Chapter 1

INTRODUCTION

"Good management is better than good income."
- (Portuguese proverb)
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1.1 STATEMENT OF RESEARCH WORK

Throughout the lifecycle of a project, the project management will be a dynamic and complex process due to the presence of many interacting factors that impact the final cost, schedule and quality. To meet the objectives of the project, the ability to understand and reason about dynamic and complex behaviour of project management and its evolution processes is becoming increasingly valuable. In that process, many techniques like PERT (Program Evaluation and Review Technique), CPM (Critical Path Method), WBS (Work-breakdown structure), EVA (Earned Value Analysis), etc. have evolved.

The present research work is focused on a detailed analysis, modeling and simulation of dynamics involved in different activities of project management in each and every phase in the lifecycle of a project by the application of system dynamics methodology and techniques. A project is treated as a system consisting of various sub-systems or phases. In each phase of a project, the different management issues that influence the performance of major project management activities have been treated as 'salient' (most important) variables and used to model and simulate the behaviour of that particular activity. A project progresses through several phases like conception, planning, execution and termination (closure) and in each phase, all the various relevant influencing issues should be managed properly to improve the performance of the total project.

1.2 OBJECTIVES OF RESEARCH WORK

a) To study the project management system at different phases in the life cycle of a project in different organizations and collect important data from the respective managers.

b) To identify different important project management issues (or variables) that influence the performance of the particular sub-system or phase of a project.
c) To model the performance of each phase of a project based on the relationships among the variables using system dynamics methodology.

d) To simulate the behaviour of important parameters which measure the performance of a project.

e) To perform sensitivity analysis by varying the values of various variables and by carrying out sufficient number of simulation runs to predict the noticeable influence of some variable that influence the system highly.

f) To generate graphical simulation results to give clear picture of the dynamics of the system and to enable the managers to have good vision about the variables that influence the performance of the system and the extent to which their influence lie.

1.3 SCOPE OF THE RESEARCH WORK

The present research work studies and analyses the different influencing issues of project management in each phase in the lifecycle of a project and then models and simulates the behaviour of the major project management activities in each phase using the system dynamics methodology and techniques. For this purpose, help has been taken from the literature reports on project management experiences, observation of project management in information technology (IT) departments and the feedback of those managers in different organizations surveyed.

The industrial surveys are limited to the information technology project management in different organizations like software, manufacturing and services. The study does not extend to any particular organization surveyed and to any particular information technology project. Main focus is kept on the general project management issues and some specific issues pertaining to some phases of IT projects. Even through some organizations use sophisticated techniques to have random picture of the status of the project and manage it, the underlying management issues are almost common either locally or globally. Hence the different views and experiences, expressed by the respective managers of the organizations surveyed, have been utilized wherever necessary along with the literature reports.
Since different projects have different durations and these durations sometimes change, for the purpose of modeling and simulation of the behaviour of project management activities in each phase in the lifecycle of a project, each such activity has been allotted a particular duration in months. For example, the total duration of the activity of feasibility study has been assumed as one month, scope of project as 2 months, evaluation of tender bids as 2 months, etc.

1.4 LIMITATIONS OF THE STUDY

The present research work confines to the different project management issues, especially in the context of information technology projects.

Industrial surveys and literature reports covering the management experience and feedback of some managers and authors while managing projects, mostly IT projects, at different places all over the world have been taken as inputs. The surveys have been conducted in India and Malaysia covering both public and private sector companies. The IT companies and the MIS departments of other manufacturing and service companies were surveyed.

Modeling and simulation of the system of project management has been carried out using the system dynamics methodology and techniques. Software designed on the concepts of system dynamics has been used.

Performance of the system as a whole by variations in the values of different variables that influence the system has only been studied, with an objective to check how the performance can be improved further and further and what variables show considerable effect on the system.

To avoid complex mathematics, maximum possible simplicity has been implemented in framing mathematical expressions for different variables in the models throughout the work.
1.5 METHODOLOGY OF THE STUDY

The present research work studies the different project management activities involved in each phase in the life cycle of a project. The study includes identification of different salient variables that influence each major activity of project management, model the activity based on the relationships framed among the variables, simulate the model, generate the graphical results and validate the model based on the survey and literature reports and sensitivity analysis as well. This method has been applied to each and every phase in the life cycle of a project.

The present work attempted to apply the revolutionary System Dynamics (SD) methodology and its techniques for modeling and simulation of the complex project management system. SD influence, causal loop and stock-and-flow models have been developed. The stock and flow models are used for simulation studies. The techniques of loop analysis and sensitivity analysis have been used to validate the models. The VENSIM software (Personal Learning Edition) has been used for drawing the causal loop and influence diagrams and stock-and-flow diagrams and simulation of those SD models. All the different SD models thus developed and their simulation results have been incorporated in the thesis.

The research methodology comprises four parts:

1) In the first part, different salient variables (issues) that influence the particular project management activity have been identified. Support has been taken from literature reports and the survey reports as well.

2) In the second part, based on the relationships existing among the identified variables, causal (influence) links have been framed between each pair of variables. Feedback loops have been formed with the respective causal links. Using causal links and feedback loops, a complete model has been developed for each major project management activity. In SD terminology, the model without feedback loops (having only causal links) is called an influence diagram and the model with causal links and feedback loops is called a causal loop model.
3) In the third part, for each SD model the primary rate and stock (or level) variables and other auxiliary (secondary) variables have been identified. All the variables in each model have been assigned values or simple mathematical expressions for the purpose of simulation. Simulation results have been generated to study the performance of the system.

4) In the fourth part, sensitivity analysis by varying values of some influencing variables has been carried out and simulation runs have been performed to explain the extent to which those variables influence the system.

In addition, a new simple decision making method, named as 'Bit Decision Making (BDM) method', has been developed and proposed to apply to the critical process of decision making in complex systems. This method has been developed using Boolean logic and Boolean algebra. A complex decision system will be divided into as many meaningful sub-systems or phases as possible. In each phase of the total system, the method assigns binary digits (1 or 0) to the important decision variables based on the logic and analogy that is implemented in that system. The method also correlates the input variables to the output by generating a mathematical equation using Boolean algebra. The correlation equation acts as a standard for each phase of the system selected. As an example of application of the BDM method, the method has been applied to the activity of evaluation of IT tender bids.

1.6 INTERPRETATION

In the present research work, to study and analyse the influence of different project management issues in different phases in the lifecycle of a project, help has been taken from the industrial surveys and literature reports on project management experiences.

After establishing the variations of influence of different issues in different management activities in the life cycle of a project, each activity has been modeled verbally and mathematically using system dynamics influence diagrams, causal loop and stock and flow...
models. All such diagrams along with simulation runs have been done using Vensim simulation software.

Based on the type of influence, '+' or '-' signs have been assigned to the arrows (or causal links) connecting any two variables and similar is the case in developing feedback loops formed by such causal links as per system dynamics methodology. Causal loops or feedback loops, wherever possible, have been formed and the integrated influence of different variables of those loops has been derived based on the influence of each individual relationship (shown as a causal link) between every pair of variables. Accordingly, appropriate sign has been assigned to each such loop.

With the help of causal links and feedback loops developed for a system under study, its causal loop model has been developed. The stock and flow models have been developed assigning appropriate simple mathematical expressions to each influencing salient variable and the models have been simulated in order to improve the performance behaviour of the system. Different simulation graphs have been generated to show the results pictorially for more clarity and ease of understanding. The X-axis of all the simulation graphs is the time expressed in the units of months and days. Y-axis represents the variable whose behaviour is attempted to be simulated. The values of Y-axis have been generated automatically by the software based on the values or modeling equations of different variables so as to show the proportionate changes in the behaviour of the represented variable. The behaviour may be either growth (ascending) or decay (descending) and it is shown over the selected time duration of simulation run.

Sensitivity analysis has been used to find the highly influencing variables and the extent of their influence on the system. For this purpose, the stock and flow model of the system has been simulated many times (simulation runs) by varying the value of each variable and finally finding the variables that influence the system highly and the extent of their influence.
All the system dynamics models have been validated by the use of loop analysis, sensitivity analysis and the literature and survey reports.

1.7 DEFINITION OF TERMS EMPLOYED IN THE TITLE

System dynamics (SD) is a method used to describe, model, and simulate the dynamics that take place in complex systems. It describes the total system along with its structure and the interactions and inter-relationships among the various structural elements of the system, models such detailed system and simulates the behavioural changes in the system due to changes in the influencing elements.

Project management is the activity that applies various tools, resources, knowledge and skills to manage a project to achieve its goals and objectives. The present work applies the system dynamics methodology and techniques to the dynamic project management system, study and analyse its behaviour in various situations under the influence of various issues.

1.8 PREVIOUS WORK DONE

System Dynamics was introduced by Forrester (1958) for modeling the behaviour of complex socio-economic systems. The approach is based on a holistic perspective of managerial problems and focuses on the human aspects of a system's behaviour. System dynamics has been applied to a wide range of problem domains. It includes work in corporate planning and policy design (Forrester 1958, Lyneis 1980), economic behaviour (Sterman et al 1983), public management and policy (Homer and Clair 1991), management science (Coyle 1977), research and development project management (Roberts 1964), biological and medical modeling (Hansen and Bie 1987), energy and the environment (Ford and Lorber 1977), theory development in natural and social sciences (Dill 1997), dynamic decision making (Sterman 1989), complex non-linear dynamics (Mosekilde et al 1991), software engineering (Abdel-Hamid 1984, Abdel-Hamid and Madnick 1982, 1989, 1991, Tausworthe et al 1983, McKenzie et al 1984, Cooper and

Roberts (1964) developed a comprehensive system dynamics model of research and development project management, which traces the full life cycle of a single R&D project and incorporates the interactions between the R&D product, the firm, and the customer. Richardson (1982) focused on development group and his model reproduced the dynamics of a development group over an eight-year period as a continuous stream of products are developed and placed into production. A number of applications to the area of management are available in literature (Sushil 1993).

The present work attempted to apply SD methodology to each and every important phase in the lifecycle of a project and to each and every important activity of project management therein. The variables that considerably influence the performance of respective project management activities have been identified and their influences highlighted. To collect the information of practical cases relevant and useful to develop and validate the models, the Information Technology (IT) companies and MIS departments of different manufacturing and services organizations have been surveyed.

1.9 SURVEYS PERFORMED

The project management workflow has been studied in fourteen organizations dealing with information technology (IT), electronics manufacturing and other services like cargo shipping, insurance, and construction in India and Malaysia as well. Half of the organizations are pure IT companies. The departments of Management Information Systems (MIS) in non-IT organizations were surveyed by focusing more attention on IT projects. Important case by case studies and the problems being faced by those organizations in managing projects have been incorporated throughout the present work wherever necessary. A brief introduction of each surveyed organization is given below.
Andhra Pradesh Technology Services Limited, (APTS) Hyderabad, India

Andhra Pradesh Technology Services Limited (APTS) is an IT organization, set up by Andhra Pradesh State Government in 1986 providing IT solutions mainly to Government organizations and now extending to Non-Government organizations also. APTS extends its consultancy services to the organizations from conception to commission in application development, project consultancy, web applications, message applications, networking, software purchasing, hardware procurement, office automation, customer support services, training in IT related areas, etc. The author earlier worked in this organization for about three years as a Systems Analyst.

New Horizons Cybersoft Pvt. Ltd., Hyderabad, India

New Horizons Cybersoft Pvt. Ltd. (NHCL) is a private organization having its offices in Hyderabad and also in USA under the name, New Horizons Software Inc. NHCL has the expertise in developing web applications, software development, e-learning applications, etc. Swcaliber.com is a robust software skills testing tool to recruit the software professionals. The author worked in this organization as a Project Manager for two years from 2000 to 2002 and headed the content department in developing swcaliber.com and other applications. NHCL, at present, has been engaged seriously in developing software applications for the hand-held billing machines to be used for the electricity departments in different states in India. NHCL already developed application for the Andhra Pradesh Central Power Distribution Corporation and is also hosting a website for the department to update the customers with necessary information like viewing their bills, information, bill history, Government orders on power, etc.

Cubic Electronics Sdn Bhd, Ayer Keroh, Melaka, Malaysia

Cubic Electronics is a manufacturing facility for Creative Technology Ltd., Singapore. It manufactures digital entertainment products like the highly acclaimed Creative Technology Ltd. Sound Blaster Sound cards, NOMAD Jukebox, PC Camera and Speaker systems for the personal computers and the Internet. It is having a separate IT division header by a Manager. In addition to manufacturing the above hardware products, the company develops the necessary driver software.
United Arab Shipping Co. (S.A.G.), Kuala Lumpur, Malaysia

United Arab Shipping Co. (UASC) is a big ocean carrier of dry cargo to the Middle East and was established in 1976 jointly by six shareholding countries of the Arabian Gulf (Bahrain, Iraq, Kuwait, Qatar, Saudi Arabia and U.A.E.) and the head office is located in the State of Kuwait with regional hubs in four other cities all over the world. UASC is offering services to the Arabian Gulf/Red Sea and Indian sub-continent regions. The project management activities of the IT development center of UASC in Kuala Lumpur, Malaysia have been studied.

HeiTech Padu Berhad, Subang Jaya, Kuala Lumpur, Malaysia

HeiTech Padu is one of the largest IT companies in Malaysia offering variety of IT infrastructure to government, public and private sectors. Their IT services include IT project management, network setup and management, disaster recovery, facilities management, record management, structured cabling and renovation works, internet and WAN (Wide Area Networking) connectivity, general technology strategy consultancy, upgrading and maintaining their installed services, etc.

MCIS Zurich Insurance, Subang Jaya, Malaysia.

MCIS (Malaysian Cooperative Insurance Society) Zurich Insurance is a composite insurer providing life and non-life products with its head office in Kuala Lumpur. It has 32 branches all over Malaysia, 5000 agents and 3,50,000 policy holders and a total of 450 staff. The organization has an IT division handling all the computerization jobs.


AMS is a manufacturer of visual information products. AMS started its operation in 1991 and its parent company is in US. AMS is producing nearly 125 models of high quality visual information products and the marketing of all these products is being handled by its parent company. The company has a separate MIS (Management Information System) division.
Eversendai Engineering Group, Pekellang Business Centre, Kuala Lumpur, Malaysia.

The company deals with power plant construction and steel structure construction works. The company formed a separate software division temporarily to develop the necessary software applications for its use by hiring the services of software technical people from other software development companies.

Highest Summit Technologies Sdn. Bhd., Kuala Lumpur, Malaysia

This is a software company dealing with development of different IT applications. This company has good experience in developing software applications for its own use and for the use of outside companies. They also develop IT applications for other companies by deploying their staff in the user location.

R.K. Group of Companies (the i professionals), Subang Jaya, Malaysia

The company deals with software development. The company has deputed a group of software developers headed by a project manager and deputy project managers to develop different software packages for the Kolej Universiti Teknikal Kebangsaan Malaysia (KUTKM) (Malaysia National Technical University College), Ayer Keroh, Melaka.

Osram Opto Semiconductors (Malaysia) Sdn. Bhd., Penang, Malaysia

This company is basically a manufacturer of semiconductor lighting sources like Light Emitting Diodes (LEDs), lighting systems, sensors, infrared sensors, etc. The company is having its own IT division.

MCSB Systems, Kuala Lumpur, Malaysia

MCSB Systems (or briefly, MCSB) is a software development company developing many software applications. Its business applications products cover management solutions for financial, document, workflow and human resources. Its service products deal with IT services assurance plan covering internet-centric remote management services, etc.
QuickNet Com (M) Sdn Bhd, Kuala Lumpur, Malaysia
QuickNet Com (M) Private Limited is a mobility solutions provider. It focuses on providing commercial grade mobility solutions, enabling new business models and services in the mobile internet space to meet the growing business and consumer requirements. It provides application, platform technology solutions and system integration services that facilitate and enable transactions in the mobile marketplace.

Apex Communications Sdn. Bhd., Kuala Lumpur, Malaysia
Apex Communications is one of the leading providers of communications products and services in Malaysia. It is a provider of digitalized telecommunications, network services, equipments and technology in broadcasting systems and equipments. It provides Telekom Malaysia with vast end-to-end internet systems and solutions comprising the deployment and maintenance of Remote Access servers, Router networks and Corporate Dial-VPN nationwide, etc.