Cost and time reduction of concrete slabs construction by selecting the most economical structural design

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Abstract. In construction industry, projects are usually completed in a budget more than what is estimated for, finished in a time more than the contracted time, not executed properly according to the specifications, and not constructed with the client satisfaction. The thing that causes lowering the profits of contractors, clients losing, time to market prolonging, and other consequences. Projects execution on or under the budgeted money requires valid practices, precise decisions, good strategies, and needs developing new techniques, such as cost reduction technique. Thus, this paper mainly aims to relieving part of the big concerns of those who specialized in construction media respecting construction cost overruns by determining the most economical structural design, which can be realized by studying, quantifying, analysing cost, and comparing a number of structural elements with different dimensions, different design combinations, and different materials proportions. Then, the optimum structural element, the element that meets the design requirements, comprises the least materials quantities, and costs least, was selected in case to achieve an economical construction.

1. Introduction
Mantel et al. [17] clarified the main criteria by which the performance of construction projects can be measured, which are: is the construction project completed on or ahead of time, is the construction project finished within or under the estimated budget, is the construction project delivered according to the expectations of clients? The three criteria are known as performance targets. Hence, when any criterion of these criteria is not realized, then the construction project management is unsuccessful. Cost and time are the major parts of construction projects planning because they constitute the most frequent problems in the construction projects that are caused by various reasons as illustrated below by citing a number of published studies and performed surveys. A survey was conducted by Akalya et al. [5] to specify the reasons of time and cost overruns. They revealed that the main reasons of time overruns include high demand of quality, market rates of construction materials, and modifications and changes on contracts. While the major causes of cost overruns comprise changes in the prices of the construction materials, high cost of transportation, and changes in the specifications of the construction materials. Other factors were specified by other researchers; for example, Ali et al. [1] specified another factor that causes cost overruns, which is inaccurate estimation for the original projects cost. Subramani et al. [25] carried out a survey to specify the main reasons of cost overruns and found that slowness in making decisions, in adequate contract and schedule management, delays in providing projects designs, maintenance of wrongly performed works, and long period between time of bidding and design are the key reasons of construction projects’ cost overruns. Memon et al. [16] investigated the most affecting factors on the construction cost of MARA projects that comprise unsuitable management of construction
site, financial difficulties and cash flow, wrong scheduling and planning, not sufficient experience of contractors, and deficiency in the number of site workers.

In the industry of construction, competition has been noticed to be increased sharply. That is because the world economic has been growing slowly, rigid cost has been rising, inflation has been causing very much pressure, credit policy has been deflated, etc.; the thing that raises the competition of prices in the construction media, consequently increasing the necessity for a good management of cost [27]. Moreover, clients are constantly demanding construction of projects with a better performance and high quality with lessening the construction prices, emphasizing the need of controlling cost of construction and the need of adopting techniques of reduction of cost [6]. Since construction materials represent the most dominating role in the projects construction where cost of equipment and materials contributes about 70% of the total project cost [26], therefore when they are duly controlled then the overall project cost can be reduced [9].

Therefore, authors of this paper intended by conducting this study lowering cost of construction of concrete slabs by adopting the technique of selecting the most optimal slab as a technique of cost reduction. Next, for this study, four scaled concrete slabs that were designed differently to provide an impact load ranging from 6.5 kN to 7 kN were used and studied after verifying experimentally their validity of providing the design loads [2]. The four slabs were designed differently by changing a number of design parameters, such as slabs’ concrete content and steel fiber content. After that, the four slabs were quantified, priced, and compared to pick up the optimum slab, which is the slab that realizes the design requirements, comprises the least quantities of the construction materials, costs less, and saves time of construction to achieve by that an economical construction.

2. Types of costs

It is important to mention that cost control does not mean only recording data or monitoring costs, but also it means analyzing data to apply the corrective actions at the right time. Therefore, good cost control requires good cost management that should include: cost estimating and accounting, project and company cash flows, and direct labor and overhead costing [10]. Therefore, when a construction project is launched, there would be a necessity to establish the project financial base-line or project cost where its preparation relies principally upon the six factors mentioned in the previous paragraph then the project status can be specified and measured. Harold [10] illustrated the cost breakdown in Fig. 1.

![Figure 1. Costs breakdown [10].](image)
It is necessary to understand the breakdown of costs to ease cost control of construction projects. Time-phased budget is the summation of all cost accounts, and the cost baseline is the summation of time-phased budget and undistributed budget, which is linked with the contract changes. Management reserve is needed and added to the cost baseline to be used when there would be changes in prices of construction materials, changes in salaries, changes in the rates of overhead, or for unexpected problems that may happen during projects construction.

Next, the summation of costs shown in Fig. 1 or total work cost comprises direct and indirect costs. Total direct costs represent the directly chargeable costs, such as cost of material, labor, and equipment. Indirect costs are administrative costs, and can be divided into home office and job overheads costs. Home overhead costs may include office rent, bills, taxes, furnishing, salaries (estimators, secretaries, purchasing agents, etc.), advertising, donations, ravel, etc. while job overhead costs comprise salaries of superintendents, foreman, security personnel, etc.

3. Influencing factors on cost of construction

After reviewing a number of published studies and surveys, common factors were indicated to have a distinguishing mark on the accuracy of cost of construction, and consequently on the total cost of projects, which include [12, 16, 18, and 24]:

3.1. Sources of pricing data

To estimate accurately cost of a project, the best reference to be adopted for estimating the new project is cost of a similar project that is constructed previously. In fact, some estimators consider the historical data for their estimation, but in this case, these estimates could be misleading where a lot of differences that can affect the accuracy of estimation, such as difference in the location of projects, difference in the weather conditions, difference, in the projects specifications, difference in locations of sources of construction materials, etc. Therefore, an adjustment is needed for the estimated cost of the new project by depending the cost of previous project after considering the differences between the two projects. In this case, the estimator will specify the value of a factor to know how much approximately should lower or increase the estimated cost of the new project.

3.2. Cost of construction materials

Cost of construction materials comprise cost of the material itself, freights cost (In factory or warehouse), cost of uploading and transportation of the construction material, cost of material handling (cost of the uploading and hauling equipment), storage cost, taxes, and insurance cost (covering any losses until the final installation). Therefore, it would be important to consider any variation in any cost of these cost combinations at the time of cost estimation to avoid increasing the construction project cost.

3.3. Wage rates of labor

Wages of labor change from a country to another, from a state to another, from city to another, and from a period to another. In addition, other factors should be considered when calculating wage rates like union payments, and insurance benefits where these change as well depending on geographic location of the project. So that, wage rates should be considered in the estimation of cost of a project. When cost estimation is prepared for a project that will start after a number of months, then this estimation should keep updated to take in consideration the changes in the wage rates.
3.4. Conditions of construction site
Cost of construction projects can be increased because of abnormal site condition. These unusual conditions may be related to weather conditions, properties of site soil, or others. For example, poor conditions of site soil like wet soil, high levels of pollution at site, high level of ground water at site location, heavy traffic, vestigial sites, buried tanks, environmentally sensitive construction site, crossing utilities like overhead pipes, cables, buried pipes, etc. If these conditions are not carefully considered at the time of cost estimation, then the cost of the construction project could be increased.

3.5. Inflation
Execution of some construction projects lasts for a number of years, and over this period prices of construction projects’ resources, such as equipment fleet, labor, and construction materials, tend to increase. That is what is known as inflation, and must be taken in consideration by the estimator of the project.

3.6. Scheduling techniques
Scheduling techniques were mainly developed to handle the firm deadlines, data, and increasing complexity of construction projects. In addition, their importance shows in illustrating the projects’ cost data where cost of construction projects is influenced principally by the project’s duration. Increasing the duration of construction projects results in the cost of projects because of happening increase in the indirect costs, while reducing cost of construction projects causes increasing in the direct costs. Thus, intelligently scheduling of projects’ activities could save cost of construction.

3.7. Plans and specifications’ qualification
When plans and specifications of construction projects are wisely prepared, then the projects objectives will be well understood, the work that is required to be performed will be defined to all involved parties, all the required resources can be allocated, a safe construction site will be obtained, efficiency in project completion will be increased, the projects activities will be more coordinated, an accurate schedule is gotten, the process of monitoring and controlling the projects execution will be easier. As a result to good projects planning and specifications, the cost and time of construction projects can be reduced.

3.8. Insurance
Also, estimator should count special costs that are associated with government supplies as part of cost of construction projects. For instance, cost of insurance needed for covering any losses till final stages of installation, cost of insurance of special storage, and cost of insurance required for special security measures basing on type of project and specified requirements.

3.9. Availability of workers
In case of a construction project is a big project, then workers availability becomes the main factor for rate of productivity. If work that should be accomplished, but you don’t have the suitable number of local workers to finish it, then you will have to call foreign workers. Additionally, if work needs professionals or skilled workers whom are not available, then skilled workmen should be brought from abroad. In these cases, extra costs will be needed to build up the project within the required quality.

3.10. Location of project
How far is the site of construction project from the sources of construction materials? Is the site of project is plane or sloped? These questions must be answered at the time of estimation where extra costs will be needed when the sources of construction materials are far away from the location of construction
project, or when site of project is sloped. These extra costs are required for transportation of all of materials, equipment, workman, etc.

3.11. Contingency
It is like an excuse for not performing a good estimation. Its importance appears when estimator of the project does not estimate everything. In some projects, it is not allowed to add a percentage to the total project cost as contingency, but in others about 10% is added. Its range should be within the acceptable range by the project’s owner. Moreover, it can be used for the scope changes, making allowance for the unforeseen risks or circumstances associated with the construction projects.

3.12. Lack of communication
Good communication between all parties of construction projects plays a key role in lowering cost of projects. For instance, additional held meetings before bidding, giving more time for contractors for performing bidding, providing additional drawings, providing additional plans, and supplying extra details at the bidding time can help in providing more understanding of projects for contractors, resulting in submitting more accurate bids. On the other hand, poor coordination between the projects parties could results in problems, poor selection of materials, weakness and slowness in taking decisions, and poor management, consequently causing increase in cost of projects.

4. Techniques of cost reduction
Many techniques were developed by a number of researchers all around the world to reduce cost of construction projects. Since, developed countries care about economy, therefore, there was a significance to put in use the most durable, energy saving, and environment friendly materials, in addition to the importance of developing appropriate technologies that save time and cost of construction of projects. In this section, a summary regarding the most efficient techniques of cost reduction of construction projects are included.

4.1. Value engineering
Value Engineering (VE) is a systematic application of engineering economy where its overall effort is aimed to a particular analysis of each function of a service or product [3]. Then, it would eliminate or modify anything that may increase the cost of project without increasing its functional capabilities. By applying the concept of VE, the most value of every dollar of cost can be obtained. Thus, VE is considered an effective technique to reduce cost without reducing the required quality. VE always looks for using materials with a less cost and weight, design with less processing and less number of pieces, and pursues a shape that is easy to be manufactured. Value engineering technique was applied on projects of buildings construction in the Middle East and West Africa, which helped the management team of projects in getting a solution that assures the projects functions with great helping in making the final choice, resulting in projects cost effective design.

4.2. Materials management
Materials management can be defined as “an integrated process that consists of procedures, technologies, organizations, and people put to use to efficiently identify, quantify, acquire, expedite, inspect, transport, receive, store, and preserve materials, equipment, and associated information across the life cycle of a capital project” [7]. Materials management is a pivotal part in projects management where materials share more than 60% of projects total cost. Materials management influences the whole performance of project since the success of construction projects depends mainly on delivering materials at a reasonable cost and on time [14]. Projects’ cost raises when materials poorly are identified or planned. Moreover, when there is a deficiency in the storage of construction materials, then labor
productivity will suffer losses. Thus, to effectively manage the construction materials, to supply equipment and materials on time, and to lower projects cost then there is a necessity to prepare a good planned program of materials management.

4.3. Budget control
A budget in business can be defined as official terms of the expected outcomes and incomes for a definite period [4]. Budget control focuses on the effective usage of project resources to realize the predetermined objects comprised with a plan [15]. It is a systematic process where the budgets are put to use as means of cost controlling and planning. Hence, manufacturing organisations use it as a way for cost control; where it is a methodical review for the resources of companies to achieve their principal goal of profitability. Therefore, it is also referred to as cost management. Projects’ cost control is a continuous procedure that starts with the annual budget. When projects execution starts, the involved management begins with comparing the actual results with the estimated in the budget to put a new plan; depending on the experience, the current operations would be evaluated. Through process of budgeting of cost control, management sets all objectives, specifies centers of responsibilities, identifies the responsibility of each center, then puts procedures of reporting and evaluating. To control effectively cost of a project, budget should be constructed because it draws a road map to direct the efforts of the involved management and to access effects of techniques of cost control on the expected revenues.

4.4. Techniques of optimization
Optimization is a methodical process conducted to rise profit margins and to get the best outputs under given situations and circumstances. The concept of optimization requires developing a mathematical model that comprises the objective function, which is the function that is needed to be minimized like cost or maximized like profit, and a number of constraints. Optimization can be performed at any stage of construction projects stages, where it can be performed during the design stage of a project or during the execution stage to keep cost of construction within the estimated costs and to maximize profits. Additionally, different techniques of the mathematical programming are available to optimize not only cost of projects, but they can be used to optimize critical decisions, schedules, quantities, etc. These programming techniques include linear, integer, dynamic, stochastic, and others. Regarding cost optimization, many methods of cost optimization have been applied by different companies and organisations, and some of them have not endured. Cost optimization is a difficult and expensive process. Three types of cost optimization can be utilized for cost optimization, such as by subdividing by details, by comparing with standards of costs, and by integrating with other functions [20].

Moreover, other researchers have conducted other optimization techniques to lower cost of construction projects as summarized in this paragraph. Zho et al. [28] applied a number of algorithms and methods to optimize schedules of construction projects, such as Metaheuristic, and Heuristic methods. Said et al. [23] developed a new model for planning construction logistics and to ease the process of integration and optimization of materials procurements decisions and materials storage decisions at construction sites. Kale et al. [13] applied the optimization technique of nonlinear programming to optimize the used materials like concrete and steel. Sarma et al. [21] used Reliability Theory for optimization concrete structures cost. Naik et al. [19] used the Artificial Neural Networks to optimize total cost of projects by increasing productivity and forecasting costs of resources. Dehmourdi [8] developed a mathematical model to optimize the cost of transportation of equipment.

4.5. Techniques of cost reduction at site
A number of techniques can be used during execution stage as a way for cost reduction. For instance, progress of executing of work can be monitored by using schedules. Work can be inspected and compared with the estimated budget. Meetings including all the involved parties in performing work
can be held to review work progression and to motivate all the participated parties like stake holders and workers to enhance their performance. Additionally, documenting all the implemented activities and keeping recording all performed actions at site can help in finding out deviations from the standards that are set up in advance. Moreover, work cost and quantities can be compared with bill cost and quantities to evaluate the executed work and to assess work progress.

5. Concept of cost reduction
As mentioned previously, cost reduction could be done at the design stage of life stages of construction projects to make sure that cost of a project will not exceed the estimated limits of costs. Hence, authors of this paper conducted a study to lower cost of construction of concrete slabs by choosing the slab with a design combination that meets the structural requirements, and at the same time that is least quantified, which is an example about cost reduction at the design stage. Also, another purpose will be realized by adopting the technique of quantification of the concrete slabs which is time of construction can be reduced by selecting the optimal design combination, which is another important thing in the construction industry. Saving time of execution of construction projects can be beneficial where it serves as a bonus of early execution, or it helps in saving projects overheads. Therefore, it is very important for the construction companies to take in consideration both factors: cost and time; optimizing both of time and cost is the extremely encouraged and preferable where the tender with the lowest price could not the only criterion for the success of projects.

5.1. Methodology
The four scaled concrete slabs are designed differently to provide a resistance to impact loads with a range of 6.5 kN to 7 kN. Therefore, some design parameters are changeable. For example, thickness of slabs, percent of content of steel fiber, and content of the other ingredients like cement, sand, silica fume, and glenium are different for the four slabs. Thus, the various design combination must be well studied. Next, the four slabs should be quantified; the quantity of each ingredient used for casting these slabs should be calculated. After that, cost of each slab should be specified by summing up the costs of its ingredients. Finally, the slab with a design combination that costs least should be selected.

5.2. Slabs’ details
In this section, the details of slabs are included. The details comprise dimensions of slabs, thickness of slabs, content of steel fiber, quantity of concrete, and quantity of steel fiber. Tables 1 through 4 include the details of design combinations of slabs 1, 2, 3, and 4, respectively.

| Table 1. Details of design combination of slab no. 1. |
|-----------------------------------------------------|
| **Size of slab** | (800X800) mm |
| **Thickness of slab** | 60 mm |
| **Steel fiber content** | 0.5% |
| **Quantity of concrete** | 0.0384 m3 |
| **Quantity of steel fiber** | 0.177 Kg |
Table 2. Details of design combination of slab no. 2.

| Size of slab | (800X800) mm |
|--------------|---------------|
| Thickness of slab | 80 mm         |
| Steel fiber content | 0.5%         |
| Quantity of concrete | 0.0512 m³   |
| Quantity of steel fiber | 0.236 Kg    |

Table 3. Details of design combination of slab no. 3.

| Size of slab | (800X800) mm |
|--------------|---------------|
| Thickness of slab | 40 mm         |
| Steel fiber content | 1%            |
| Quantity of concrete | 0.0256 m³   |
| Quantity of steel fiber | 0.24 Kg      |

Table 4. Details of design combination of slab no. 4.

| Size of slab | (800X800) mm |
|--------------|---------------|
| Thickness of slab | 40 mm         |
| Steel fiber content | 2%            |
| Quantity of concrete | 0.0256 m³   |
| Quantity of steel fiber | 0.471 Kg     |

5.3. Cost and time calculations
This section includes the cost and time details of each slab of the four slabs. Table 5 comprises cost of steel fiber, cost of concrete, and total cost for each design combination.

Table 5. Construction materials’ cost of various design combinations.

| No. of Slab design combination | Cost of steel fiber, C | Cost of concrete, C | Total cost, C |
|--------------------------------|------------------------|---------------------|---------------|
| 1                              | 19.43                  | 1092.18             | 1111.6        |
| 2                              | 25.96                  | 1464.24             | 1490.2        |
| 3                              | 26.40                  | 728.600             | 755.00        |
| 4                              | 51.81                  | 728.490             | 780.30        |

In addition, Fig. 2. illustrates cost of the four design combinations (cost of ingredients).
Next, to get an idea regarding savings in labor time and cost as a result to using more fibers in two design combinations, the ratio of area of formwork per one cubic meter of concrete is estimated, and then the area of formwork of each scaled slab, time of work, and cost of work are estimated. After reviewing a number of references and websites, the following ratios and estimates are specified. The ratio of area of formwork to concrete volume is about 6.67 m$^2$/m$^3$, the labor time of concrete formwork is nearly 0.7 wh/m$^2$, and the cost of labor of concrete formwork is 460 cent per square meter [11, 22]. Hence, by considering design combinations with slab thickness 40 mm (design combinations No. 3&4) as reference, the increase rate in formwork area and labor time of the design combinations No. 1 & 2 were found to be approximately 53% and 100%, respectively. Additionally, cost of formwork labor of each design combination is illustrated in Fig. 3.

![Figure 2. Costs of different design combinations.](image)

![Figure 3. Costs of labor of concrete formwork.](image)
6. Results discussion
As it is clear from the outputs shown in Fig. 2, the slab’s design combination No. 3 is the most economical one. In this slab, the quantity and cost of concrete were the least, and cost of steel fiber was the second highest cost among the other slabs. Hence, the importance of adding steel fiber material to the ingredients of concrete plays a key role in saving time and cost of construction. SF material reduced the quantity of concrete, consequently reduced cost of construction materials and cost of labor needed for formworks, see Fig. 3. Moreover, the reduction in the quantity of concrete resulted in less dead loads, so that, less cross sections of all beams, columns, and foundations are required, saving more cost of construction. In addition, time of construction is saved as a result to the reductions in the cross sections of the structural elements where less labor time is needed, and less overheads costs are required as a result to that.

Furthermore, adopting techniques of cost reduction in construction projects would help a lot in recommending the most optimum design combination for those who are interested in design buildings, reducing time and effort of buildings design, and consequently buildings will be ready for bidding in a less time improving by the that time to market.

7. Conclusion
Four scaled slabs with the same dimensions that are designed differently to provide an impact load ranging from 6.5 kN to 7 kN by varying a number of parameters, such as thickness of slab, and percentage of content of steel fiber were used for this study. The desirable design combination among the other design combinations of the other slabs is selected by selecting the most economical structural design depending on the parameter of cost of construction. The most economical structural design combination was selected after studying, quantifying, analysing cost, and comparing a number of structural elements. The obtained outputs of this study produced an economical and a time saving construction where the slab design combination with an acceptable resistance to the applied impact loads, with the least concrete quantity, and least cost was chosen, resulting in saving all of cost of construction materials, cost of labor, overhead costs, and time of construction.

8. References
[1] Ali A S and Kamaruzzaman S N 2010 Cost performance for building construction projects in Klang valley, JBP, Vol. 1, pp. 110-118.
[2] AL Zahid M A A 2016 Impact resistance of cambered reactive powder concrete slabs with steel stiffeners, PHD Eng. thesis, Babylon University, Babylon, Iraq.
[3] Attarde P M 2016 Application of value engineering in commercial building projects, IILTET, vol. 6, pp. 286-291.
[4] Akeem L B 2017 Effect of cost control and cost reduction techniques in organizational performance, IBM, vol. 14, pp. 19-26.
[5] Akalya K, Rex L K, and Kamalnataraj D 2018 Minimizing the cost of construction materials through optimization techniques, IOSRJEN, vol.1, pp. 29-33.
[6] Barbole A N, Nalwade Y D, and Parakh S D 2013 Impact of cost control and cost reduction techniques on manufacturing sector, ISRI, vol. 3, pp. 1-8.
[7] Caldas C H, Menches C L, Reyes P M, Navarro L, and Vargas D M 2015 Materials management practices in the construction industry, Practice Periodical on Structural Design and Constructio, vol. 20.
[8] Dehmourdi S A M 2014 Optimization of construction cost applying advanced techniques, ISCER, vol. 3, pp. 48-54.
[9] Georgekutty C K and George M 2012 Research methodology for material optimization in construction projects, IJERT, vol. 1, pp. 1-19.
[10] Harold K 2009 Project Management, 10th ed., Hoboken, New Jersey.
[11] Hofstadle C 2010 Calculation of construction time for building projects – application of the monte carlo method to determine the period required for shell construction works, CIB World Congress, pp. 1-12.
[12] Ivan D, Stuart A, Andrew W, Kenneth F R, and Devanshu P 2009 Evaluation of ways and procedures to reduce construction cost and increase competition, Texas A&M University, Texas, Tech. Rep. 0-6011-1.
[13] Kale R F, Gore N G, and Salunke P J 2014 Cost optimization of R.C.C. T-beam girder, IJSCE, vol. 3, pp. 184-187.
[14] Koriom N K, Brahim J, Zakaria I, Kaish A B M A, and Mohsen M 2019 The State of the art of materials management research in the construction industry, in M ATEC Web of Conferences, pp. 1-6.
[15] Lucey T 1996 Management Accounting, 4th ed., London: Continuum Publisher.
[16] Memon A H, Rahman I A, Abdullah M R, and Azis A A A 2010 Factors affecting construction cost in mara large construction project: perspective of project management consultant, IJSCE, vol. 1, pp. 30-35.
[17] Mantel S J, Meredith J R, Shafer S M, and Sutton M M 2011 Project management in practice, 4th ed, United States: John Wiley & Sons. Inc.
[18] Mahadik U A 2015 Cost reduction in construction projects, IJETMAS, vol. 3, pp. 397-400.
[19] Naik G M and Kumar M 2013 Project cost and duration optimization using soft computing techniques, JAMS, vol. 1, pp. 299-303.
[20] Rajguru A and Mahatme P 2016 Effective techniques in cost optimization of construction projects, IJIFR, vol. 3, pp. 1645-1658.
[21] Sarma K C and Adeli H 1998 Cost optimization of concrete structures, JSE, vol. 124.
[22] Shabbar R, Noordin N, Dawood E T, and Sulieman M Z 2010 Comparison between ribbed slab structure using lightweight foam concrete and solid slab structure using normal concrete, CJCRRL, vol. 1, pp. 19-34.
[23] Said H and El-Rayes K 2011 Optimizing material procurement and storage on construction sites, JCEM, vol. 137, pp. 421-431.
[24] Shanmugapriya S and Subramanian K 2013 Investigation of significant factors influencing time and cost, IJETAE, vol. 3, pp. 734-740.
[25] Subramani T, Sruthi P S, and Kavitha M 2014 Causes of cost overrun in construction, IOSRJEN, vol. 04, pp. 01-07.
[26] Patel K V and Vyas C M 2011 Construction materials management on project sites, in Proc. NCRTET, pp. 1371-1378.
[27] Tang J, Zhang M, Tang H, and Chen Y 2015 Research on cost management of construction project based on activity-based costing, in CMES, pp. 51-54.
[28] Zhou J, Love P E D, Wang X, Teo K L, and Irani Z 2013 A review of methods and algorithms for optimizing construction scheduling, JORS, vol. 64, pp. 1091-1105.