SCHEDULING MODEL FOR MULTIPLE CONSTRUTION PROJECTS

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ABSTRACT: From the end of 20th century, developed countries are making efforts to regenerate old downtown areas of their cities. Urban regeneration program can be simplified as the demolition of existing deteriorated buildings and the construction of multiple new facilities. To maximize the benefit of the construction program within the restricted time and the limited financial resources, each project needs to be carefully planned considering the incomes and the expenses of the whole construction program. In this study, 3 types of scheduling situations, that are smoothing periodic loan, reducing program duration, and matching cost to budget are proposed under the constraints of time and budget. And concept models to find out optimal arrangement of projects' schedule for satisfying the goal of each scenario are presented.

***Keywords**: Scheduling, Multiple Projects, Cash-flow, Optimization*

1. INTRODUCTION

From the end of 20th century, organizations who improve their survivability by diversifying the range of business are increasing. The urban regeneration program becomes fascinating investment vehicle for construction companies, financial investors, and public investors. The urban regeneration program can be simplified as the demolition of existing deteriorated buildings and the construction of multiple new facilities.

The success of investment projects that most of the finances required for projects are delivered by private capitals depends on whether expected profits can be secured or not. To maximize the profits of construction program, each project needs to be carefully planned considering the incomes and the expenses of the whole construction program.

From the viewpoint of construction program, net values of investments for each project and incomes from those projects are fixed. Just only there's a differences between interest incomes and interest expenses that were influenced by time value of money and opportunity costs. Therefore, to maximize the profits of construction program, it is important to minimize the interest expenses occurred by financing, and to bring the revenue-generation point forward by minimizing the delivery time of construction program.

The objective of this study is to present the scheduling methodology of multiple construction projects to maximize the benefits of whole construction program. In other words, on a one time line, it is to find out the optimal combinations of individual project's scheduling that could minimize the financial costs and reduce delivery time.

2. SCHEDULING OF MULTIPLE PROJECTS

Previous studies about scheduling could be classified into the methods for scheduling to complete the project as fast as possible with restricted resources and the studies for TCTP(Time-Cost Trade-off Problem). These are looking for the best solution under the situations that program budgets are limited. However, if moving up to the planning phase of a project that the budgets or resources are not limited, a business scheme to maximize the profit or benefit should be considered too.

In this point of view, interviews with experts (2 public owners and 3 developers) who manage construction program were conducted. And the results are as follows. 1) in comparison with construction project, construction program has higher uncertainties about cost and duration, therefore flexible scheduling of individual project upon stable financing plan is required. 2) to maximize the profits of construction program, it is required to minimize the financing costs and to bring the revenue-generation point forward by minimizing the delivery time of construction

program. This study presents scheduling models to maximize benefits of construction program with three situations, pre-negotiation, post-negotiation, and self-funding, that can be occurred in the early phase of construction program.

3. SCHEDULING MODELS FOR MULTIPLE PROJECTS

Each model can be applied when monthly incomes and expenses are prepared such as Fig. 1. Each model aims to find the optimal combination of projects' scheduling using monthly cumulative incomes, expenses, and profit.

	Month	1	2	3	4	5	6	7	8	9
Project A	Incomes	0	0	0	0	0	4,900,000	700,000	1,564,000	1,564,000
	Expenses	427,437	527,437	427,437	427,437	427,437	3,605,589	3,501,336	2,088,202	920,936
Project B	Incomes	0	0	0	5,460,000	780,000	1,644,000	1,644,000	1,152,000	0
	Expenses	783,564	883,564	783,564	3,975,936	3,619,404	2,135,004	983,004	1,011,862	1,080,399
Project C	Incomes	0	0	0	0	0	12,600,000	1,800,000	3,096,000	3,096,000
	Expenses	1,031,270	1,181,270	1,031,270	1,031,270	1,031,270	8,880,384	6,330,640	3,700,638	1,972,638
Project D	Incomes	0	0	0	0	0	5,600,000	3,360,000	3,360,000	3,360,000
	Expenses	1,283,520	1,483,520	1,283,520	1,283,520	1,283,520	1,680,000	7,688,813	4,289,453	1,985,453
Project E	Incomes	0	0	0	0	0	0	15,600,000	0	0
	Expenses	241,453	341,453	241,453	241,453	241,453	241,453	0	5,686,018	3,408,418
Project F	Incomes	0	0	0	0	0	0	0	6,000,000	6,000,000
	Expenses	391,000	491,000	391,000	391,000	391,000	391,000	0	12,485,100	7,469,100
TOTAL	Cum. Incomes	0	0	0	5,460,000	6,240,000	30,984,000	54,088,000	69,260,000	83,280,000
	Cum. Expenses	4,158,245	9,066,489	13,224,734	20,575,350	27,569,435	44,502,866	63,006,660	92,267,933	109,104,877
	Cum. Profit	-4,158,245	-9,066,489	-13,224,734	-15,115,350	-21,329,435	-13,518,866	-8,918,660	-23,007,933	-25,824,877

Fig. 1 Monthly cash-flows of each projects and their sum.

In general, lenders prefer to lend constant amount of money continuously during a certain period. Therefore before to proceed negotiation with bank, the borrower, program manager should smooth periodic maximum loan such as Fig. 2 so that the negotiation with bank could be successful.

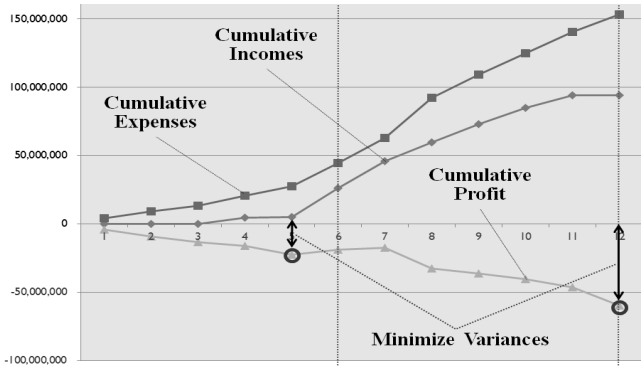

Fig. 2 Smoothing periodic loan model for pre-negotiation

When the negotiation about financing between bank and borrower are finished, the amount of periodic loan is determined. As finances are secured, program manager should modify schedules of projects to minimize the duration of whole program within the range that negotiated periodic loan can bear.

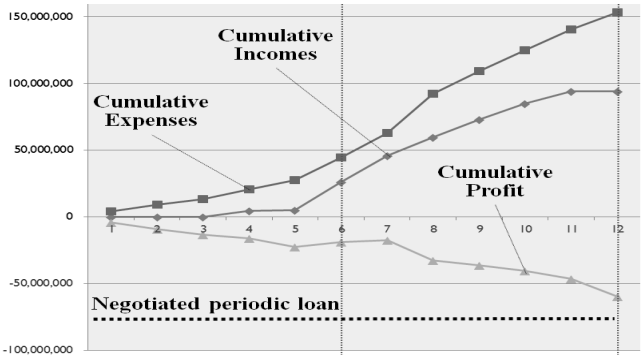

Fig. 3 Reducing program duration model for post-negotiation

When public or private owner provides whole budget, program manager should make an effort to spend all periodic budgets if possible. Less spent budget may increase the probability of schedule delay and be evaluated as poor plan that leads to decline program's reliability. So program manager should minimize variances between periodic budgets and expenses shown as Fig. 4.

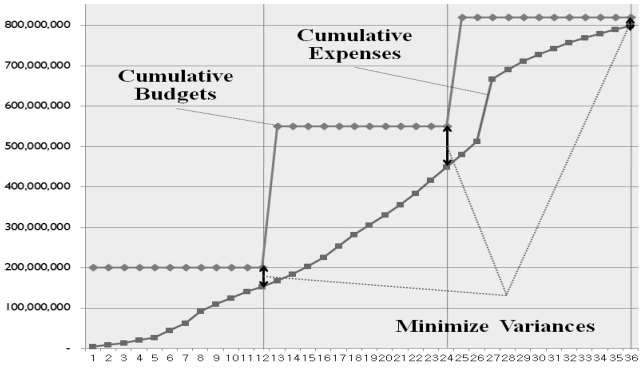

Fig. 4 Matching cost to budget model for self-funding

4. CONCLUSION

The next step of this study is to develop concept models presented in this proceeding minutely, to develop optimization algorithms for each model, and finally to implement computerized tool.

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