not be any room for misunderstandings and any misunderstanding should be removed as and when they are observed during system study and analysis.

A number of studies (Gray and Larson 2003, Smith and Tucker 1984, Gobeli and Larson 1986, Ashley et al 1987, Pinto and Slevin 1988) on project management ranked the factor, poor project definition (scope) as a major barrier to project success. Gobeli and Larson (1986) reported different barriers identified by 1,654 participated project managers in their survey and Gray and Larson (2003) reported that there is no evidence that these factors have changed over the years, although some differences in relative importance have been noted in different industries. According to them, project scope is the keystone interlocking all
elements of a project plan. It consists of the elements like project objectives, deliverables, milestones, technical requirements, limits and exclusions, and reviews with customer.

The data collected on the user's existing system and requirements should be thoroughly evaluated. The user(s) should also cooperate and actively participate in developing the scope of the project by giving required information clearly. Any misunderstanding in collection of information may fire at any moment in the form of defects and lead to serious damage to the project. The tasks that are to be accomplished in the project depend upon the requirements of the project and hence the scope of the project should list all the things to be done in order to fulfill the requirements of the project. There are three major types of requirements – project requirements, system requirements, and functional requirements. Project requirements are the customer-imposed schedules, deliverables, and resources under which the project has to operate. System requirements are the performance, standards, conventions, protocols, etc. that must be met by the product. Functional requirements are the product-specific content, capabilities, limitations, and look and feel of the planned end product. All the necessary requirements should be collected and any misunderstandings should be removed so as to improve the scope of the project. Figure, Fig. 3.6, gives a brief and rough picture of the scope of a project in terms of requirements and misunderstandings.

**Fig. 3.6. Simple structure of 'Scope of project'**

```
Fig. 3.6. Simple structure of 'Scope of project'

Requirements  add  remove

SCOPE OF PROJECT  →  Misunderstandings
```

In a simple mathematical form, the above rough diagram of scope can be represented as

\[
\text{Scope of a project} = \text{Requirements} - \text{Misunderstandings} \quad \text{...(1)}
\]

The Manager of the IT division, Cubic Electronics Sdn. Bhd., Malaysia expressed that there is a lot of difficulty in defining user requirements and the users are more resistant to IT
projects and this is leading to unclear definition of scope and requirements and when the scope is not wide enough, it is difficult to achieve the project goal. She finally suggested that the users and project team need to carefully note down the things and review the requirements so that the scope can be clearly defined and improved.

APTS encourages the project team to pay as many visits as possible to the users to get things clear so as to improve the scope of the project. The user will be motivated and made cooperative to provide information on the requirements of the proposed project. In some projects like APGLI, due to work pressure on the staff and the mounting pending works for a long time, the users could not give the necessary information to the APTS developers, nor updating their data in the computers. Due to these problems, the project had been continuing without end for a long time.

In view of the above discussions, the important salient variables that influence the scope of a project are listed in Table 3.6.

<table>
<thead>
<tr>
<th>Salient variables</th>
<th>Scope of project</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Collection of Requirements</td>
<td></td>
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<tr>
<td>2. Functional requirements</td>
<td></td>
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<tr>
<td>3. Project requirements</td>
<td></td>
</tr>
<tr>
<td>4. System requirements</td>
<td></td>
</tr>
<tr>
<td>5. User cooperation</td>
<td></td>
</tr>
<tr>
<td>6. Analysis time</td>
<td></td>
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<tr>
<td>7. Misunderstandings</td>
<td></td>
</tr>
<tr>
<td>8. Defects in data</td>
<td></td>
</tr>
</tbody>
</table>

3.6.1. Basic SD feedback loops in the system of ‘Scope of project’
(a) If the user cooperates well, the important requirements of the user can be collected satisfactorily and the scope of the project will be improved by clearly understanding the
user's requirements. When the scope of the project gradually improves, the activity of collection of requirements will receive good encouragement and it goes on aggressively. Hence all the three causal link connections among the three variables, 'Collection of Requirements', 'User cooperation' and 'Scope of project' will become positive ones. The feedback loop thus formed by these positive causal links will be a positive loop.

(b) If the requirements are analysed by taking sufficient time, there will be good improvement in reducing the misunderstandings in requirements collected and thereby increasing the scope of the project. Hence the causal links connecting the variable 'Analysis time' with the two variables 'Misunderstandings' and 'Scope of project' have been represented as negative and positive links respectively. Any misunderstanding in the requirements collected will spoil the scope of the project and hence the causal link between 'Misunderstandings' and 'Scope of project' has been represented as a negative link. The feedback loop formed by these three causal links will become a positive loop because of the presence of even (two) number of negative links.

(c) User cooperation reduces misunderstandings, showing negative effect and hence the causal link between the variables 'User cooperation' and 'Misunderstandings' will be a negative link. The causal link between 'Misunderstandings' and 'Scope of project' is negative, whereas the link from 'User cooperation' to 'Scope of project' is positive. These three causal links form a positive feedback loop.

(d) If user doesn't cooperate, misunderstandings in requirements increase and it leads to growth of defects in the data collected. That is, the increase in user cooperation will reduce the misunderstandings and defects in data collected. Hence the causal links connecting the variable 'User cooperation' to the two variables, 'Misunderstandings' and 'Defects in data' will be negative. The increase in defects in data leads to lot of misunderstandings and hence the causal link connecting the variables 'Defects in data' and 'Misunderstandings' will be positive. Ultimately, the feedback loop formed by the three causal links connecting user cooperation, defects in data and misunderstandings will become a positive loop, because of the even (two) number of negative causal links.
All the four feedback loops explained above are shown in the figure, Fig. 3.6.1.

**Fig. 3.6.1. SD feedback loops in the system of 'Scope of project'**

![Diagram of SD feedback loops in the system of 'Scope of project'](image)

3.6.2. Causal loop model of the system of 'Scope of project'

The causal links connecting the variables representing the three different types of requirements, namely, 'Functional requirements', 'Project requirements' and 'System requirements' with the variable, 'Collection of requirements' will be positive links, because of the fact that those three requirements compose the total requirements and increase in any one or all of them will increase the total requirements collected. These three positive causal links and the four feedback loops explained earlier form the SD causal loop model for the system of scope of project as shown in the figure, Fig. 3.6.2.
3.6.3. Stock and flow model of the system of ‘Scope of project’

The stock and flow diagram has been developed for the system of scope of project and is given in the figure, Fig. 3.6.3. The variable ‘Scope of project’ has been treated as the level (or stock) variable, the variable ‘Collection of Requirements’ as rate variable and the other variables as auxiliary ones.
3.6.4. Modeling equations for the system of 'Scope of project'

The modeling equations for improvement of scope of project have been developed and given in the Table 3.6.4. The duration of the activity of developing the scope of project in the conception phase of a project has been assumed as two (2) months. All the three types of requirements, namely, 'Functional requirements', 'Project requirements' and 'System requirements' have been treated as being collected satisfactorily and hence each of those variables has been assigned a value of 1. Similarly it is assumed that user cooperation is satisfactory and hence 'User cooperation' is equated to unity. The analysis time has been assumed as 0.25 month spread over the total duration of 2 months for development of scope of the project. ‘Defects in data’ is equated to the reciprocal of user cooperation. The variable ‘Misunderstandings’ has been equated to the ratio between defects in data and the product of user cooperation and analysis time. Collection of requirements has been treated as the sum of the three types of requirements multiplied by user cooperation plus the scope of project developed till that time. The level variable, 'Scope of project' is equated to the integration of the product of analysis time, user cooperation, a numeral 5 and the difference between collection of requirements and misunderstandings. The scope of project has been
assigned an initial value of 5, assuming that the scope already existing is 5%. The equations are fed to the stock and flow model and the model has been simulated.

**Table 3.6.4. SD modeling equations of the system of 'Scope of project'**

(i) INITIAL TIME = 0 (The initial time for the simulation).
(ii) FINAL TIME = 2 (The final time for the simulation).
(iii) TIME STEP = 0.125 (The time step for the simulation).
(iv) SAVEPER = TIME STEP (The frequency with which output is stored).

1. Functional requirements = 1.
2. Project requirements = 1.
3. System requirements = 1.
4. User cooperation = 1.
5. Analysis time = 0.25.
7. Misunderstandings = Defects in data/(User cooperation * Analysis time).
8. Collection of Requirements = (Project requirements + System requirements + Functional requirements) * User cooperation + Scope of project.
9. Scope of project = INTEG ((Collection of Requirements - Misunderstandings) * Analysis time * User cooperation * 5, 5).

3.6.5. Simulation results of the system of 'Scope of project'
From the simulation of the stock and flow model of the system of scope of project, improvement in the behaviour of the system is observed. It is observed that during the assumed total time of 2 months allotted for developing the scope of project, the pattern of behaviour of the scope is continuously and exponentially improving. The final value
touched by the graph of scope of project is around 40 that means 40%. The pattern of growth behaviour is shown in the figure, Fig. 3.6.5.

**Fig. 3.6.5. Pattern of growth behaviour in the system of 'Scope of project'**

![Graph showing pattern of growth behaviour in the system of scope of project](image)

3.6.6. Sensitivity analysis results of the system of 'Scope of project'

The model has been undergone automatic simulations by changing the values of three different parameters, namely the three types of requirements, analysis time and user cooperation. This automatic simulation has been performed to study the subsequent changes in the behaviour of scope of project. Three different patterns of behaviour in the scope of project based on the changes made in the above three parameters have been generated and are represented by the figures, Fig. 3.6.6. (i), (ii) and (iii). In each figure, the graph I (red colour) represents the behaviour with initial set of values (initial simulation) and the graph II (blue colour) represents the changed behaviour with the changes made in the value(s) of one or more parameters.

(i) When the value of all the three types of requirements, namely, 'Project requirements', 'System requirements' and 'Functional requirements' is increased simultaneously from the initial value of 1 to 1.2, slight improvement is observed in the growth behaviour of scope of project. From the survey reports of some Malaysian software companies and the usual experience as well, it is experienced and expressed that whatever requirements we collect will not solely improve the scope of a project, but there will be other factors
like analyzing the requirements, distinguishing the misunderstandings, user cooperation, etc. that play an important role in improving the scope. The sensitivity analysis result is supporting this fact.

**Fig. 3.6.6(i) Sensitivity analysis of 'Scope of project'**

(ii) Next, keeping other variables at their initial values, the value of the variable, when the value of 'User cooperation' is increased from its initial value of 1 to 1.2, that is, 20% increase, a lot of growth is observed in the scope of project and it touched nearly 90, that is, 90%. The software companies like MCSB, QuickNet and Apex Communications gave high importance to the factor, user cooperation to improve the scope of a project and run the project smoothly. The same thing has been experienced by several companies that are involved in developing applications for external users. Hence the sensitivity analysis result has been validated by this feedback.

**Fig. 3.6.6(ii) Sensitivity analysis of 'Scope of project'**
(iii) Keeping all other variables with their initial values, the value of the variable 'Analysis time' is increased from its initial value of 0.25 to 0.35, that is, an increase of 0.1 month (around 3 days a month). This change produced a tremendous improvement in the scope of project, exceeding a value of 100 (about 120), that means, the scope of project is becoming complete with further improvement. MCSB stressed the importance of providing enough time for analysis and estimation process in software development and expressed that the requirements collected should be thoroughly analysed. The same feedback has been received from some other organizations like Cubic electronics, United Arab Shipping Co., Osram Opto Semiconductors, etc. and also experienced in APTS. This feedback is validating the top-most importance of the analysis time in improving the scope of a project.

**Fig. 3.6.6(iii) Sensitivity analysis of 'Scope of project'**

![Graph showing the trend of scope of project improvement](image)

From the above results, it is evident that the increase in the three types of requirements is showing normal and nominal improvement in the scope and whereas the analysis time and user cooperation are showing great impact. But analysis time is dominating even user cooperation.
Chapter 4

PLANNING PHASE

"Effective managers live in the present, but concentrate on the future."
- James L. Hayes