13th INTERNATIONAL PROJECT MANAGEMENT CONFERENCE
28-29 January 2018, Tehran
سیزدهمین کنفرانس بین المللی مدیریت پروژه
۸ و ۹ بهمن ماه ۱۳۹۶ - تهران

OPTIMIZING FINANCING COST USING A LINE-OF-CREDIT AND A LONG-TERM LOAN

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Keywords: Project Financing; Long-term Loans; Lines of Credit; Cash Flow Forecast

ABSTRACT

Contractors need financing throughout a project, mainly because (1) the owner withholds retainage to make sure that the project is performed properly by the contractor, and (2) the periodic payments made by the owner are usually delayed. Since financing has a cost, the integration of financing and scheduling is of vital importance in managing construction projects successfully. This study presents a model that minimizes financing cost by integrating a line-of-credit and a long-term loan using a work schedule with normal activity durations. The proposed model provides the optimum schedules of financing inflow (borrowed money) and outflow (repayments of principal and interest). The contractor benefits when the proposed model is used because the contractor: (1) pays less financing cost, (2) obtains higher profit, and (3) has more negotiating power with a lender because the contractor provides an optimal financing schedule when applying for a loan and/or credit line. The model has been tested in two scenarios and the results are analyzed. The model works well as long as the original work schedule is reliable.

1. Introduction

Since retainage is withheld by the owner until final completion, and because progress payments are often delayed by the owner, the contractor`s monthly outflows consistently exceed monthly inflows during the project (Peterson 2013). Therefore, contractors need to borrow money or use their own capital to finance the project. If contractors do not consider financing cost and cash availability constraints, the calculation of the expected profit is not realistic because using the company`s capital or borrowing from a third party has a cost.

Since financial and budgetary factors are the most common causes of business failure of construction companies (Arditi et al. 2000) and because the lack of finance causes 77 to 95% of contractor failures (Russell 1991), ignoring financing cost leads to a high rate of contractor failure. Thus, not only the consideration of financing cost, but also the minimization of financing cost is of vital importance when profit is calculated. The objective of this study is to integrate financing optimization into the scheduling function considering long-term loans and lines of credit simultaneously: (1) to minimize financing cost, (2) to obtain higher profit, and (3) to provide an optimum financing schedule. The optimum financing schedule specifies: (1) what amount of money should be taken each month in each alternative, and (2) what amount of money including interest should be repaid each month.

2. Literature Review

In 2004, Elazouni and Gab-Allah (2004) considered financing cost and introduced "finance-based scheduling" for the first time using a mathematical method. Finance-based scheduling balances cash outflows and cash inflows by changing the start times of activities and using additional funds from external resources. If the cash available is not enough to balance the disbursements, finance-based scheduling extends the duration of the project. Although a few subsequent researchers have developed finance-based scheduling by considering different assumptions and using different methods (e.g., Alghazi et al. 2013; El-Abbasy et al. 2017; Elazouni et al. 2015; Fathi and Afshar 2010; Liu and Wang 2010), the proposed model differs from all current finance-based scheduling models in four respects.

(1) All current finance-based scheduling models consider only one source of financing (i.e., a line-of-credit). Even though a long-term loan can reduce interest charges and avoid a large withdrawal from a line-of-credit (Au and Hendrickson 1986), long-term loans are not considered in any of the current finance-based scheduling models. The model proposed in this research integrates long-term loans and lines of credits.

(2) All current finance-based scheduling models except the ones conducted by Fathi and Afshar (2010) can handle only a predetermined credit limit for a line-of-credit. However, if optimum limits are considered, an optimal financing schedule may be different (Fathi and Afshar 2010). The model proposed in this research can handle both a predetermined and an undetermined credit limit.

(3) The current finance-based scheduling models do not provide an optimum financing schedule. To increase the contractor`s negotiating power with a lender, the model proposed in this research provides an optimum schedule of borrowed money, and an optimum schedule of repaid money

and interest.

(4) An optimum schedule of borrowed money and an optimum schedule of repaid money including interest are not provided by current finance-based scheduling models. The model proposed in this research provides an optimum financing schedule to increase the contractor`s negotiating power with a lender.

3. Methodology

Financing optimization and construction scheduling are integrated in this research. As shown in Figure 1, the model proposed in this research consists of three steps: (1) creation of project schedule, (2) creation of project cash flow, and (3) optimization of financing.

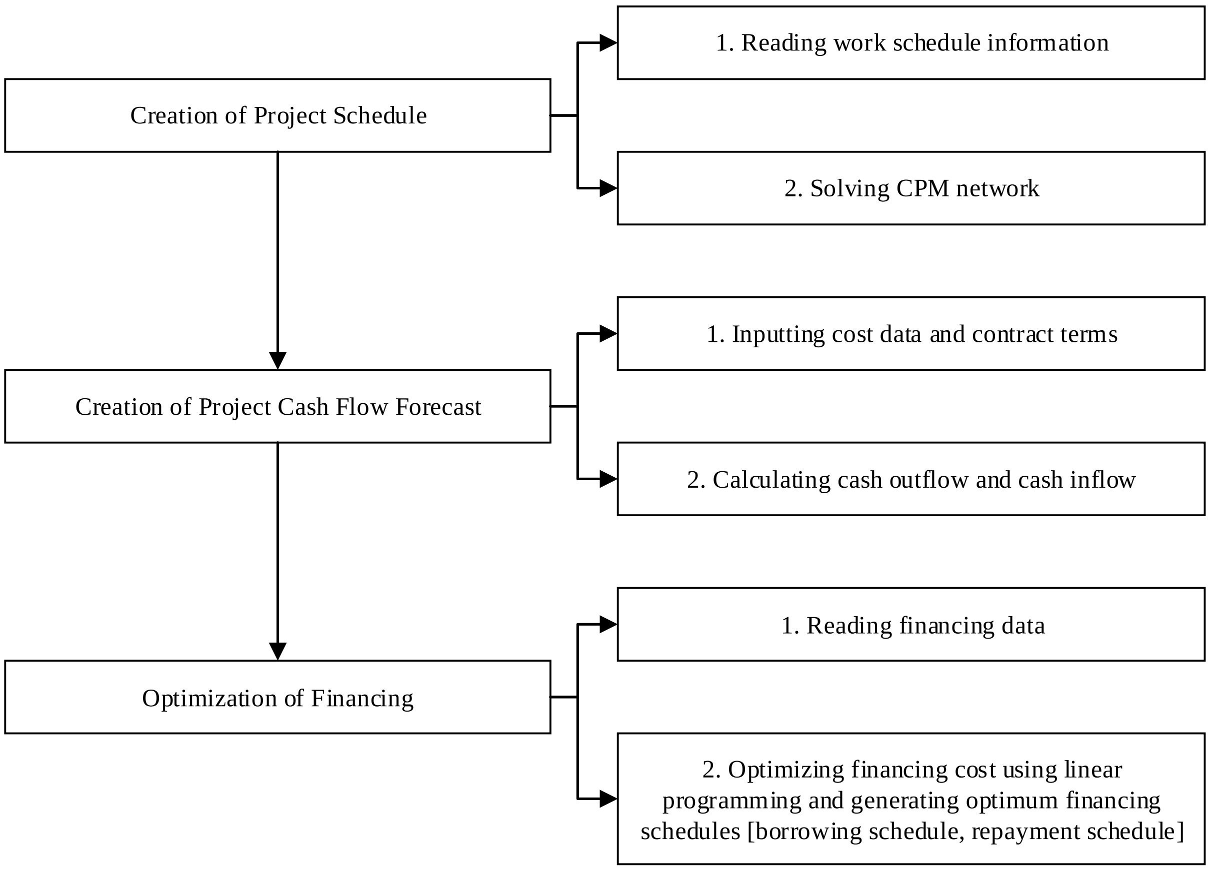

Figure 1. Model Algorithm

3.1 Creation of Project Schedule

The start and finish times of activities should be calculated to create a cash flow forecast. In this study, the CPM algorithm is used to calculate the early start, early finish, late start, late finish, and total float of activities. It should be noted that all activities are scheduled at their early times in this study in contrast to current finance-based scheduling models that considered variable start times of activities. It is true that the financing cost may be lower if activities start and finish as late as possible, but this situation creates a schedule composed of more critical activities. As a result, all activities are scheduled at their early times in this study to avoid such a situation.

3.2 Creation of Project Cash Flow Forecast

The cost data and contract terms are input by the contractor, and the cash outflow forecast (expenditures) and cash inflow forecast (incomes) are calculated when the start and finish times of activities are computed. The cash outflow includes direct and indirect costs, and the cash inflow is the owner payments. The direct cost includes the costs of materials, labor, equipment, and subcontractors. The indirect cost is composed of fixed overhead, variable overhead (Fathi and Afshar 2010; Peterson 2013), and mobilization and bonding. The owner payments consist of periodic progress payments made after the retainage is deducted and final payment which is made at the end of the project.

3.3 Optimization of Financing

The line-of-credit is the most common form of construction financing (Ahuja 1976). Lenders are always cautious when establishing lines of credit for contractors. Although contractors prefer a larger credit limit to avoid extending the project duration, lenders want to minimize their risk of reserving big amounts of cash for a specific contractor (Elazouni and Metwally 2005). Therefore, the contractor is limited in obtaining the required financing for the project and may be forced to extend the project duration if the credit limit is dictated by the lenders. Even if the contractor is able to obtain a higher credit limit, lenders raise the interest rate, in such cases, resulting in higher financing costs to the contractor (Elazouni and Metwally 2005). Consequently, considering a long-term loan is essential: (1) to reduce interest charges, (2) to avoid a large withdrawal from only a line-of-credit (Au and Hendrickson 1986), and (3) to avoid extending the project duration due to the lack of required money when a large line-of-credit cannot be obtained. However, it is possible that lenders do not offer both long-term loans and lines of credit. The proposed model is able to handle such situations, such that a contractor can consider only the alternative that is offered by lenders.

3.3.1 Lines of Credit

The line-of-credit can be an ideal form of meeting the financing needs, especially when the contractor is on an uncertain schedule and needs to access the specified credit as needed at any time as long as the credit limit that is specified by a lender is not exceeded (Peterson 2013). The model that is proposed in this study is able to specify what amount and when to withdraw and pay back the money to the line-of-credit account. In other words, the optimum timing of withdrawals and payments are calculated by the proposed model. It should be noted that if the withdrawn money from the line-of-credit is not paid in one month, compounded interest is considered in calculating the financing cost. In addition, the proposed model is able to determine the optimum amount of credit for the line-of-credit if the lenders leave that to the contractor to specify.

3.3.2 Long-Term Loans

Long-term loans are usually obtained at the beginning of the project and should be repaid in one year or more. Most lenders require the contractor to pay a fixed amount monthly, including both interest and principal (Peterson 2013), while others allow the contractor to pay off both the principal and compounded interest at the end of the project. Both conditions can be handled by the model proposed in this study. It should be mentioned that if a lender imposes a limit on borrowed money, the proposed model is able to consider a limit for the long-term loan, otherwise the proposed model finds the optimum limit for a long-term loan.

3.3.3 Optimization

Once a cash flow forecast is created, the financing variables (X) that are mentioned in Equation 1 should be added to the cash flow forecast. In Equation 1, B_{LTL} and B_{LC_t} represent borrowed money relative to the long-term loan at the beginning of the project and the line-of-credit in each month t, respectively; R_{LTL_t} and R_{LC_t} represent repaid money in each month t relative to the long-term loan and the line-of-credit, respectively; and FC_{LTL_t}, and FC_{LC_t} represent financing cost in each month t relative to the long-term loan and the line-of-credit, respectively. It should be noted that T_F is the time when the final payment including a retainage is made by the owner.

$$X = \left\{ FC_{LTL_t}(B_{LTL}, R_{LTL_t}),\ FC_{LC_t}(B_{LC_t}, R_{LC_t}) \right\};\ t = 0,\ 1,\ 2,\ \ldots, T_F \text{ months} \tag{1}$$

Once the financing variables (X) are added to the cash flow forecast, optimization is implemented using linear programming to minimize the financing cost (C_{fin}) in Equation 2.

$$\textit{Minimize } C_{fin} = \sum_{t=0}^{T_F} (FC_{LTL_t} + FC_{LC_t}) \tag{2}$$

The financing cost should be minimized such that the cumulative net balance of the cash flow (including financing flow) (N'_t) is greater than or equal to N_{min} which should be never less than zero (Equation 3). N_{min} is the minimum cumulative net balance of the cash flow (including financing flow), and is set by the contractor if the contractor wishes to have some funds as contingency.

$$N_t' \geq N_{min}\ ;\ t = 0,\ 1,\ 2,\ \ldots,\ T_F \text{ months} \tag{3}$$

If the long-term loans and lines of credit are restricted by lenders, Equations 4 to 6 are considered where the total amount of borrowed money relative to long-term loans and lines of credit (B_{LTL} and B_{LC_t}) should not exceed the limit agreed upon by the contractor and the lender (L_{LTL} and L_{LC}), respectively (see Equations 4 and 5). In terms of the line-of-credit, the total debt (i.e., sum of all withdrawals plus the interest minus all repayments) (left side of Equation 5) should not exceed the total credit limit of the line-of-credit (L_{LC}). Moreover, if the amount of money to be borrowed in each period relative to the line-of-credit (B_{LC_t}) is restricted, it should not exceed the respective limit of the line-of-credit in each period (L'_{LC}) (see Equation 6).

For long-term loan:

$$B_{LTL} \leq L_{LTL} \tag{4}$$

For line-of-credit:

$$\sum_{0}^{t}(B_{LC_t} + FC_{LC_t} - R_{LC_t}) \leq L_{LC} \;;\; t = 0,\ 1,\ 2,\ \ldots,\ T_F \text{ months} \tag{5}$$

$$B_{LC_t} \leq L'_{LC};\;\; t = 0,\ 1,\ 2,\ \ldots, T_F \text{ months} \tag{6}$$

4. Testing the Model in Two Scenarios

The network of an example project is shown in Figure 2. This network is a modified version of the network used by Ali and Elazouni (2009), where some activities are added and some predecessors and successors are modified. After the schedule data of this project is read from an Excel sheet by MATLAB 2013a, the CPM algorithm is used to calculate the early and late activity start and finish times, and floats (see Table 1). Then, the cost data and contract terms are input by the contractor (see Table 2). The inputs used in this research were inspired from the inputs that were considered in past studies (e.g., Alghazi et al. 2013; Fathi and Afshar 2010). After the cost data and contract terms are input by the contractor, the costs of the project and the contract bid price are calculated (see Table 3). Then, the project cash flow forecast is developed, which is then integrated with the project financing flow in the next process.

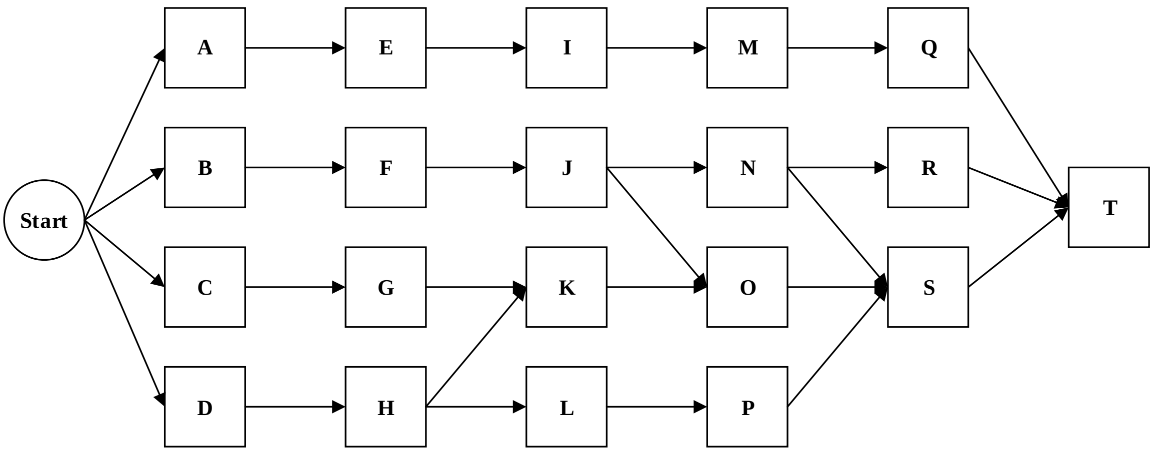

Figure 2. Network of the Example Project

Two different scenarios are considered in this study. In Scenario 1, a long-term loan and a line-of-credit are considered. The interest payment is made monthly in the long-term loan, whereas the interest payments in the line-of-credit can be paid either monthly or compounded over more than a month. The optimum timing of interest payments is determined by the model. In Scenario 2, which was the scenario in all finance-based scheduling models, developed in the past, only a line-of-credit is considered (no long-term loan). The interest payment time for the line-of-credit is the same as in Scenario 1. In addition, no credit limit is considered in both Scenarios 1 and 2 where the optimum credits are specified by the model.

The effective APRs are the same in both Scenarios 1 and 2 and are based on market conditions. APRs of 2-28% for loans and 5-40% for lines of credit are offered by traditional banks and alternative lenders (Mclntyre 2017; White 2017). When banks and alternative lenders specify APRs for borrowers, they consider both financial and non-financial factors in addition to the contractor's ability to repay the borrowed money with interest. If the requirements are met by the contractor, lenders are content with a low APR, whereas if the contractor does not satisfy the requirements fully, higher APRs will be sought by lenders. In addition, loans with longer duration are charged lower APRs (Au and Hendrickson 1986). In this study, a long-term loan is assigned a 15% APR and a line-of-credit is assigned a 23% APR. These APRs represent the average market conditions and this assignment does not favor one alternative over the other.

Table 1. Project Schedule Data and Activity Acceleration Method Inputs

Activity ID	Activity name	Predecessors			Duration (weeks)	Direct cost ($/week)	CPM calculations				
		Predecessor 1	Predecessor 2	Predecessor 3			Early start	Early finish	Late start	Late finish	Total float
1	Start	-	-	-	-	-	-	-	-	-	-
2	A	1	-	-	11	20,000	0	11	1	12	1
3	B	1	-	-	9	20,000	0	9	2	11	2
4	C	1	-	-	9	35,000	0	9	7	16	7
5	D	1	-	-	6	55,000	0	6	0	6	0
6	E	2	-	-	5	40,000	11	16	12	17	1
7	F	3	-	-	8	30,000	9	17	11	19	2
8	G	4	-	-	6	75,000	9	15	16	22	7
9	H	5	-	-	9	40,000	6	15	6	15	0
10	I	6	-	-	11	45,000	16	27	17	28	1
11	J	7	-	-	7	75,000	17	24	19	26	2
12	K	8	9	-	6	65,000	15	21	22	28	7
13	L	9	-	-	9	65,000	15	24	15	24	0
14	M	10	-	-	8	45,000	27	35	28	36	1
15	N	11	-	-	7	55,000	24	31	26	33	2
16	O	11	12	-	5	55,000	24	29	28	33	4
17	P	13	-	-	9	60,000	24	33	24	33	0
18	Q	14	-	-	8	65,000	35	43	36	44	1
19	R	15	-	-	9	40,000	31	40	35	44	4
20	S	15	16	17	11	60,000	33	44	33	44	0
21	T	18	19	20	10	80,000	44	54	44	54	0

Table 2. The Inputs of Cost Data and the Contractual Terms of the Project

Data type	Item	Amount
Cost data	Weekly fixed overhead cost (O_{foc})	\$110,000/week
	Variable overhead, expressed in percentage (O_{voc}) of direct cost (C_{dc})	5%
	Mobilization cost, expressed in percentage (O_{mob}) of (direct cost (C_{dc}) + variable overhead (C_{voc}))	4%
	Profit, expressed in percentage (O_p) of (direct cost (C_{dc}) + fixed overhead (C_{foc}) + variable overhead (C_{voc}) + mobilization cost (C_{mob}))	5%
	Bond premium, expressed in percentage (O_{bond}) of (direct cost (C_{dc}) + fixed overhead (C_{foc}) + variable overhead (C_{voc}) + mobilization cost (C_{mob}) + profit (P))	1%
Contract terms	Advance payment, expressed in percentage (O_{AP}) of contract price (CP)	0%
	Retained percentage (R) of periodic payments	10%
	Number of months between submitting pay requests	1 month
	Lag in responding to payment requests (months)	1 month
	Lag in making the final payment and return the retainage (months)	0 month

Table 3. The Project Costs and Contract Price Calculation

Type of cost/price	Calculation	Amount (\$)
Direct cost (C_{dc})	Summation of activities` direct cost	8,190,000
Fixed overhead cost (C_{foc})	$C_{foc} = \text{Project duration} \times \text{fixed overhead per week } (O_{foc})$ $= 54 \text{ weeks} \times \$110{,}000/\text{week}$	5,940,000
Variable overhead cost (C_{voc})	$C_{voc} = O_{voc} \times C_{dc}$ $= 0.05 \times \$8{,}190{,}000$	409,500
Mobilization cost (C_{mob})	$C_{mob} = O_{mob} \times (C_{dc} + C_{voc})$ $= 0.04 \times (\$8{,}190{,}000 + \$409{,}500)$	343,980
Profit (P)	$P = O_p \times (C_{dc} + C_{foc} + C_{voc} + C_{mob})$ $= 0.05 \times (\$8{,}190{,}000 + \$5{,}940{,}000 + \$409{,}500 + \$343{,}980)$	744,174
Cost of bonding (C_{bond})	$C_{bond} = O_p \times (C_{dc} + C_{foc} + C_{voc} + C_{mob} + P)$ $= 0.01 \times (\$8{,}190{,}000 + \$5{,}940{,}000 + \$409{,}500 + \$343{,}980 + \$744{,}174)$	156,277
Contract price (CP)	$CP = (C_{dc} + C_{foc} + C_{voc} + C_{mob} + P + C_{bond})$ $= \$8{,}190{,}000 + \$5{,}940{,}000 + \$409{,}500 + \$343{,}980 + \$744{,}174 + \$156{,}277$	15,783,931

4.1 Analysis of the Results

As shown in Table 4, Scenario 1 results in a lower financing cost (\$347,472) when a long-term loan is considered in conjunction with a line-of-credit, whereas Scenario 2 results in higher financing cost (\$413,596) because only a line-of-credit is considered. In addition, if the contractor uses a long-term loan in addition to a line-of-credit (i.e., Scenario 1), the profit of the project amounts to \$396,702, whereas the profit of the project amounts to only \$330,578 if only a line-of-credit is used (i.e., Scenario 2). Therefore, the contractor achieves higher profit if the proposed model is used. It should be noted that in Scenario 1, not only is the financing cost lower and the profit is higher than in

Scenario 2, but also the contractor can avoid a large withdrawal on its line-of-credit.

Table 4. Summary of Project Financial Parameters Considering Three Cases

Financial Parameters	Scenario 1	Scenario 2
Total financing cost of the project ($)	347,472	413,596
Profit of the project ($)	396,702	330,578
Size of long-term loan ($)	1,802,250	-
Size of line-of-credit ($)	1,317,193	2,193,201

The optimum financing schedule for both Scenarios 1 and 2 are shown in Table 5. In Scenario 1, a large amount of money should be borrowed as a long-term loan (i.e., $1,802,250) in spite of the belief that a long-term loan is not a good idea for temporary needs in projects. In addition, despite the complexity and unscheduled nature of a line-of-credit, the proposed model provides an optimum schedule for managing the line-of-credit. In other words, the proposed model provides the optimum timing of the repayment of the interest and withdrawn money from the line-of-credit (see Table 5).

Table 5. Optimum Financing Schedule (Borrowed and Repaid Schedule) for Scenarios 1 and 2

Month	Scenario 1				Scenario 2	
	Schedule for borrowed money		Schedule for repaid money, including interest		Schedule for borrowed money	Schedule for repaid money, including interest
	Long-term loan	Line-of-credit	Long-term loan	Line-of-credit	Line-of-credit	Line-of-credit
0	$1,802,250	0	0	0	$500,257	0
1	0	0	$131,716	0	$1,030,951	$44,951
2	0	0	$131,716	0	$393,433	$340,872
3	0	$383,312	$131,716	0	$464,853	$213,257
4	0	$373,333	$131,716	$101,601	$421,602	$281,586
5	0	$448,491	$131,716	$183,571	$440,038	$306,833
6	0	$190,388	$131,716	$429,867	$263,099	$634,294
7	0	$274,295	$131,716	$195,849	$323,991	$377,261
8	0	$126,037	$131,716	$331,989	$180,851	$518,519
9	0	$159,443	$131,716	$137,185	$176,991	$286,449
10	0	$355,170	$131,716	$131,153	$340,351	$248,050
11	0	$188,520	$131,716	$304,823	$182,980	$430,999
12	0	$353,645	$131,716	$200,435	$310,901	$289,407
13	0	$648,831	$131,716	$296,154	$503,708	$282,747
14	0	$630,780	$131,716	$666,103	$238,006	$405,045
15	0	0	$131,716	$1,327,495	0	$1,525,335

5. Conclusion

One of the important factors that affect project profit is financing cost. Profit can be maximized if financing cost is minimized. The model proposed in this study results in a lower financing cost and higher profit compared to past finance-based scheduling models. In the proposed model, a long-term loan is considered in conjunction with a line-of-credit: (1) to avoid a large withdrawal from the line-of-credit, and (2) to reduce the interest paid on the contractor`s primary account. The proposed model can consider a predetermined or an undetermined credit limit. The proposed model provides an optimum financing schedule to increase the contractor`s negotiating power with a lender. It should be noted that an updated financing schedule can be obtained if the work schedule changes during the project.

This study has some limitations that can be eliminated in future research. First, although construction companies may run multiple projects simultaneously, the proposed model can be used only for a single project. Second, although delaying the start times of activities can result in a more critical schedule, it can reduce the financing cost. This tradeoff is not explored in this research. In addition, the performance of the proposed model is not evaluated relative to macroeconomic factors such as changes in government policies, and changes in market conditions caused by periodic recessions.

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