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Financing Cost Optimization in Construction Sector: A Review

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ABSTRACT

The main aim of this research is to introduce financing cost optimization and different financing alternatives. There are many studies about financing cost optimization. All previous studies considering the cost of financing have many shortcomings, some considered only one source of financing as a credit line without taking into account different financing alternatives. Having only one funding alternative powers, restricts contractors and leads to a very specific financing model. Although it is beneficial for the contractor to use a long-term loan to minimize interest charges and prevent a substantial withdrawal from his credit line, none of the existing financial-based planning models have considered long-term loans in their models or included a schedule of borrowed money and a repayment schedule with interest rates. The aim of this study is not only to eliminate the shortcomings of previous studies but also to incorporate a financing optimization model for various funding alternatives available to contractors in terms of funding sources and forms, cash provision times, interest rates and repayment options. This work proposes a financing optimization model, not only to remove the limitations but also to find optimal financing costs while offering the financing schedule without increasing the project duration and adjusting the starting times of the activities.

Keywords: Financing alternatives, Project financing cost, Cash flow forecast, Work schedules, Project financing optimization.

تكاليف التمويل المثلى في القطاع الإنشائي: مراجعة

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الخلاصة

الهدف الرئيسي من هذا البحث هو للتعرف على تكاليف التمويل المثلى وبدائل التمويل المختلفة. توجد العديد من الدراسات حول تكاليف التمويل المثلى ، وجميع الدراسات السابقة التي اخذت بنظر الاعتبار تكلفة التمويل بها العديد من أوجه القصور ، حيث

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نظرت بعض المصادر في مصدر تمويل واحد فقط كخط الائتمان دون مراعاة بدائل التمويل المختلفة. وأن النظر في بديل تمويل واحدة فقط يفرض قيودًا على المقاولين ويؤدي إلى تمويل جامد للغاية. على الرغم أنه من المستحسن أن يستخدم المقاول قرضًا طويل الأجل لتقليل رسوم الفائدة وتجنب سحب كبير من خط الائتمان الخاص به ، لم ينظر أي من نماذج جدولة التمويل الى قروض طويلة الأجل أو يوفر جدولًا للأموال المقترضة وجدولًا للأموال المدفوعة بما في ذلك الفائدة. الهدف من هذه الدراسة ليس فقط إزالة أوجه القصور في الدراسات السابقة ، ولكن أيضًا تقديم نموذج تحسين التمويل فيما يتعلق ببدائل التمويل المختلفة المتاحة للمقاولين من حيث مصادر وأنواع التمويل ، وأوقات المخصصات النقدية ، ومعدلات الفائدة ، وخيارات السداد. يقترح هذا البحث نموذجًا لتحسين التمويل ، ليس فقط لإزالة أوجه القصور ، ولكن أيضًا لإيجاد تكلفة تمويل مثالية مع توفير جدول التمويل دون تمديد مدة المشروع وتغيير أوقات بدء الأنشطة.

الكلمات الرئيسية: بدائل التمويل، تكلفة تمويل المشروع، توقعات التدفق النقدي، جدولة العمل، أمثلية تمويل المشروع.

1. INTRODUCTION

The most common causes of contractor failure are financial factors. If the financing cost exceeds the credit limit, the profit of the project may be reducing. Contractors need to use resources throughout the project as the manager maintains participation in many contracts to ensure the contractor completed the work properly. Therefore, the contractor will face financial problems and encounter deficits. Financial factors affect not only the cash flow but also relationships between participants in the project **(Lu, Won, and Cheng, 2016) (Al-Ageeli, Hatem and Alzobaee, 2016)**.

Since the execution of construction projects requires large investments, contractors borrow money from banks or appropriate lenders. They will have to pay interest on money borrowed or consider a percentage of total cost during the preparation of the bid. This method is based on a guess and will overestimate or underestimate **(Sears, S Keoki and Sears, Glenn A and Clough, Richard H and Rounds, Jerald L and Segner, 2015)**.

The contractor will not win the contract and will lose the money they disbursed to prepare the bid if the bid price is overestimating. Whereas if the price of the bid is underestimated, the contractor may remain in business, but due to the higher actual cost of financing, there may be a decline in profit or loss. Therefore, it is very important to properly estimate the financing costs based on the cash flow forecast of the project instead of taking into account the percentage of construction costs. **(Sears, S Keoki and Sears, Glenn A and Clough, Richard H and Rounds, Jerald L and Segner, 2015)**.

2. REVIEWING FINANCING TERMS AND METHODS FOR CONSTRUCTION COMPANIES

Financial organizations like to offer a financing alternative just as a package of several options, including savings accounts, checking accounts, lines of credits, and short and long-term loans **(Peterson, 2013)**. Contractors prefer to get a single source financing. Despite whether the financing is gotten from one or multiple sources, contractors are inclined to borrow money such that accomplishes their overall goals. Subsequently, the determination of the optimal financing schedule out of the alternatives offered by available financial organizations is essential for the profitable presence of construction firms; in this way, the combination of alternatives offered by financial organizations is in the interest of contractors to be considered. Among the most remarkable problems for construction companies is to keep up liquidity to support day-to-day activities **(Valance, 2012)**.

The absence of credit to perform day-to-day activities has brought about many construction companies leaving business rather than as opposed to the lack of technical capability to execute the project. Because of poor cash flow prediction, other construction companies have gone bankrupt and being unable to predict the required financing for the project, which brings about looking for unnecessary credit from banks or other lenders.

Therefore, difficulty in predicting and getting the required financing has made many construction contractors fail more often than businesses in other industries, and brought about the construction industry being delegated as a high-risk industry. It is difficult for contractors to borrow a large amount of funds, particularly from one single source of financing. This is much progressively difficult for small contractors since there are restricted alternatives offered by banks or other lenders without adequate collateral **(Valance, 2012)**. Usually, bankers or other borrowers need to see the cash flow forecast to ensure that the cash generated by the activities is sufficient to meet the obligation in addition to their interest **(Peterson, 2013)**. Also, it is essential for a building company to decide the financing necessary instead of leaving the lending institution to guess which credit is needed **(Peterson, 2013)**. To address the problems of forecasting and securing enough credit from banks or even other borrowers, first, the contractor should explore further sources and methods of funding, and second, the contractor should ensure the critical credit by giving the lenders a credible cash flow estimate, including financing costs. Many banks may need protection from con as well as specific cash flow forecasts. As well as accurate cash flow forecasts, some banks can need collateral from contractors as a guarantee for repayment. To consolidate the financing cost into the cash flow, first, the contractors should determine the potential banks and lenders, and then dependent on their terms of interest rate, repayment options, and credit limit try to foresee project cash flow including financing cost. It ought to be noticed that choosing banks and potential lenders necessitate the contractors to think about the alternative of financing methods and the differences.

Regarding the financing method for construction, there could be both long and short-term aspects. In the long term, financing should cover the mobilization, bonding, and some other costs that take place at the beginning of the project. In the short term, financing should cover the negative cash flow, which takes place because of the retainage and late payments of the owner. While a line of credit is the most widely recognized form of construction financing for small or medium size projects, other forms incorporate business credit cards, loans equipment financing, trade credit, refinancing, and personal savings **(Valance, 2012)(Fathi and Afshar, 2010)**. These mechanisms depending upon which one is selected, can be collateral intensive (secured) or unsecured. Methods of financing are discussed in the following sections.

2.1 Line of Credit (Overdraft Accounts).

A line of credit is flexible financing acquired from a bank or other alternative lender. It is a limited amount of funds with two options of repaying, immediately or over a pre-specified period. With a line of credit, the contractor can, at any time, obtain the defined credit as necessary **(Peterson, 2013)**.

A line of credit charges interest when money is borrowed. However, some banks charge interest even for unused credit **(Elazouni and Metwally, 2005)**. Moreover, lenders may charge the contractor drawing fees, maintenance fees, commitment fees, and other fees for a line of credit. Also, although lines of credit are considered to lower-risk methods of financing for short periods, contrasted with loans, they can be more complicated since money can be drawn and repaid on an unplanned basis, without realizing how much money will be borrowed across the life of the credit line **(Elazouni and Metwally, 2005)**.

The line of credit can be one of the perfect forms of meeting short-term needs. At the point when the contractor is on an uncertain schedule and requires ongoing cash procurements, this might be a good option. This kind of financing should not be used for long-term financing **(Alavipour and Arditi, 2018)**.
In most cases, the interest on a line of credit is not imposed deductible. Besides, a line of credit may have a variable interest rate, which implies that the total amount to be paid back will change over time with market conditions. This line of credit can be restored, provided that the contractor is in good standing. The line of credit can be utilized as overdraft protection when linked to a business account with a maximum overdraft limit forced. The features of a line of credit can be summarized as follows **(Peterson, 2013)(Elazouni and Metwally, 2005)**:

- Needs approval (harder to qualify compared to loans);
- In most cases, unsecured **(Simpson, 2018).** Lower interest rate is contrasted with unsecured loans.
- Usually, variable interest rate (changes with the market).
- Maintenance, transaction, commitment fee, and other fees (some however not all banks and lenders).
- In some cases, charge for unused credit.
- Different credit limits (higher credit limit results in higher interest rate).
- Appropriate for short-term, ongoing, and unexpected needs.
- Repayment promptly or over a pre-specified period of time.
- In most cases monthly interest payment.

2.2 Business Credit Card.

A credit card is used by a business than for private use. Banks are trying to attract business customers by giving them some benefits that might not be exactly the same as each other. Some business credit cards, for example, offer cashback on supplier purchases with which contractors are likely to interact frequently. There may also be some drawbacks to business credit cards. If the bill is not fully paid through the grace period (the period with no late fees, usually 15 days up to a month), the interest will be billed in the same manner as the credit lines. Therefore, if a business needs to borrow money for more than the grace period, another source of funding should be considered. **(Alavipour, 2017)**. Although business credit cards typically have lower interest rates than personal credit cards, they are generally a costly funding option compared to other forms of financing such as loans or credit lines. In particular, a secured loan is likely to have a lower interest rate as it requires collateral, which reduces the bank's risk. The attributes of **(Alavipour, 2017**);

- Includes approval (Easier than loans or credit lines to qualify).
- Unprotected (usually requires personal protection rather than collateral).
- Interest rates are higher than loans or credit lines.
- The rate of interest is adjustable (market changes).

2.3 Loans.

A lump sum of money is lent with a business term loan either once or in a sequence of loans with a fixed principal and interest repayment schedule. The duration and time of repayments are usually stated in the loan agreement **(Hendrickson, C. and Au, 2008)**. Loan benefits are different fixed repayment periods (as opposed to credit lines) with fixed (typically) or variable interest rates, secured (collateralized) with lower interest rates when compared to credit lines or unsecured with simple and fast cash access. If a loan has fixed interest rates and fixed repayment periods, the monthly payments

are the same at that point until the loan is paid out, making it easier for contractors to schedule and manage to finance **(Peterson, 2013)**.

In many situations, applying for a loan is easier than a credit line, because credit lines can be unsecured and are riskier for banks and other lenders. Also, contractors involved in large-scale projects own large assets. They can use their property as collateral and use loans with lower interest rates than credit lines **(Peterson, 2013)**; a third-party guarantee is another common provision in acquiring a loan. In this method, the company or person assets are used to guarantee the loan under a third-party guarantee. This provision is commonplace for a small company or a company without a good credit history. In any case, a third-party guarantee ought to be avoided where possible since assets other than the company's assets are in danger.

Loans can be extended for periods of three months to twenty years, and compared to credit lines that are usually renewed every six months to two years (as long as the contractors are in good standing'), a term loan is set for the predefined duration. Loans can usually be classified as short-term loans and long-term loans. Unlike long-term loans with fixed repayment periods of one year or more, in a much shorter period, For one year or less, a short-term loan used to fund short-term financial needs must be repaid **(Peterson, 2013)**. Although financial institutions usually are willing to lend money for a shorter period of time, long-term loans have typically been used to finance large projects **(Kramer and Fusaro, 2010)**. The features of a loan can be summarized as follows:

- Approval required (Easier to apply as long as one has appropriate collateral in comparison to the credit line) **(Peterson, 2013)**.
- Secured, in most cases **(Peterson, 2013)**;
- Lower interest rate on secured loans as compared with credit lines **(Hendrickson, C. and Au, 2008)**.
- The interest rate is normally fixed **(Peterson, 2013)**.
- No maintenance and no transaction fees however other fees such as application fees, processing fees, courier fees, and additional title charges known as closing costs (some but not all banks and lenders) **(Peterson, 2013)**;
- Different credit limits.
- Long-term and expected needs and repayments appropriate **(Peterson, 2013)**.
- Negotiated and prearranged series of loans **(Hendrickson, C. and Au, 2008)**.
- Negotiated and scheduled repayment of principal and interest payments, but typically monthly interest payments with repayment of principal at the end of the period (Hendrickson, C. and Au, 2008).

2.4 Equipment Financing. There are two categories of equipment financing: equipment loans and equipment leasing.

The equipment serves as collateral in the equipment loans, and usually, no other collateral is required by contractors to secure the loan. Many equipment loans are typically pre-approved and fixed-rate loans with the same monthly schedule of repayment.

In any case, the choice of variable rates is as well available. Equipment loans provide a low-risk funding option for banks. Banks for the most approved contractors within hours for 100% financing with no down payment and with the benefit of tax benefits and financing of up to 25% of the soft costs that could be covered by the financing ('i.e., sales tax, shipping, software, training, maintenance and

installation') **(Chase Bank, 2016**). Most equipment loans enable 62 contractors to deduct the monthly payments from their taxes as an operating expense. Payments can also be structured to enable a company to more reliably predict its monthly cash flow. Payments can also be planned to meet the contractors ' seasonal needs, e.g., weekly, quarterly, semi-annually, or annually **(Equipment Leasing and Finance Association, 2016)**.

In addition, numerous pieces of equipment can be financed with one application. Most banks allow contractors to make different transactions within 12-2 years, and at the time that transaction is done, lock the interest rate and terms. These offers make this type of financing safe, flexible, and low risk to the bank due to collateral for contractors. Such deals make this type of collateral funding secure and versatile and low risk to the borrower. For the life expectancy of the equipment, the APR for equipment loans can vary from 7% to 30%. The APR is based on the banking relationship of the client, collateral, credit history, and the loan term **(Chase Bank, 2016)(Equipment Leasing and Finance Association, 2016)**. Equipment loan features can be summarized as follows **(Chase Bank, 2016)**:

- Needs authorization (easier to apply as opposed to loans and credit lines)
- Secured
- Varying interest rate 100% of lending without a down payment and up to 25%. High Costs
- Prearranged payments schedule
- Multiple pieces of equipment are Financing in one application
- Multiple purchases within the period.
- Tax benefits

2.4 Trade Credit

This type of financing is an agreement between a contractor and subcontractors or suppliers **(Peterson, 2013)**. This type of financing can be used whenever there are a delay between the delivery of services and/or materials and the contractor's payment for services received or materials supplied. Even if a trade loan is granted for specific periods, some suppliers or subcontractors may offer a discount if construction companies pay their bills early **(Peterson, 2013)**.

This type of financing may void discounts offered by suppliers or subcontractors.

For instance, if a contractor pays within 15 days of the purchase, the contractor might get 3% discount, whereas if the payment is received in 60 days, the contractor might pay 3% more on the price of purchased goods. This type of financing is short term and allows the contractor to use the freed-up cash for other purposes.

2.5 Refinancing.

It is the replacement of an older loan with another loan under better terms, usually of the same size, and using the same collateral. Refinancing of debts could have some advantages for a contractor. The significant benefit of refinancing is that it allows a contractor to refinance at intermediate stages of a project to save interest charges. In other words, the agreement allows a contractor to refinance at a lower interest rate if the borrowing agreement is made during a period of high-interest rate **(Hendrickson, C. and Au, 2008)**.

3. FINANCING COST OPTIMIZATION METHODOLOGY

To create a cash flow forecast, a work schedule is needed, the cash flow forecast is required to find the minimum financing cost, and the minimum financing cost is necessary to reduce the bid price.

3.1 Creation of project schedule

The project begins when a client provides a work statement and when a project charter is defined. When the work schedule is planned, the project charter is an important input. The activities are first defined to create a work schedule using the schedule management plan and the baseline of scope. A list of activities, activity attributes, and a list of milestones is then prepared and used to sequence activities and create a schedule for a project network. The specifications for the activity asset and projections of the length of the operation are then estimated to create a project schedule **(Guide and Edition, 1996)**.

3.2 Creation of project cash flow forecast

Cost data and contract terms are input by the contractor, and cash outflow forecast (expenditure) and cash inflow forecast (income) are calculated when activity start and end times are calculated. The cash outflow includes direct and indirect costs, and the owner's payments are the cash inflow. The indirect cost is composed of fixed overhead, variable overhead, and mobilization and bonding **(Peterson, 2013)(Fathi and Afshar, 2010) (Al-suhili, 2015)**. The owner payments consist of periodic progress payments made after the retainage is deducted and the final payment that is made at the end of the project.

4. FINANCING COST OPTIMIZATION

To optimize funding costs, several alternatives are used to look at the relative costs of different funding schedules and to ensure adequate funding for the project to be completed. These options are classified into three categories: short-term borrowing, long-term lending, and a credit line **(Alavipour, 2017)**.

4.1 Short-Term Loans

Short-term loans are one-year or less term loans. Simple interest is often used instead of compound interest when calculating interest on a short-term loan. At the time the loan is issued, the interest on short-term loans paid. This is known as the interest discount **(Peterson, 2013)**.

Discounting interest increases the effective annual interest rate on loan by reducing the amount of the principal available to the borrower and requiring payment of the interest at the start of the loan **(Peterson, 2013)**.

4.2 Long-Term Loans

Long-term loans are typically acquired at the beginning of the project and should be repaid in one year or more. Some lenders demand a fixed amount charged monthly by the contractor, including interest and principal **(Peterson 2013)**, While others require the contractor to pay the principal interest as well as the compound interest at the end of the project. Both conditions can be dealt with in this study. It should be noted that if a creditor imposes a cap on borrowed money, the proposed model may consider a long-term loan limit. Otherwise, the proposed model must determine the optimal limit for a long-term loan **(Alavipour and Arditi, 2018)**.

4.3 Line of credit

The credit line can be the best way to meet the funding needs, mainly if the contractor is on an unpredictable schedule and needs to access the necessary credit at any time as long as the credit limit provided by the lender is not exceeded **(Alavipour and Arditi, 2018)**. In this experiment, the

proposed model will determine what amount and when to withdraw and return the money to the credit line account.

5. LITERATURE REVIEWS

All relevant studies carried out **(Fathi and Afshar, 2010) (Liu and Wang, 2010)** have identified only one means of financing, (a line of credit) without considering different financing alternatives in terms of funding sources and forms, interest rates, cash requirements periods, and repayment options. Construction financing costs are usually determined using a credit line only, as the credit line is one of the most common financing methods in construction projects.

Considering just one financing alternative, this gives rise to a very rigid financing model that enforces contractors ' limits. Borrowing a large amount of money from a single lender is daunting and ungratifying for contractors, despite the fact that it is covetable for the contractor to use a long-term loan to prevent a large withdrawal from his credit line and reduce changes in interest.

The proposed model differs from all past studies model in the following respects.

- All previous studies except those deemed to be a fixed credit limit for a credit line only, but a funding schedule may vary if optimum limits are assumed for each of several potential financing alternatives **(Fathi and Afshar, 2010)**.
- None of the scheduling publications focused on finance provide a schedule of borrowed money and a schedule of repaid money, including interest **(Alavipour and Arditi, 2018)**.
- The contractor may need to include a contingency plan to cover unforeseen expenses or unexpected changes in the projected cash flow **(Hendrickson, C. and Au, 2008).**
- A financing model would allow contractors to calculate the minimum total net cash flow balance, including funding stream, at the end of each period as contingency funds at the end of each year. Still, not all previous studies address this issue. **(Alavipour and Arditi, 2018)**.
- 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 **(Alavipour and Arditi, 2018)**.
- Some models were developed to quantify and reduce the price of the offer **(Chou *et al.*, 2015)** (**Kuyzu *et al.*, 2015**). None of them, however, find operating expenditures based on a cash flow estimate. Some other models are suggested to calculate the cost of funding based on a cash flow forecast **(Fathi and Afshar, 2010) (Elazouni and Metwally, 2005) (Liu and Wang, 2010) (Alghazi, Elazouni, and Selim, 2013) (Ali and Elazouni, 2009) (Al-Shihabi and AlDurgam, 2017) (El-Abbasy, Elazouni, and Zayed, 2016)(Elazouni and Gab-Allah, 2004) (Elazouni, Alghazi, and Selim, 2015).** Nevertheless, these models can only be used after the contract has been signed to find a timetable that satisfies the requirements of cash availability, not to determine the value of the deal. Therefore, a model is required not only to measure the actual cost of funding based on the cash flow estimate but also to decrease the cost of funding to reduce the price of the deal.

(1) Ali and Elazouni, 2009 (Finance-based CPM/LOB scheduling of projects with repetitive non-serial activities) **(Ali and Elazouni, 2009)**

The goal of this study is to combine cash flow models with the CPM / LOB methodology and use the integrated model to establish financially feasible schedules for repetitive non-serial activities projects. The optimized schedule generated by the model maximizes the benefit of the project within certain credit limits by a template. The model was created in [Microsoft Excel 2003, and the Excel plug-in of Evolver was utilized to implement the GAs technique].
The systematic implementation of the three CPM, LOB, and cash flow methods concurrently incorporates all applicable planning and financial factors and ultimately leads to the contractor's calculation of negative aggregate balance values in addition to the gain at the end of the project through the length of the project.
The sensitivity analysis model offers further insight into the relationships across a wide range of credit limits between credit limits and interruption amount parameters, CPM length, crew number, direct cost, funding cost, and overall project period. This review supports the model and offers further insight into the interaction of the various parameters.

(2) Liu and Wang, 2010 (Profit Optimization for Multi project Scheduling Problems Considering Cash Flow **(Liu and Wang, 2010).**

The objective of this study is to research cash flow for profit optimization and manages scheduling problems in a multi-project environment, and it handles cash flow and the financial requirements of contractors working in a multiple-project environment and suggests a profit optimization model for multi-project scheduling problems using constraint programming. Scenario analysis uses a scenario that requires three projects to explain the template, and the optimal plan to achieve the total maximum profit is carried out. Possible task restrictions, including due date and CL, are also assigned to the overall profit maximization scenario, and financial pressure is smoothed without delay by changing operation schedules. The proposed model, therefore, determines a convenient scheduling plan to achieve financial requirements for contractors related to multi-project scheduling issues. Furthermore, the system benefits contractors from a sensitive analysis in dealing with such scheduling problems. Under different conditions, project managers may analyze different schemes to find an overall benefit to improve the financial performance of the company.

(3) Eabbasy, et al , 2017 (Generic Scheduling Optimization Model for Multiple Construction Projects **(El-Abbasy, Elazouni and Zayed, 2017).**

The objectives of this study are to present the development of a multi-objective scheduling optimization model for multiple construction projects utilizing the fast elitist non dominated sorting genetic algorithm (NSGA-II). The proposed model aims to achieve optimal tradeoffs between the goals of different projects. The scheduling optimization model includes resource allocation and leveling sub-models, project scheduling, and cash flow forecasting .
Two case studies are used to illustrate the design capabilities under unconstrained resource and resource constraints to address integrated asset scaling, resource allocation, and funding-based scheduling issues for single and multiple projects. The model helps to build companies solve the problems of prioritizing resource conflict projects, allocating limited resources to multiple projects to meet the resource requirements of different projects, and balancing multiple goals within the cash limits of all projects.

(4) Alavipour and Arditi, 2019 (Maximizing expected contractor profit using an integrated model) **(Alavipour and Arditi, 2019).**

The goal of this study is to create an Integrated Profit Maximization Model (IPMM) that aims to maximize profit by using time-cost tradeoff analysis, adjusted start-up times, minimized funding costs, and minimized work schedule extension beyond contract length. By using MATLAB 2016a, IPMM is designed into an automated system and evaluated for various project durations, optimal approaches, different start-up/financing times, and alternatives to project financing.
The proposed model takes into account a deterministic timeline of the project, while the suggested model will be improved by stochastic time-cost tradeoff analysis. Therefore, resource allocation and resource balancing are not included in the proposed model, and future studies may be integrated into the model. The long processing time is, therefore, a serious challenge to be solved in future studies. Finally, Ultimately, under the impact of macroeconomic variables such as changes in government policy and adjustments to market conditions caused by frequent recessions, the performance of the proposed model can be evaluated. The proposed IPMM model is likely to allow contractors to survive and grow better than their competitors in this study.

(5) Elazouni and Arditi, 2018 (FINANCING COST USING A LINE-OF-CREDIT AND A LONGTERM LOAN) **(Alavipour and Arditi, 2018).**

The objective of this study is to integrate financing optimization into the scheduling function considering long-term loans and lines of credit simultaneously with normal activity durations. The model proposed provides optimum funding inflow schedules (borrowed money) and outflow schedules (principal and interest repayments).

The model proposed in this study results in lower funding costs and higher profits compared to past finance-based scheduling models. The proposed model involves a long-term loan paired with a credit line: (1) avoiding a significant withdrawal from the credit line and (2) reducing interest paid on the contractor's primary account.
The proposed model may consider a predetermined or undetermined credit limit. The proposed model provides an optimum financing schedule to increase the contractor's negotiating power with a lender. The model has been tested in two scenarios; Scenario 1 results in a lower financing cost when a long-term loan is considered in conjunction with a line-of-credit, whereas Scenario 2 results in higher financing cost 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, the profit is higher than the profit of the project if only a line-of-credit is used. Therefore, the contractor achieves higher profit if the proposed model is used. It should be noted that the financing costs are not only lower in Scenario 1, and the profit is higher than in Scenario 2, but the contractor can also avoid a large withdrawal on its credit line. The model works well as long as it is accurate for the original work schedule.

6. CONCLUSIONS

In this study, the researcher emphasized alternative financing costs and exploring the optimization of financing costs in the construction sector. This proposed model remove the limitation and find optimal financing costs while offering the financing schedule without increasing the project duration and adjusting the starting times of the activities. Furthermore, as shown in **Table 1**, the researcher compared between this study and previous studies. It recommended applying this research in Iraq since it is very important and has complete details regarding the subject of the research.

Table 1. Previous Studies comparison.

Study	Year	Country	Study Objective	Statistical Method	Methods Used
1- Finance-based CPM/LOB scheduling of projects with repetitive non-serial activities	2009	Saudi Arabia	1. Integrating cash flow models with CPM / LOB methodology and designing financially feasible schedules for projects with repeated non-serial operations using the integrated model.	none	Microsoft excel 2003, sensitivity analysis
Conclusions: It is found that the application of project management methodology increased the project's chance of success by a wide margin.					
2- Profit Optimization for Multi-project Scheduling Problems Considering Cash Flow	2010	Syria	1. To investigate cash flow for profit optimization and handles scheduling problems in a multi project environment.	Regression Analysis	sensitive analysis, profit optimization model, constraint programming

Conclusions: The proposed model defines an effective scheduling plan to meet the needs of financial contractors related to multi-project scheduling issues, and from sensitive analysis, the system assists contractors in resolving these scheduling issues. Under different conditions, project managers may analyze different schemes to find a beneficial overall scheme to boost the company's financial results.					
3- **Generic Scheduling Optimization Model for Multiple Construction Projects**	2017	Canada	1. Is to present the development of a multi-objective scheduling optimization model for numerous construction projects using the fast elitist non dominated sorting genetic algorithm	Pareto	Optimization model, CPM.
Conclusions: The model helps building companies solve the problems of prioritizing resource conflict projects, allocating limited resources to several projects to meet the resource requirements of different projects, and maximizing multiple goals within cash limits for all projects.					
4- **Maximizing expected contractor profit using an integrated model**	2018	USA	1. To create an Integrated Profit Maximization Model (IPMM) aimed at maximizing profit through the use of time-cost tradeoff analysis, modified start-up times, minimized financing costs and minimized work schedule extension beyond contract duration.	None	Linear programming, MATLAB2016a
Conclusion: It is likely that the proposed IPMM model would help contractors to survive and grow better than their competitors.					

5- FINANCING COST USING A LINE-OF-CREDIT AND A LONGTERM LOAN	2019	United Arab Emirates (UAE)	1. Is to integrate financing optimization into the scheduling function considering long-term loans and lines of credit simultaneously with normal activity durations. 2. The model proposed offers optimum funding inflow schedules (borrowed money) and outflow schedules (principal and interest repayments).	None	Optimization model, MATLAB2003a.
Conclusions: If the suggested template is used, a substantial withdrawal on its credit line can also be prevented by the contractor.					

NOMENCLATURE

CPM	Critical path method
CL	Credit limit
LOB	Line of balance

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