

Multi-Project Cash Flow Analysis and Integrated Schedule Management

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Abstract- The construction market is a highly competitive marketplace with large profit markets. With the current state of the nation's economy, there has been an increase in the number of competitors competing over the projects. For a company to survive in this market, it must have a close eye on costs and have accurate cost estimates. Most of the owners and contractors have usually large ongoing construction portfolios rather than singular construction projects, project management largely speak about the single project paradigm, and little about the multi-project environment. A single project paradigm does not necessarily reflect the real time scenarios of many construction companies. Thus it can be clearly stated that there are much differences between multi-projects and traditional projects to question the applicability of straight project management approaches. Management of multi-projects is not as simple as a collective of various single project level management, rather it requires unique and advanced management techniques and tools. The purpose of this study is to understand, in a multi-project scenario, the basics of the cash flow optimization, project scheduling and integration of the two. The study provides method for optimizing the cash flow in a multi-project scenario in order to achieve a stable cash flow throughout the life time of the company. Case study employs an example involving eleven projects for model illustration, and the optimized schedule is conducted to pursue a constant profit through the overall period.

Index Terms- Multi-project, cash flow optimization, project scheduling, construction management.

I. INTRODUCTION

In a Construction project, its cash flow at any point during the project can provide a complete history of all cash disbursements cash outflow and earnings, cash inflow received from project execution, and net difference between the cash inflow and outflow i.e. the overdraft. The problem of achieving healthy cash flow during valuation periods relates to that of properly estimating cash inflows and outflows along with project progress. The concern focuses not just on the amount of cash flow but also on its timing, which is critical to effective budget management during construction. By identifying the amount and timing of individual inflow or outflow at the end of each period, contractors can observe cash flow at a specific time point according to project progress[1]. Hence the importance of project finance was understood and numerous researchers employed various techniques to solve project scheduling problem by integrating scheduling and financial factors to assess overall performance while minimizing project duration or maximizing project profit.

In the Indian construction industry, most of the owners and contractors have usually large ongoing construction portfolios rather than singular construction projects. However, general found literatures on project management largely speak about the single project paradigm, and little about the multi-project environment. A single project paradigm does not necessarily reflect the real time scenarios of many construction companies. Thus it can be clearly stated that there are much differences between multi-projects and traditional projects to question the applicability of straight project management approaches[2]. Management of multi-projects is not as simple as a collective of various single project level management, rather it requires unique and advanced management techniques and tools, hence the need for this study.

II. THEORY OF MULTI-PROJECT CASH FLOW ANALYSIS

A multi-project cash-flow model must be based on cash flows of all the individual projects. Whenever possible, i.e., when detailed data is available, the project-level forecast is resource-based. But detailed data is not always available for all the projects, for some projects the only available data are their total cost, their duration, and some general data.

There are various models flexible enough to accommodate such projects as well. Cash-flow forecasts of such projects with limited data are based on a cost-flow forecast, which is generated with the aid of mathematical models that use a variety of polynomial formulas for the project level, in order to calculate its monthly costs.

These monthly costs must be transformed into monthly expenses by adding time lags, which refer to resources and consequently cannot be added to costs that are not resource-based. The solution to this problem, for limited data projects, is to divide the costs into cost groups (labour, materials, equipment, formwork, scaffolding, etc.). This division would be based on earlier experience of the company with similar projects (the model provides default values for such division, based on the literature). Some of the groups have a typical time lag (such as labour), others (e.g., materials) do not. For the latter group, a decision regarding a "typical" time lag must be made based on the company's historical information. The expense flow is generated by taking the monthly costs, dividing them into cost groups, and projecting them according to their "payment" time, on the basis of the appropriate time lag.

III. MULTI PROJECT SCHEDULING

Managing one project at a time to success is challenging enough. More than 50% of all projects fail and a recent study discussed on the PMI.org forums indicated that as many as 76% of all projects fail to some degree. While that figure seemed high, it's not all that surprising.

Currently, projects in the portfolio are managed independently by a project manager. Scheduling is based on Gantt chart and CPM method and schedules are prepared only for one project. The schedule is prepared at the beginning of the project and is presented to the customer as a baseline to the contract regulations. Analysis of resources availability is not prepared before a contract is signed. If new project appears it is scheduled independently, without analyzing its influence the other concurrent projects. Resources availability is not controlled during the scheduling phase. Sometimes company hires external resources to meet the deadlines.

Now consider that many project managers are running several projects at once – not just focusing on one single project. The prospect of keeping multiple projects in focus and on track as well as successfully managing several project teams and customers simultaneously can definitely add to the potential for multiple project failures.

Multi-projects have tended to be treated as monolithic projects, even though unique problems, particularly regarding their management, have been identified by several authors. In brief, there are enough differences between multi-projects and traditional projects to question the applicability of straight project management approaches.

The management of multi-projects is not simply an aggregate of single project efforts and as such requires unique approaches, techniques and tools. Use of common resources provides usually important constraints on the individual planning of these kinds of projects. Some of these limitations are: storage capacity, transportation, specialized and non-specialized manpower and even cash resources.

A integrated project schedule for all the concurrent projects should be prepared each time when some changes occurs, e.g. new project introduction, change in the resources availability, change in project scope, contract renegotiation. Each of those situations influences the multi-project schedule. That is why a methodology and tool, which will prepare a schedule in the short period of time is necessary. Multi-Project scheduling problem described above consists of many factors, like contract statements, resources availability and goals for project portfolio manager. To build a methodology to solve this problem some general assumptions need to be prepared.

The following assumptions were made:

- Projects in the given multi-project scenario shall not be delayed due to any reason and/or the penalty to be paid in case of delay to be minimum.
- Resources to be used by the project manager in order to manage the projects are the internal resources without exceeding the available resources of the company.

IV. STUDY OF PROJECT SCHEDULING AND CASH-FLOW

As a case study a group projects of a construction company from India, B L K & Sons Ltd have been considered. This group consists of a mixture of projects with respect to its type, location, budget and duration. Though the company is working on many projects as of now, however for our study purpose we have considered only those projects which are being worked on within the period of 5 years i.e. 2009 to 2014. The details of the projects under this portfolio can be referred in Table 1.

TABLE 1: CASE STUDY - B L K & SONS LTD.

Sl No.	Name Of The Project	Location	Type	Value Of Work In Crores (Rs.)	Date Of Commencement As Per Contract	Actual / Stipulated Date Of Completion
1	HPCL	Bhatinda (Punjab)	Township	134.43	Jan'09	Oct'11
2	HCL	Noida	IT Office	105	Jun'09	Jan'13
3	Daimler Hero	Chennai	Industrial	216.07	Aug'09	Oct'11
4	JW Marriot Hotel	New delhi	Hotel	85	Apr'10	Jan'13
5	The North Country mall	Mohali	Commercial	137.99	Oct'10	Sep'13
6	World Trade Tower	Noida	Commercial	126	Mar'11	Jun'14
7	Holiday Inn	Bangalore	Hotel	34	Oct'11	Jun'14
8	Jaypee Project	Noida	Housing	503	Feb'12	Feb'16
9	Divyashree	Chennai	Housing	24	Apr'12	Jun'14
10	Zonashe paradiso villas	Bangalore	Housing	15	May'12	Jun'14
11	Hooghli river bridge project	Kolkata	Institutional	221.58	Jan'13	Jul'14

THE CASH FLOW ESTIMATION

As a common practice, the construction companies in India form a cash flow study on the basis of its resources i.e. Labour, Equipment and Materials. However for this case study we are dividing our cash flow on elemental basis. The elements into which these projects are divided are as follows:

- Mobilization
- Foundation/Piling
- Sub-structure
- Super-structure(civil)
- Façade
- Internal Finishes
- Electrical
- Plumbing
- HVAC
- Landscape

On the basis of these elements the cash inflows and cash outflows were found for the earlier mentioned projects in the Tables 2 to 12.

Table 2 project 1 - element wise cash flow

HPCL, Township, Bhatinda							
S.No.	Element	Duration	Start date	End date	Typical Cash flow		PROFIT
					Cash flow In	Cash flow Out	
1	Mobilization	22	08-01-2009	30-01-2009	Rs. 6,85,59,300.00	Rs. 67,21,500.00	Rs. 6,18,37,800.00
2	Foundation/Piling	38	30-01-2009	09-03-2009	Rs. 2,82,30,300.00	Rs. 2,55,41,700.00	Rs. 26,88,600.00
3	Sub-structure	0	09-03-2009	09-03-2009	Rs. 0.00	Rs. 0.00	Rs. 0.00
4	Super-structure(civil)	568	09-03-2009	28-09-2010	Rs. 65,87,07,000.00	Rs. 57,13,27,500.00	Rs. 8,73,79,500.00
5	Façade	345	28-09-2010	08-09-2011	Rs. 2,82,30,300.00	Rs. 2,68,86,000.00	Rs. 13,44,300.00
6	Internal Finishes	268	09-08-2010	04-05-2011	Rs. 18,82,02,000.00	Rs. 21,50,88,000.00	-Rs. 2,68,86,000.00
7	Electrical	345	28-09-2010	08-09-2011	Rs. 11,82,98,400.00	Rs. 10,75,44,000.00	Rs. 1,07,54,400.00
8	Plumbing	345	28-09-2010	08-09-2011	Rs. 17,61,03,300.00	Rs. 14,78,73,000.00	Rs. 2,82,30,300.00
9	HVAC	345	28-09-2010	08-09-2011	Rs. 5,10,83,400.00	Rs. 3,89,84,700.00	Rs. 1,20,98,700.00
10	Landscape	190	11-04-2011	18-10-2011	Rs. 2,68,86,000.00	Rs. 1,34,43,000.00	Rs. 1,34,43,000.00
Total					Rs. 1,34,43,00,000.00	Rs. 1,15,34,09,400.00	Rs. 19,08,90,600.00

Table 3 project 2 - element wise cash flow

HCL, IT Office, Noida							
S.No.	Element	Duration	Start date	End date	Typical Cash flow		PROFIT
					Cash flow In	Cash flow Out	
1	Mobilization	15	16-06-2009	01-07-2009	Rs. 7,56,00,000.00	Rs. 1,99,50,000.00	Rs. 5,56,50,000.00
2	Foundation/Piling	45	01-07-2009	15-08-2009	Rs. 3,36,00,000.00	Rs. 2,10,00,000.00	Rs. 1,26,00,000.00
3	Sub-structure	0	15-08-2009	15-08-2009	Rs. 0.00	Rs. 0.00	Rs. 0.00
4	Super-structure(civil)	822	15-08-2009	15-11-2011	Rs. 54,49,50,000.00	Rs. 46,88,25,000.00	Rs. 7,61,25,000.00
5	Façade	555	03-07-2011	08-01-2013	Rs. 1,15,50,000.00	Rs. 1,68,00,000.00	-Rs. 52,50,000.00
6	Internal Finishes	535	03-07-2011	19-12-2012	Rs. 8,29,50,000.00	Rs. 8,40,00,000.00	-Rs. 10,50,000.00
7	Electrical	555	03-07-2011	08-01-2013	Rs. 8,50,50,000.00	Rs. 7,35,00,000.00	Rs. 1,15,50,000.00
8	Plumbing	555	03-07-2011	08-01-2013	Rs. 12,81,00,000.00	Rs. 9,56,55,000.00	Rs. 3,24,45,000.00
9	HVAC	555	03-07-2011	08-01-2013	Rs. 7,77,00,000.00	Rs. 7,03,50,000.00	Rs. 73,50,000.00
10	Landscape	153	26-08-2012	26-01-2013	Rs. 1,05,00,000.00	Rs. 84,00,000.00	Rs. 21,00,000.00
Total					Rs. 1,05,00,00,000.00	Rs. 85,84,80,000.00	Rs. 19,15,20,000.00

Table 4 project 3 - element wise cash flow

Damiler Hero, Industry , Chennai							
S.No.	Element	Duration	Start date	End date	Typical Cash flow		PROFIT
					Cash flow In	Cash flow Out	
1	Mobilization	14	16-08-2009	30-08-2009	Rs. 12,96,42,000.00	Rs. 4,75,35,400.00	Rs. 8,21,06,600.00
2	Foundation/Piling	45	30-08-2009	14-10-2009	Rs. 4,32,14,000.00	Rs. 3,67,31,900.00	Rs. 64,82,100.00
3	Sub-structure	0	14-10-2009	14-10-2009	Rs. 0.00	Rs. 0.00	Rs. 0.00
4	Super-structure(civil)	482	14-10-2009	08-02-2011	Rs. 1,27,04,91,600.00	Rs. 1,03,71,36,000.00	Rs. 23,33,55,600.00
5	Façade	235	08-02-2011	01-10-2011	Rs. 4,10,53,300.00	Rs. 4,32,14,000.00	-Rs. 21,60,700.00
6	Internal Finishes	235	08-02-2011	01-10-2011	Rs. 11,01,95,700.00	Rs. 6,69,81,700.00	Rs. 4,32,14,000.00
7	Electrical	235	08-02-2011	01-10-2011	Rs. 21,39,09,300.00	Rs. 16,85,34,600.00	Rs. 4,53,74,700.00
8	Plumbing	235	08-02-2011	01-10-2011	Rs. 17,71,77,400.00	Rs. 10,56,58,230.00	Rs. 7,15,19,170.00
9	HVAC	235	08-02-2011	01-10-2011	Rs. 12,74,81,300.00	Rs. 12,96,42,000.00	-Rs. 21,60,700.00
10	Landscape	159	19-05-2011	25-10-2011	Rs. 4,75,35,400.00	Rs. 2,39,83,770.00	Rs. 2,35,51,630.00
Total					Rs. 2,16,07,00,000.00	Rs. 1,65,94,17,600.00	Rs. 50,12,82,400.00

Table 5 project 4 - element wise cash flow

JW Marriot Hotel, Delhi							
S.No.	Element	Duration	Start date	End date	Typical Cash flow		PROFIT
					Cash flow In	Cash flow Out	
1	Mobilization	14	14-04-2010	28-04-2010	Rs. 5,27,00,000.00	Rs. 1,80,20,000.00	Rs. 3,46,80,000.00
2	Foundation/Piling	48	28-04-2010	15-06-2010	Rs. 1,61,50,000.00	Rs. 83,30,000.00	Rs. 78,20,000.00
3	Sub-structure	90	15-06-2010	13-09-2010	Rs. 4,33,50,000.00	Rs. 1,95,50,000.00	Rs. 2,38,00,000.00
4	Super-structure(civil)	536	13-09-2010	02-03-2012	Rs. 37,57,00,000.00	Rs. 34,17,00,000.00	Rs. 3,40,00,000.00
5	Façade	330	02-03-2012	26-01-2013	Rs. 1,02,00,000.00	Rs. 1,19,00,000.00	-Rs. 17,00,000.00
6	Internal Finishes	250	07-12-2012	14-08-2013	Rs. 9,43,50,000.00	Rs. 7,73,50,000.00	Rs. 1,70,00,000.00
7	Electrical	330	02-03-2012	26-01-2013	Rs. 6,71,50,000.00	Rs. 6,80,00,000.00	-Rs. 8,50,000.00
8	Plumbing	330	02-03-2012	26-01-2013	Rs. 8,41,50,000.00	Rs. 7,75,20,000.00	Rs. 66,30,000.00
9	HVAC	330	02-03-2012	26-01-2013	Rs. 9,60,50,000.00	Rs. 6,63,00,000.00	Rs. 2,97,50,000.00
10	Landscape	85	18-11-2012	11-02-2013	Rs. 1,02,00,000.00	Rs. 94,35,000.00	Rs. 7,65,000.00
Total					Rs. 85,00,00,000.00	Rs. 69,81,05,000.00	Rs. 15,18,95,000.00

Table 6 project 5 - element wise cash flow

The North Country Mall, Commercial, Mohali							
S.No.	Element	Duration	Start date	End date	Typical Cash flow		PROFIT
					Cash flow In	Cash flow Out	
1	Mobilization	20	14-10-2010	03-11-2010	Rs. 9,93,52,800.00	Rs. 2,62,18,100.00	Rs. 7,31,34,700.00
2	Foundation/Piling	48	03-11-2010	21-12-2010	Rs. 4,41,56,800.00	Rs. 2,75,98,000.00	Rs. 1,65,58,800.00
3	Sub-structure	148	21-12-2010	18-05-2011	Rs. 5,24,36,200.00	Rs. 5,38,16,100.00	-Rs. 13,79,900.00
4	Super-structure(civil)	364	06-02-2011	05-02-2012	Rs. 66,37,31,900.00	Rs. 57,26,58,500.00	Rs. 9,10,73,400.00
5	Façade	545	05-02-2012	03-08-2013	Rs. 2,89,77,900.00	Rs. 1,37,99,000.00	Rs. 1,51,78,900.00
6	Internal Finishes	485	05-02-2012	04-06-2013	Rs. 10,90,12,100.00	Rs. 10,48,72,400.00	Rs. 41,39,700.00
7	Electrical	545	05-02-2012	03-08-2013	Rs. 12,55,70,900.00	Rs. 9,65,93,000.00	Rs. 2,89,77,900.00
8	Plumbing	545	05-02-2012	03-08-2013	Rs. 12,69,50,800.00	Rs. 13,10,90,500.00	-Rs. 41,39,700.00
9	HVAC	545	05-02-2012	03-08-2013	Rs. 11,59,11,600.00	Rs. 9,24,53,300.00	Rs. 2,34,58,300.00
10	Landscape	132	10-05-2013	19-09-2013	Rs. 1,37,99,000.00	Rs. 1,10,39,200.00	Rs. 27,59,800.00
Total					Rs. 1,37,99,00,000.00	Rs. 1,13,01,38,100.00	Rs. 24,97,61,900.00

Table 7 project 6 - element wise cash flow

World Trade Tower, Commercial, Noida							
S.No.	Element	Duration	Start date	End date	Typical Cash flow		PROFIT
					Cash flow In	Cash flow Out	
1	Mobilization	16	12-03-2011	28-03-2011	Rs. 9,07,20,000.00	Rs. 2,39,40,000.00	Rs. 6,67,80,000.00
2	Foundation/Piling	45	28-03-2011	12-05-2011	Rs. 4,03,20,000.00	Rs. 2,52,00,000.00	Rs. 1,51,20,000.00
3	Sub-structure	90	12-05-2011	10-08-2011	Rs. 4,78,80,000.00	Rs. 3,96,90,000.00	Rs. 81,90,000.00
4	Super-structure(civil)	696	26-06-2011	22-05-2013	Rs. 60,60,60,000.00	Rs. 52,29,00,000.00	Rs. 8,31,60,000.00
5	Façade	355	22-05-2013	12-05-2014	Rs. 1,38,60,000.00	Rs. 2,52,00,000.00	-Rs. 1,13,40,000.00
6	Internal Finishes	250	22-05-2013	27-01-2014	Rs. 11,21,40,000.00	Rs. 9,57,60,000.00	Rs. 1,63,80,000.00
7	Electrical	355	22-05-2013	12-05-2014	Rs. 11,46,60,000.00	Rs. 8,82,00,000.00	Rs. 2,64,60,000.00
8	Plumbing	355	22-05-2013	12-05-2014	Rs. 12,85,20,000.00	Rs. 11,47,86,000.00	Rs. 1,37,34,000.00
9	HVAC	355	22-05-2013	12-05-2014	Rs. 9,32,40,000.00	Rs. 9,95,40,000.00	-Rs. 63,00,000.00
10	Landscape	168	02-01-2014	19-06-2014	Rs. 1,26,00,000.00	Rs. 1,00,80,000.00	Rs. 25,20,000.00
Total					Rs. 1,26,00,00,000.00	Rs. 1,04,52,96,000.00	Rs. 21,47,04,000.00

Table 8 project 7 - element wise cash flow

Holiday inn, Commercial, Bangalore							
S.No.	Element	Duration	Start date	End date	Typical Cash flow		PROFIT
					Cash flow In	Cash flow Out	
1	Mobilization	14	01-10-2011	15-10-2011	Rs. 3,46,80,000.00	Rs. 64,60,000.00	Rs. 2,82,20,000.00
2	Foundation/Piling	34	15-10-2011	18-11-2011	Rs. 1,08,80,000.00	Rs. 68,00,000.00	Rs. 40,80,000.00
3	Sub-structure	28	18-11-2011	16-12-2011	Rs. 1,29,20,000.00	Rs. 1,07,10,000.00	Rs. 22,10,000.00
4	Super-structure(civil)	318	11-12-2011	24-10-2012	Rs. 16,35,40,000.00	Rs. 14,11,00,000.00	Rs. 2,24,40,000.00
5	Façade	230	24-10-2012	11-06-2013	Rs. 37,40,000.00	Rs. 34,00,000.00	Rs. 3,40,000.00
6	Internal Finishes	160	25-08-2012	01-02-2013	Rs. 2,68,60,000.00	Rs. 2,58,40,000.00	Rs. 10,20,000.00
7	Electrical	230	24-10-2012	11-06-2013	Rs. 2,75,40,000.00	Rs. 2,38,00,000.00	Rs. 37,40,000.00
8	Plumbing	230	24-10-2012	11-06-2013	Rs. 3,12,80,000.00	Rs. 3,19,60,000.00	-Rs. 6,80,000.00
9	HVAC	230	24-10-2012	11-06-2013	Rs. 2,51,60,000.00	Rs. 2,27,80,000.00	Rs. 23,80,000.00
10	Landscape	68	22-04-2013	29-06-2013	Rs. 34,00,000.00	Rs. 27,20,000.00	Rs. 6,80,000.00
Total					Rs. 34,00,00,000.00	Rs. 27,55,70,000.00	Rs. 6,44,30,000.00

Table 9 project 8 - element wise cash flow

Jaypee project, Housing, Noida							
S.No.	Element	Duration	Start date	End date	Typical Cash flow		PROFIT
					Cash flow In	Cash flow Out	
1	Mobilization	21	22-02-2012	14-03-2012	Rs. 25,65,30,000.00	Rs. 2,51,50,000.00	Rs. 23,13,80,000.00
2	Foundation/Piling	85	14-03-2012	07-06-2012	Rs. 10,56,30,000.00	Rs. 15,09,00,000.00	-Rs. 4,52,70,000.00
3	Sub-structure	110	07-06-2012	25-09-2012	Rs. 29,67,70,000.00	Rs. 18,10,80,000.00	Rs. 11,56,90,000.00
4	Super-structure(civil)	748	20-09-2012	08-10-2014	Rs. 2,16,79,30,000.00	Rs. 2,03,71,50,000.00	Rs. 13,07,80,000.00
5	Façade	430	08-10-2014	12-12-2015	Rs. 10,56,30,000.00	Rs. 10,06,00,000.00	Rs. 50,30,000.00
6	Internal Finishes	280	09-08-2014	16-05-2015	Rs. 70,42,00,000.00	Rs. 65,39,00,000.00	Rs. 5,03,00,000.00
7	Electrical	430	08-10-2014	12-12-2015	Rs. 44,26,40,000.00	Rs. 45,27,00,000.00	-Rs. 1,00,60,000.00
8	Plumbing	430	08-10-2014	12-12-2015	Rs. 65,89,30,000.00	Rs. 55,33,00,000.00	Rs. 10,56,30,000.00
9	HVAC	430	08-10-2014	12-12-2015	Rs. 19,11,40,000.00	Rs. 14,58,70,000.00	Rs. 4,52,70,000.00
10	Landscape	110	23-10-2015	10-02-2016	Rs. 10,06,00,000.00	Rs. 5,03,00,000.00	Rs. 5,03,00,000.00
Total					Rs. 5,03,00,00,000.00	Rs. 4,35,09,50,000.00	Rs. 67,90,50,000.00

Table 10 project 9 - element wise cash flow

Divyashree, Housing, Chennai							
S.No.	Element	Duration	Start date	End date	Typical Cash flow		PROFIT
					Cash flow In	Cash flow Out	
1	Mobilization	22	08-04-2012	30-04-2012	Rs. 1,22,40,000.00	Rs. 12,00,000.00	Rs. 1,10,40,000.00
2	Foundation/Piling	38	30-04-2012	07-06-2012	Rs. 50,40,000.00	Rs. 52,80,000.00	-Rs. 2,40,000.00
3	Sub-structure	0	07-06-2012	07-06-2012	Rs. 0.00	Rs. 0.00	Rs. 0.00
4	Super-structure(civil)	468	07-06-2012	18-09-2013	Rs. 11,71,20,000.00	Rs. 10,58,40,000.00	Rs. 1,12,80,000.00
5	Façade	275	18-09-2013	20-06-2014	Rs. 50,40,000.00	Rs. 56,16,000.00	-Rs. 5,76,000.00
6	Internal Finishes	238	30-07-2013	25-03-2014	Rs. 3,36,00,000.00	Rs. 3,55,20,000.00	-Rs. 19,20,000.00
7	Electrical	275	18-09-2013	20-06-2014	Rs. 2,11,20,000.00	Rs. 1,92,00,000.00	Rs. 19,20,000.00
8	Plumbing	275	18-09-2013	20-06-2014	Rs. 3,14,40,000.00	Rs. 2,64,00,000.00	Rs. 50,40,000.00
9	HVAC	275	18-09-2013	20-06-2014	Rs. 91,20,000.00	Rs. 69,60,000.00	Rs. 21,60,000.00
10	Landscape	75	16-04-2014	30-06-2014	Rs. 48,00,000.00	Rs. 24,00,000.00	Rs. 24,00,000.00
Total					Rs. 23,95,20,000.00	Rs. 20,84,16,000.00	Rs. 3,11,04,000.00

Table 11 project 10 - element wise cash flow

Zonashe paradiso villas, housing, Bangalore							
S.No.	Element	Duration	Start date	End date	Typical Cash flow		PROFIT
					Cash flow In	Cash flow Out	
1	Mobilization	14	16-05-2012	30-05-2012	Rs. 76,50,000.00	Rs. 7,50,000.00	Rs. 69,00,000.00
2	Foundation/Piling	45	30-05-2012	14-07-2012	Rs. 31,50,000.00	Rs. 46,50,000.00	-Rs. 15,00,000.00
3	Sub-structure	0	14-07-2012	14-07-2012	Rs. 0.00	Rs. 0.00	Rs. 0.00
4	Super-structure(civil)	462	14-07-2012	19-10-2013	Rs. 7,32,00,000.00	Rs. 6,61,50,000.00	Rs. 70,50,000.00
5	Façade	225	19-10-2013	01-06-2014	Rs. 31,50,000.00	Rs. 30,00,000.00	Rs. 1,50,000.00
6	Internal Finishes	210	19-10-2013	17-05-2014	Rs. 2,10,00,000.00	Rs. 1,95,00,000.00	Rs. 15,00,000.00
7	Electrical	225	19-10-2013	01-06-2014	Rs. 1,32,00,000.00	Rs. 1,20,00,000.00	Rs. 12,00,000.00
8	Plumbing	225	19-10-2013	01-06-2014	Rs. 1,96,50,000.00	Rs. 1,65,00,000.00	Rs. 31,50,000.00
9	HVAC	225	19-10-2013	01-06-2014	Rs. 57,00,000.00	Rs. 58,50,000.00	-Rs. 1,50,000.00
10	Landscape	145	17-01-2014	11-06-2014	Rs. 30,00,000.00	Rs. 15,00,000.00	Rs. 15,00,000.00
Total					Rs. 14,97,00,000.00	Rs. 12,99,00,000.00	Rs. 1,98,00,000.00

Table 12 project 11 - element wise cash flow

Hooghli river bridge project, Institutional, Kolkata							
S.No.	Element	Duration	Start date	End date	Typical Cash flow		PROFIT
					Cash flow In	Cash flow Out	
1	Mobilization	14	05-01-2013	19-01-2013	Rs. 22,15,80,000.00	Rs. 4,87,47,600.00	Rs. 17,28,32,400.00
2	Foundation/Piling	34	19-01-2013	22-02-2013	Rs. 4,43,16,000.00	Rs. 3,76,68,600.00	Rs. 66,47,400.00
3	Sub-structure	28	22-02-2013	22-03-2013	Rs. 3,98,84,400.00	Rs. 2,43,73,800.00	Rs. 1,55,10,600.00
4	Super-structure(civil)	275	17-03-2013	17-12-2013	Rs. 1,26,30,06,000.00	Rs. 1,01,92,68,000.00	Rs. 24,37,38,000.00
5	Façade	180	17-12-2013	15-06-2014	Rs. 4,21,00,200.00	Rs. 4,65,31,800.00	-Rs. 44,31,600.00
6	Internal Finishes	160	18-10-2013	27-03-2014	Rs. 9,08,47,800.00	Rs. 6,86,89,800.00	Rs. 2,21,58,000.00
7	Electrical	180	17-12-2013	15-06-2014	Rs. 19,72,06,200.00	Rs. 17,28,32,400.00	Rs. 2,43,73,800.00
8	Plumbing	180	17-12-2013	15-06-2014	Rs. 13,73,79,600.00	Rs. 10,83,52,620.00	Rs. 2,90,26,980.00
9	HVAC	180	17-12-2013	15-06-2014	Rs. 13,07,32,200.00	Rs. 10,59,15,240.00	Rs. 2,48,16,960.00
10	Landscape	68	26-04-2014	03-07-2014	Rs. 4,87,47,600.00	Rs. 2,45,95,380.00	Rs. 2,41,52,220.00
Total					Rs. 2,21,58,00,000.00	Rs. 1,65,69,75,240.00	Rs. 55,88,24,760.00

V. STUDY OF MULTI PROJECT CASH FLOW AND ANALYSIS

Once the cash inflow and cash outflow are achieved elements wise re-distribute the cash flow month wise. The cash flows need to be marked against time; however the element wise cash flows will help us link our costs to our schedule. Figure 1 shows a combined schedule for all the projects. Figure 2 shows the combined cash flow for the company. The company's profit has been shown in figure 3, the graph which shows the combined profit of all projects. From the month of february'11 to September '11 the company's profit takes a large lean towards negative cash flow. Now taking these months specifically we shall solve this problem in the upcoming chapter through optimized scheduling.



Figure 1 MULTI PROJECT SCHEDULING FOR CASE STUDY

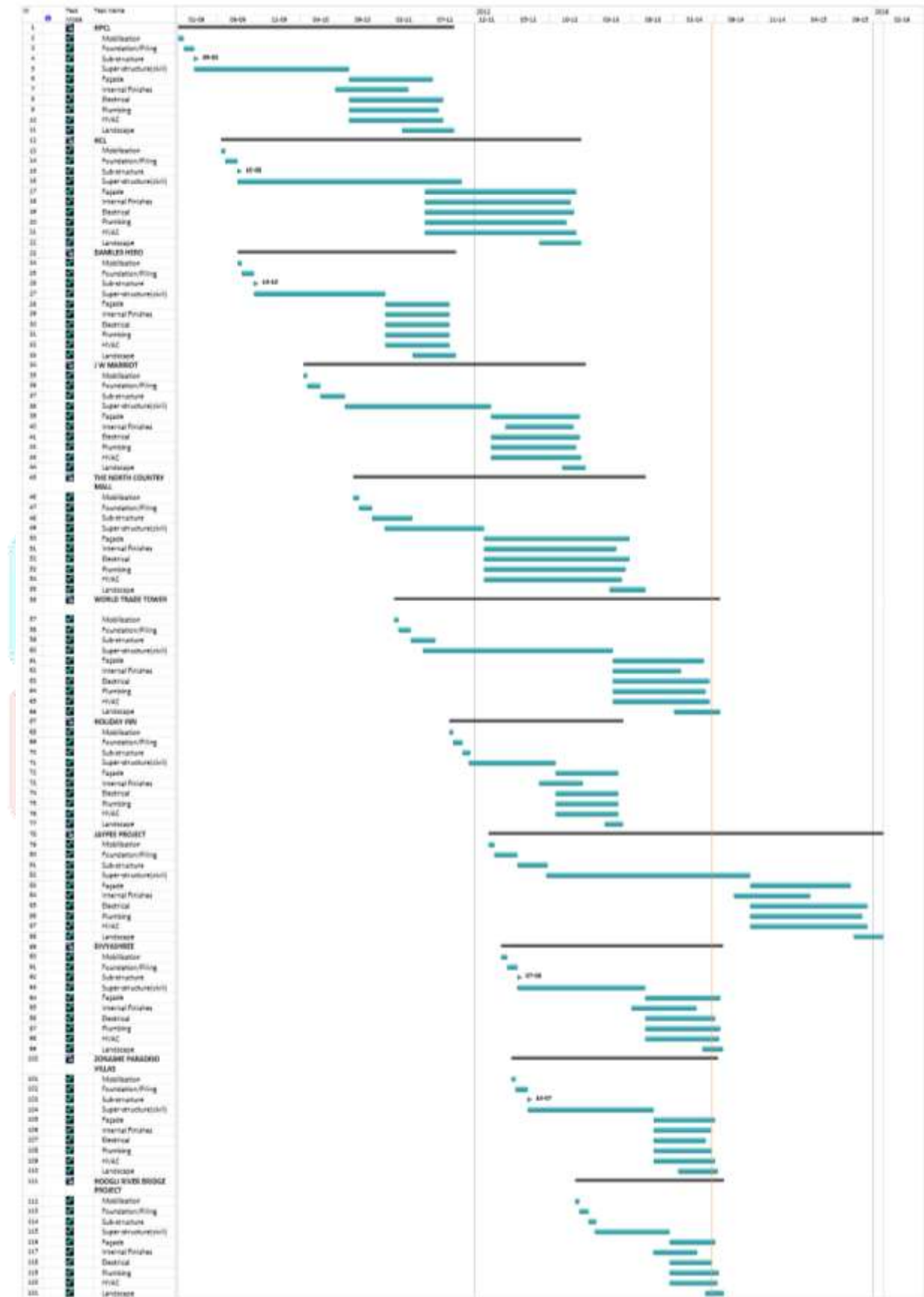


Figure 2 cash inflow and out flow for the whole model

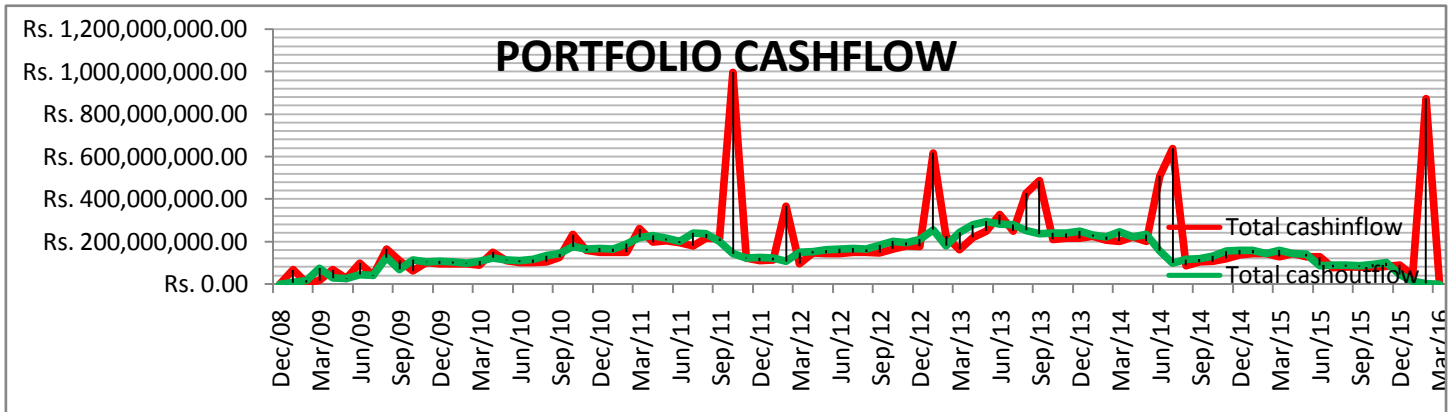
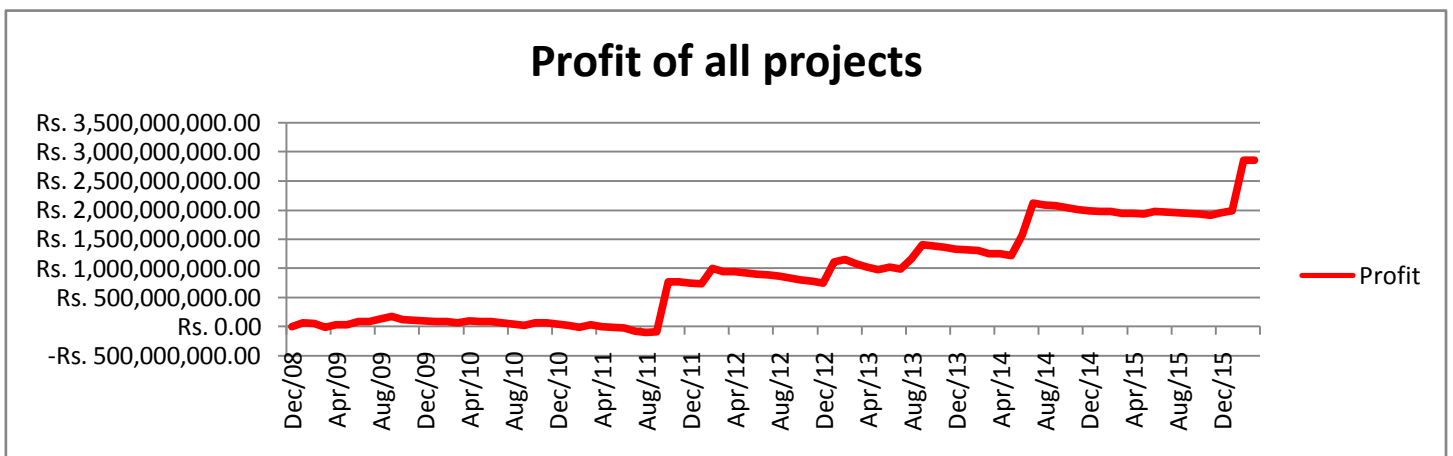


Figure 3 CUMULATIVE profit from all projects



VI. MULTI-PROJECT CASH FLOW AND SCHEDULE INTEGRATION

Lack of financing and cash deficit is considered as a primary threat to contractor's financial management. Therefore, in case of insufficient cash, many contractors find it difficult to stick with the project schedule leading to extra overhead costs and liquidated damages. Mainly contractors deal with the project scheduling and financing as two independent functions of construction project management. Thus, the main objective of this research is to solve finance-based scheduling problem of multi-projects.

In order to optimize this schedule, some ground ruled must be laid down so that by generating minimum number of favorable alternatives the best possible results can be achieved. These ground rules would help recognize the areas where beneficial alternatives can be suggested and applied. The ground rules laid down for this particular case study are as follows:

- Identify situation of least risk which are candidate for adjustment
- Study Profit accrual in each project for areas of positive cash flow, e.g. points where there is recently acquired mobilization amount.
- Areas of accumulated unutilized contingencies of risk are selected. These areas have better risk absorption capacity.
- Areas where the process of fast tracking or crashing can be employed.
- Use of Risk verses value chart and fins areas of available float.

Although the above suggested ground rules are for this particular case, however can be accounted as general ground rules and can also be subjectively modified.

The risk verses value chart for the given case study is as shown in

FIGURE 4 RISK AND VALUE PLOTTING



The plot above helps us decide which projects are flexible for re-scheduling. Figure 27 shows the schedule after optimization. There were three changes made in the new schedule:

HPCL – The start time for the activity of Landscaping was moved behind by 28 days.

Daimler Hero – The activity of plumbing was expanded into its float by 30 days

The North Country Mall – The activity of superstructure was expanded into its float by 75 days

FIGURE 5 OPTIMIZED SCHEDULE

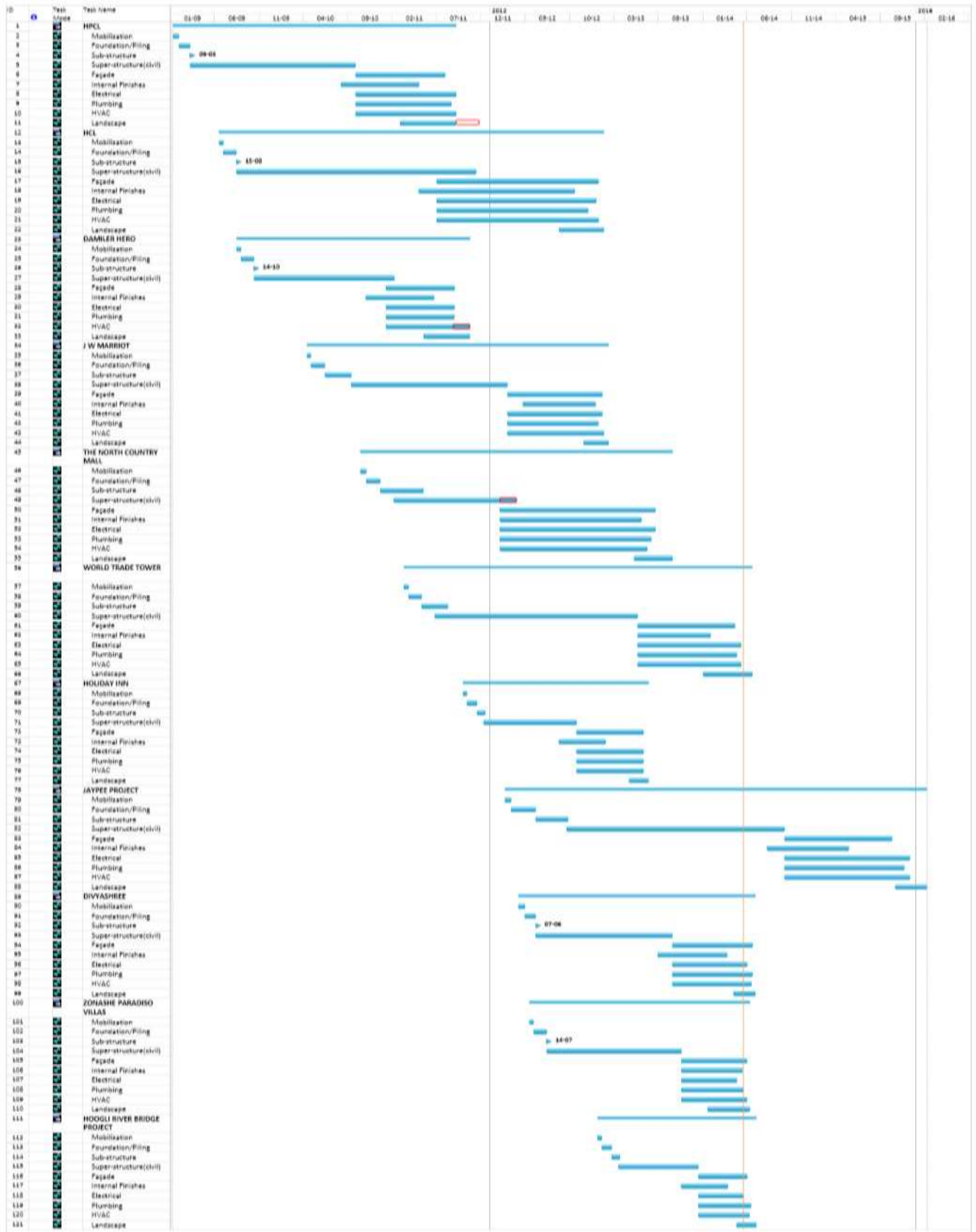


Figure 6 cash inflow and out flow for the whole model after re-scheduling

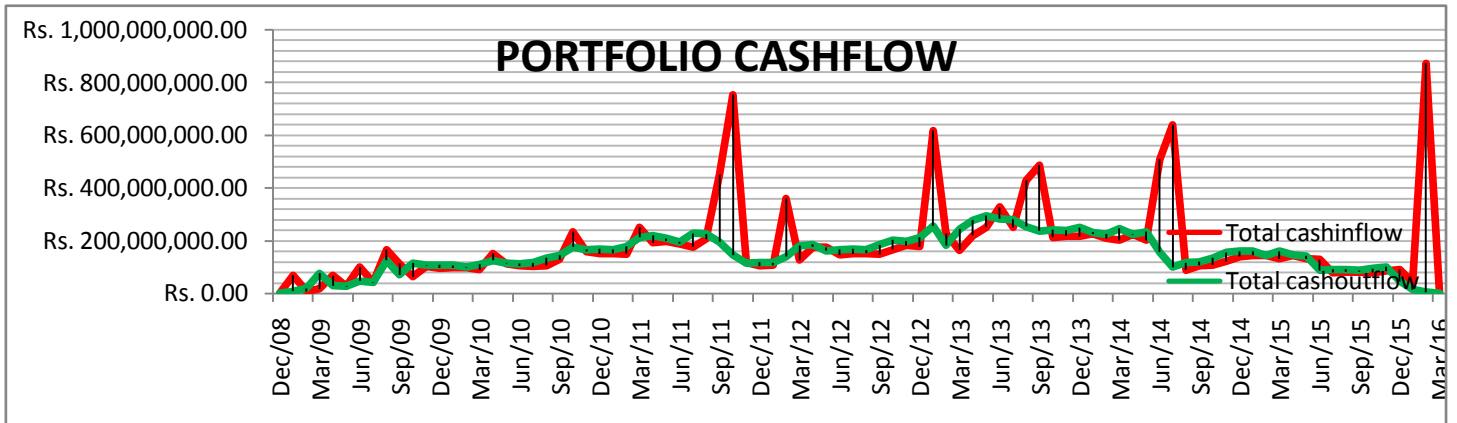
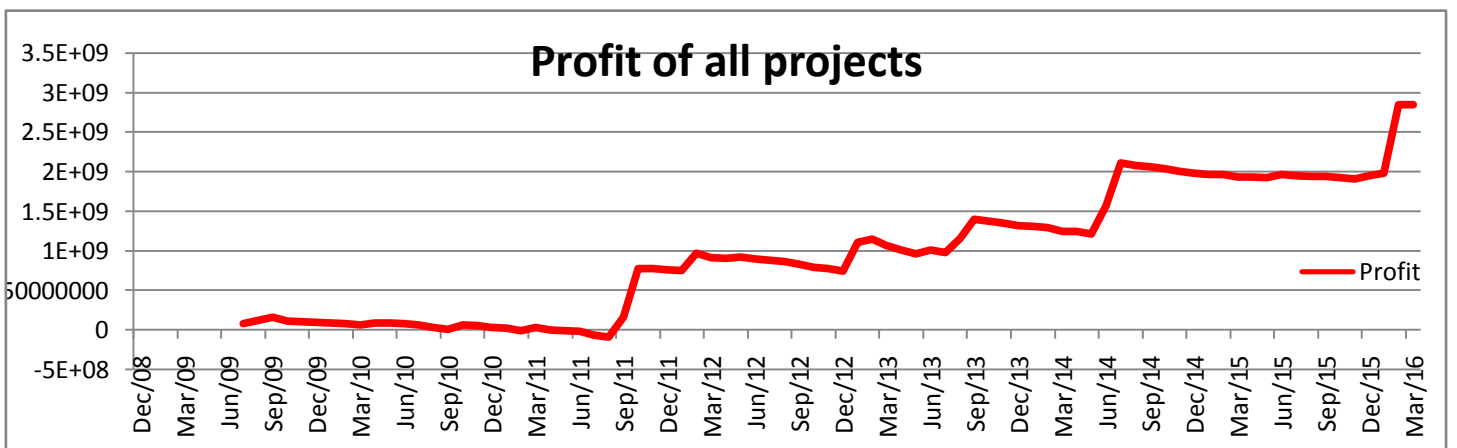
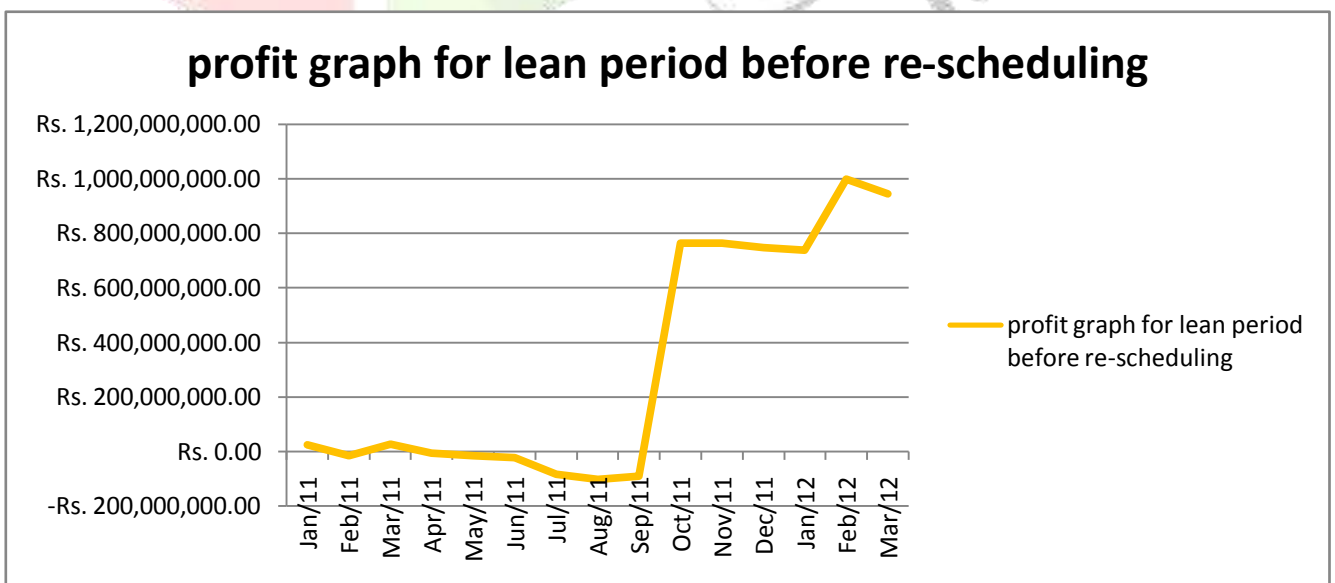
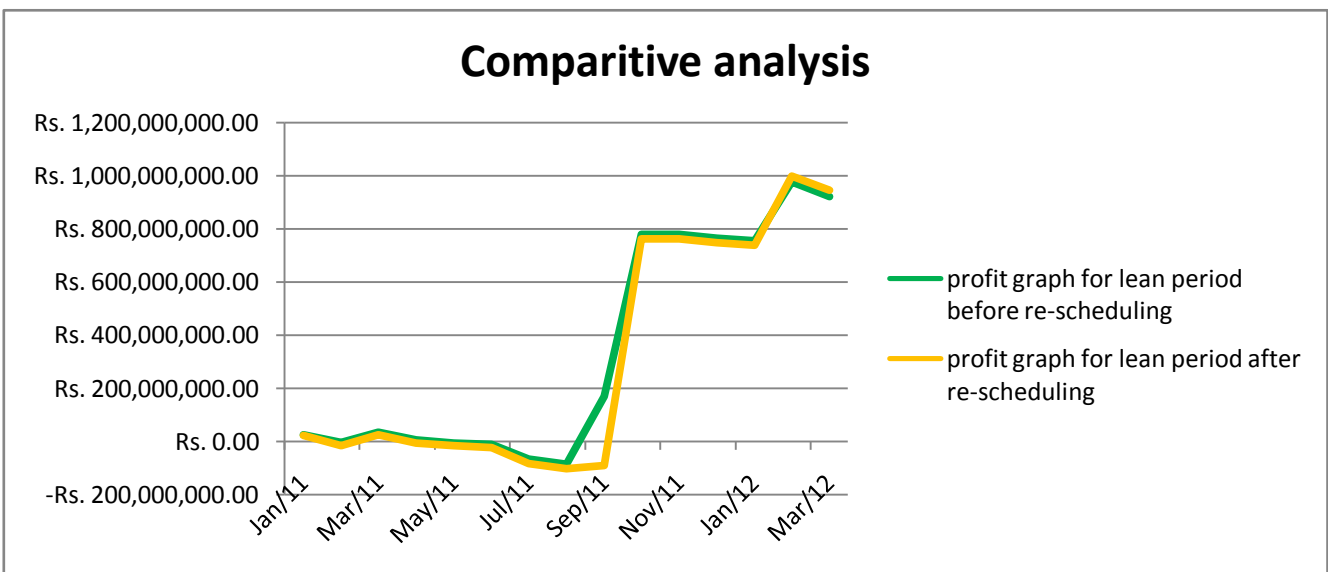
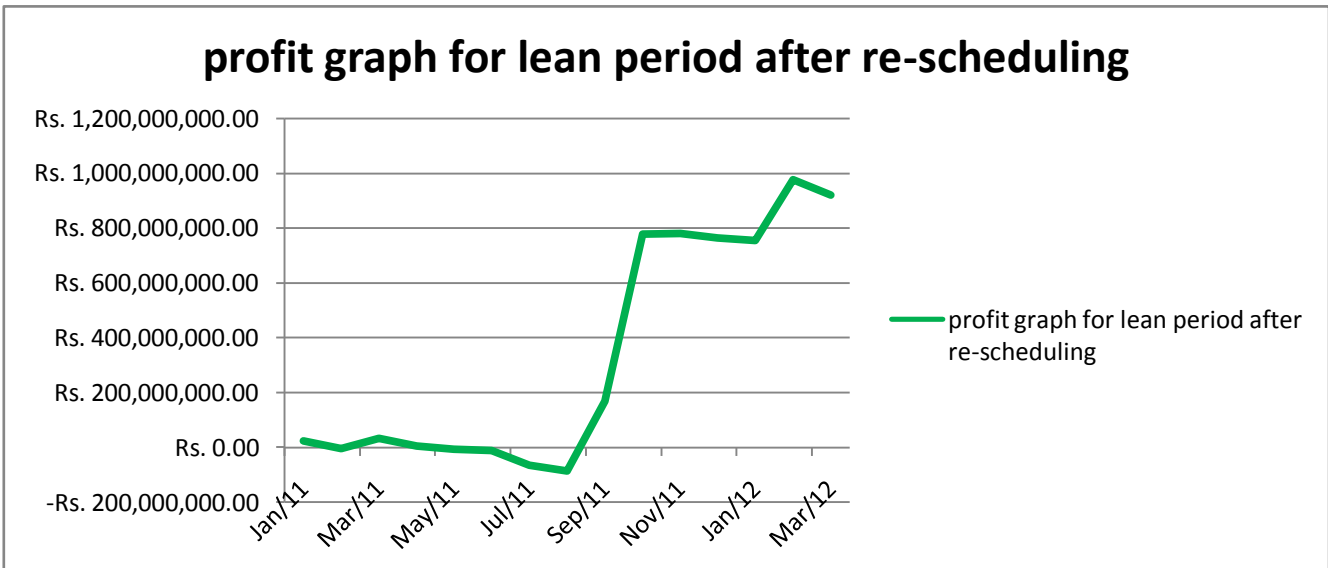


Figure 74 COMBINED PROFIT OF ALL PROJECTS AFTER RE-SCHEDULING



If we look at the lean period more closely for the company the below figure shows the profit graph for lean period before lean re-scheduling and a graph for lean period after re-scheduling. A comparative graph of the two shows in detail the effects of optimizing the schedule to achieve a better cash flow for the company.





VII. CONCLUSION

This study considers cash flow, for multi-project scheduling problems, and performs a predicted financial inspection on behalf of contractors. This work creates an overall time framework and integrates cash flow and financial elements into the scheduling to assist evaluating project financing in a multi-project environment. Scenario analysis employs an example involving eleven projects for model illustration, and the optimized schedule is conducted to pursue a constant profit through the overall period. The model capability is demonstrated smoothing financial pressure by shifting activity schedules without delayed completion time. Consequently, the proposed model identifies an appropriate scheduling plan to fulfil contractor financial needs related to multi-project scheduling problems.

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