

The adopted ways in reducing construction costs considering quality requirements

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Abstract

This research aims to identify the adopted ways to reduce construction costs without prejudice to the quality requirements. The study adopted the descriptive qualitative approach, by reviewing the relevant studies and literature. The results of the research indicated that the cost reduction without compromising the work quality is through cost management processes, as these processes provide a way to reduce costs without compromising the quality. Among the most important of these processes are activity-based costing, target costing, value engineering, materials management, budgeting, cost optimization techniques, on-site cost reduction techniques, and Lean Construction System. The study recommends the need to achieve integration between these systems to enhance the utilization of them.

Keywords: Construction costs, cost reduction, cost management, construction projects, quality management, quality standards.

Introduction

The construction sector is one of the most important economic sectors that contribute to achieving economic growth and development in general. It provides a job for a large number of competencies and work force, and works to provide a very large number of development requirements from projects, infrastructure, and others (Nwokenkwo & Chinedum, 2019, p. 82). The construction process is linked to many determinants, including cost, time, quality, and safety (Wong & Ahmed, 2018, p. 707). The success of construction projects in general depends on the ability to manage these determinants and complete construction projects within the specified costs and schedules in parallel with maintaining Quality and Public Safety standards (Hafez, Aziz, & Elzebak, 2015, p. 17). Therefore, the construction project management process is concerned with applying all skills, knowledge and techniques to implement projects with high efficiency and effectiveness within the criteria of cost, time and quality, which are the fundamental pillars on which project management operations are based (Othman & Rashed, 2016, p. 9).

Some construction projects adopted the cost criterion in determining the level of success of the project, after monitoring the huge overspending in the allocated budgets, which in some of them amounted to more than (50%) of the costs. This overspending is often attributed to poor planning, lack of organization and coordination, non-compliance with schedules, miscalculation of costs, great waste of resources, risks mismanagement, in addition to costly activities that do not enhance the benefit of the business. As a result, companies began to move towards changing the traditional systems used in cost management and moving towards modern methods and systems capable of reducing and managing construction costs without prejudice to the quality of work and the implementing projects schedules (Toosi & Chamikarpour, 2021, p. 32; Sathish & Basker, 2020, p. 48). Based on the foregoing, this research came in line with these trends, in identifying the ways used to reduce construction costs without prejudice to the construction work quality.

The problem of the research

The nature of work in the construction sectors includes many practices and activities that do not bring value to the final product, in addition to large amounts of waste of resources and an increase in the rework number (Kale, et al., 2018, p. 1528). These practices usually appear as a result of poor project management and lack of planning and coordination processes that ensure the progress of the construction process in its chains without interruptions and delays in completing the work (Mahadik, 2015, p. 397), which leads to the incurring of many additional costs and financial burdens, and this explains why many construction projects have significantly exceed their planned budgets (Toosi & Chamikarpour, 2021, p. 32). In the light of the competition increasing among construction companies and their desire to implement projects with reasonable

costs and high quality, they must adopt methods to ensure increase the efficiency of their outputs and improve the progress and delivery of projects according to schedules and specifications without additional costs and even reducing them to the lowest possible level (Wawak, Ljevo , & Vukomanovi´c, 2020, pp. 1-2). With the desire to reduce costs without compromising quality standards and considerations, the research problem was to identify ways to reduce construction costs without prejudice to quality recommendations.

The questions of research

The study seeks to answer the following main question: **What are the ways to reduce construction costs considering quality requirements?** From which the following research questions emerge:

1. What are the construction costs?
2. What are the factors affecting the determination of construction costs?
3. How is quality management in construction projects?
4. What are the methods of cost management in construction projects?

The importance of the research

The importance of the study stems from the importance of the appropriate managing of the costs in construction projects, where construction projects are characterized with their several stages, complexity and high risk, which may cause a significant and unexpected overspending. Therefore, it is important to apply systems that help manage costs in a way, without prejudice to the quality of work.

The approach of the research

The study adopts the descriptive qualitative approach, through reviewing the Arab and foreign literature and studies, which are related to the field of construction costs, and how to manage them to reduce them to the lowest possible level without prejudice to the quality of construction work.

First: Construction costs:

The concept of constructural costs or construction costs is used to describe the direct and indirect costs of carrying out construction works. It is a tool for spending resources for the project, and providing human resources such as consultants, engineers and labor, and material resources such as machines, building materials, hardware, software and others for the projects implementation (Akalya, Rex, & Kamalnataraj, 2018, p. 29). Construction costs are classified into three forms; First: Fixed Costs: They refer to costs that do not change during the project's life cycle, such as the costs of excavators and equipment used. Second: Direct costs, which are the expenses related to the project work stages and are identified within the budget. For example, if a group of developers

is hired to develop a certain part of the work, the salaries of these developers or the amount determined for their services are considered direct costs (Mahadik, 2015, p. 397). In addition, there is another type of costs that can be avoided, which are the sunk costs, they are the costs incurred by the project but do not produce any added value for the work for achieving its objectives (Sathish & Basker, 2020, p. 85).

The (Akalya, Rex, & Kamalnataraj, 2018, pp. 29-30) study classifies construction costs into direct and indirect costs. Direct costs are related to the costs that can be determined in a specific way, which are the costs of the resources used in the various activities, such as the cost of building materials, labor, contractors and others. As for the indirect costs, they are related to overheads, which are costs that cannot be specified clearly and specifically. They include site management and supervision, offices, storage sites, transportation vehicles, and public labor that is not specialized in production, such as labor used in the development of specific parts.

The process of estimating construction costs and the amount of these costs is affected by many factors that can be clarified through the study of (Sathish & Basker, 2020, pp. 85-86; Mahadik, 2015, pp. 398-399; Akalya, Rex, & Kamalnataraj, 2018, p. 30) as follows:

1. **Similar construction projects:** Similar construction projects are the best reference for calculating the cost of new construction projects. When estimating this cost, the final cost of similar projects should be taken into account, taking into account the current construction cost indicators.
2. **Building materials costs:** The cost of building materials consists of the cost of materials, transportation charges and related taxes, taking into account differences while calculating the cost of building materials.
3. **Labor wages:** Labor wages vary from place to another, and the local wages rate and possible variation in wage rates should be taken into account when starting work.
4. **Construction site conditions:** Some conditions of the construction site increase costs, such as the costs of poor soil, the high humidity land, and buried pipes and cables. Some sites are also characterized by their high environmental sensitivity, the presence of groundwater, heavy traffic, archaeological sites or monuments, which requires taking special measures to deal with them, and therefore their presence may increase the cost of projects.
5. **Inflation factor:** Construction projects are characterized by their long duration of implementation. During this period, countries may witness a difference in the purchasing power of the currency, and accordingly, a large discrepancy may occur among the prices of tools, equipment and labor costs, and therefore the difference in prices and purchasing power of the currency should be taken into account during the cost estimation.

6. **Project schedules:** The construction cost is affected by the duration of the project implementation. Increasing the project duration increases the cost of the construction project due to the increase in indirect costs. Reducing the cost estimate also increases the project cost due to the increase in direct costs. Therefore, it is important when estimating the cost to take into account the project schedules and estimating the compatible cost with them.
7. **The quality of the planning process and setting specifications:** The quality of the planning process and the accurate identification of the required construction specifications affects the reduction of construction time. Smooth workflow and proper implementation contribute to the delivery of work without delay, and on the other hand, any poor planning and confusion during implementation processes contributes to delaying delivery, which leads to additional costs and financial burdens.
8. **Reputation of the engineer:** projects run more smoothly when the contractor works with an engineering company with a good professional reputation. The smooth running of construction projects contributes to completing the project without delay, and thus is more cost-effective.
9. **Regulatory requirements:** they refer to approvals and licenses from regulatory agencies, obtaining them in some countries may be complicated and expensive, and these costs should be taken into account during cost estimation.
10. **The size and type of the construction project:** Some large projects require a large number of labor, and may require some qualified human elements with special skills that may not be available in local labor, which requires the recruitment of a number of workers from different regions, thus increasing the financial burden and the necessary costs.
11. **Project location:** The projects location in areas far from services increases costs, due to the increase in the costs of transporting labor, equipment, and others.

Second: Quality management in engineering projects

The concept of quality is one of the most prevalent concepts in the business environment. It expresses the products suitability for using and their ability to meet specifications and standards that ensure customer satisfaction and achieve their aspirations (Syaj, 2015, pp. 17-18). Quality is defined as the characteristics and components that the product has and affect its ability to meet specific requirements that contribute to meeting customer requirements (Othman & Rashed, 2016, pp. 9-10).

Given the importance of quality and its ability to achieve many savings and economic and administrative gains, a work has begun to provide a system concerned with quality and its related issues, as institutions developed a quality management system to achieve these goals (Anbar, 2016, pp. 47-48).

Quality management is defined as a management philosophy and approach, which includes a set of principles that underpin continuous improvement processes (Othman & Rashed, 2016, p. 10). It enables organizations to meet customer expectations and gain their satisfaction, increase work productivity, improve organizational performance, and achieve sustainable competitive advantage, upgrading of knowledge and skill through training processes necessary to achieve quality (Syaj, 2015, p. 28). On the other hand, the quality management applying contributes to reducing unhelpful routine administrative processes, improving the quality of production outputs, reducing costs by controlling resources waste, reducing and simplifying work completion time, in addition to enhancing the added value of products and raising their excellence level (Mansour and Ibrahim, 2010). pp. 15-16).

In view of the competitive nature of the construction sector, technological developments and great developments in building and construction systems, the concept of quality management and control has become one of the most important issues that construction companies seek to achieve. It contributes to increasing the efficiency of construction products and improving project progress and delivery processes within timelines in addition to operations cost management (Wawak, Ljevo, & Vukomanovi´c, 2020, pp. 1-2).

Quality management is practiced in construction projects at several levels, which are illustrated by the study (Al-Jawaj, 2020, pages 131-132), as follows:

1. **Checking and inspection:** Quality control and management processes begin in construction buildings through inspections of construction materials and comparing them with standard specifications. In addition, works is inspected after their completion to compare them with plans, specifications and requirements that have been followed to comply with the owner's needs and desires.
2. **Quality control:** Through quality control, the technical requirements and standard specifications for all construction items are determined, and then detailed plans are prepared and compared with the permissible requirements and limits, so that they do not affect the quality. Accordingly, the necessary corrective measures are taken to make the level of deviation as low as possible, and establish a record in which errors are monitored and their causes are identified so that their occurrence can be avoided.
3. **Quality Assurance:** It includes all procedures that ensure the achievement of project quality and customer requirements. It includes the development of a plan binding on all parties to ensure the implementation of the project objectives and compliance with the quality standards required in each part of the construction work, in addition to setting a plan and a timetable for implementing the procedures and verifying that all implementation plans conform to the quality

plan, and setting clear instructions that guide workers towards achieving quality. At this stage, the quality cost is calculated so that it is as low as possible. On the other hand, it is verified that all non-productive items such as supply operations are taken into account, and methods for estimating deviations in the approved plan are determined through statistics so that the course of these deviations can be corrected and avoided in the future.

4. **Total Quality Management:** A comprehensive system is developed aimed at continuous improvement to satisfy customers and meet their needs through the optimal use of project resources and all parties. It includes defining the technical requirements for implementing the works and employing the latest and most important technological methods, as well as cooperation between the project parties to achieve quality, follow up on the completion of quality plan, and prepare the necessary reports to correct and modify any deviations.

Third: Cost Management Tools

Cost is one of the limitations of construction projects besides time and quality. Those in charge of these projects are interested in managing these determinants and achieving a balance between them. To achieve this, it is necessary to adopt tools and strategies that help manage and control them correctly (Hassan and Yaqoub, 2018, pg. 30).

The process of managing costs in construction projects is carried out within a set of processes and procedures associated with the completion of projects within the specified budget and established specifications. Reducing construction costs along with maintaining quality is a consistent goal in the construction industry (Sathish & Basker, 2020, p. 84). To achieve this, it is necessary to adopt the methods of cost management, which is a process that is carried out by tracking the cost of production processes and bringing them to the lowest possible degree, without compromising their specifications, quality and characteristics that meet the customers' needs (Zorob, 2013, pg. 40). They are the methodologies and activities used in managing and employing resources in order to reduce costs and add value to the final products that meet the needs and aspirations of customers and are based on a set of tools that contribute to achieving continuous improvement and positive change in production processes to reduce costs without compromising the quality and efficiency of the final product (Horngren, Datar, & Rajan, 2015, p. 4).

The construction cost management process is based on four basic processes; First: Resource planning, in which the resources required to complete the project are determined according to its phases, and identifying possible alternatives if they are not available. Second: Cost estimation, in which an approximate estimate of the financial resources needed to complete the project work is developed. Third: Determining the budget, where the budget is set to create an approved cost reference. Fourth: Monitoring the cost, in which changes are tracked to make the necessary updates to the established

budget (Hassan and Yaqoub, 2018, p. 32). In cost management, a set of methods are used in cost management, and the following is an explanation of the most important of these methods:

- **Activity Based Costing**

The use of this system started due to the inability of traditional systems to deal with the changing information structure in the business environment. This system aims to achieve a high level of accuracy in calculating costs by analyzing the activities that take place within the organization and their impact on the final product (Al-Fadhel, 2018, pg. 269). This system is based on the idea that activities consume resources and therefore cause costs, and that it is the products that fulfill the demand for activities. Therefore, the cost of the product depends on the extent of its consumption of activities (Shnawa, 2018, pp. 337-338). This contributes to studying each activity and determining the resources consumed within it and the extent of its contribution to adding value to the product. Therefore, activities that do not contribute to adding value to the product are eliminated and the focus is being on those that enhance the perceived value. This reduces costs and maintains the quality of the final products (Zorob, 2013, pp. 43-44).

In construction projects, costs are reduced through activity-based costing. The activities necessary to conduct the construction operations are carefully planned and the necessary resources are identified during each activity, which leads to reducing the waste of resources and reducing the number of activities needed for each construction process. This reduces the time required for its completion and helps reduce costs and focus on effective activities that increase the quality of production (Kale, et al., 2018, p. 1531).

- **Targeted costing**

Through the target cost process, it is possible to work on reducing costs in the initial stages of the production process, that is, before producing. It is a tool used to reduce the initial costs of products without reducing their quality and innovative specifications by studying, analyzing and evaluating all procedures that would reduce the initial cost in the stages of research, development and design (Hassan & Mohamed, 2018, pp. 183-184).

Target costing can be used to reduce the costs of construction projects by focusing on the structural design process, where designs are developed in a way that reduces the project cost and does not exceed a certain cost, and this requires the presence of a supervisory authority on the entire project so that it is able to intervene in the decisions of all participating parties (Motuba, Nogqala, Monyane, & Emuze, 2016, pp. 334-335)

- **Value Engineering**

Value engineering includes a set of methods that work to determine the required functions of products and the characteristics that must be available in them, and then work to develop alternatives that work to achieve the same characteristics and level of performance for these functions at the lowest cost (Mostafaeipour, 2016, p. 26). This tool is one of the most distinguished cost management tools, as it reduces costs, raises performance, improves product characteristics, and enhances the presence of the functions required of it through the process of functional analysis and proposing suitable alternatives. It is also characterized by its ability to support suppliers and enhance cooperation between them and institutions (Zorob, 2013, pg. 49).

This method is widely used in construction projects, by focusing on the required functions and making decisions that lead to effective designs at the lowest possible cost (Sathish & Basker, 2020, p. 86). In order to enhance the effectiveness of this method in construction projects, it is recommended to apply it before the contracting process is completed to take advantage of all the clauses of the contract and the project phases, as it is a collective effort that analyzes the functions of the project. Then, working on creating alternatives that assist in achieving these functions at a lower cost without prejudice to quality and functional efficiency, through canceling some worthless operations or improving activities and works to reduce wastage of resources and time needed to implement construction works (Shatwan and Schlack, 2020, p. 249) .

- **Material Management**

Material management is the process of planning, implementing and controlling activities in construction projects, aiming to ensure that building materials are available at the point of use when needed. It also ensure the quality of materials selected, purchased, delivered and processed on site and their availability at their points of use in appropriate quantities and at reasonable cost (Mahadik, 2015, p. 399). The importance of this method is because materials constitute a large proportion of expenditures in construction, so reducing the purchase costs improves chances of reducing overall project costs. Conversely, poor material management can increase costs. For example, purchasing materials too early leads to a freezing of capital and increases the costs of storage operations, in addition to increasing the possibility of their exposure to damage or theft. Accordingly, ensuring the flow of materials in the right quantities and in a timely manner is one of the most important concerns of materials management (Patel & Vyas, 2011, p. 1).

- **Budgetary control**

The budget is an important administrative tool used to implement the necessary strategies to achieve the planned goals, and it is necessary to work continuously to ensure the progress of plans according to the specified budget and to make the necessary adjustments and updates to ensure the proper functioning of the work. This refers to the

budgetary control or operations monitoring, which refer to the processes of comparing the actual results achieved with the results specified in the schedules to ensure that the work is going within the time and budgets specified for each stage, and then taking corrective actions if required (Nwokenkwo & Chinedum, 2019, p. 82). Thus, budgetary control contributes to keeping expenditures within the limits of the planned budget, and helps to detect deviations in them on an ongoing basis to take corrective measures, and accordingly this system makes the budget a major tool for judging production and performance. Thus, through budgetary control, it is possible to collect ideas from all administrative levels for preparing the budget, coordinating between different activities, detecting gaps and deviations in the workflow continuously and taking corrective measures, planning for all expenditures and revenues, providing a tool for measuring actual results and working to change the expenditures capitalism to a more profitable form. Thus, through this tool, it is possible to work on controlling and determining costs without prejudice to the quality and efficiency of work (Oyebode, 2018, p. 5).

- **Cost Optimizing Techniques**

Cost optimization techniques aim to reduce costs through reducing effort and maximizing the desired results of this effort, in addition to reducing errors and risks that lead to work stoppage or stalling, and this is done through special software (Akalya, Rex, & Kamalnataraj, 2018, p. 31). Building Information System-BIM is one of the techniques used in construction project management. It is an integrated system includes everything related to the project as it is placed in one template. It provides a main database for the project that provides all its parties with the documents and data necessary to complete it in an accurate and coherent manner, such as engineering drawings, tables of specifications and quantities, and timetables of the project implementation. This is done through a digital representation of the physical and functional characteristics of the building as it provides a participatory knowledge that helps in making decisions during the project life cycle to manage all the factors controlling its implementation (Kharbutli, 2014, pp. 15-17). The Building Information Modeling (BIM) system makes an accurate inventory of the necessary materials before starting the implementation process. It also provides solutions for communication problems between the design parties and any participant in the implementation processes. It solves all problems related to the modification of one of the plans and the consequent modifications to other plans or in cost and others (Ali and Saleh, 2018, p. 2). It also helps to identify errors and solve them at the design stage, which leads to the efficiency of project management processes, especially in saving time, effort and cost, improving workflow and comparing between planned and actual schedules by using the building schedule and linking it to the three-dimensional parametric model (Jiang, 2011, p. 3).

- **Cost Reduction Techniques at site**

This process depends on the actions taken by the contractor or project manager to control and reduce costs without prejudice to the quality and efficiency of the work. These techniques depend on monitoring the workflow and comparing it with the specified schedules and budget. These techniques provide feedback that contributes to making improvement decisions to raise the performance level of employees and enhance the quality of work (Mahadik, 2015, p. 400). The implementation of these techniques depends on the awareness of officials and their knowledge and skill efficiency in using and managing cost reduction systems, and the nature of the systems they adopt to achieve this goal (Hafez, Aziz, & Elzebak, 2015, p. 17).

- **Lean Construction**

The concept of (Lean) is based on stopping waste processes or reducing them as low as possible during the production process, and eliminating activities and processes that do not lead to adding value to customers, such as warehousing and others. The Lean system is an important means of focusing on value and reducing costs, as it reduces waste and avoids the costs of repeating operations and returning them due to errors, which reduces costs and enhances production quality (Noor, Al-Sharbati, and Al-Nahawi, 2016, p. 84). In construction projects, this method focuses on activities that increase the added value, as adopting of this method leads to improving the flow of resources and achieving synchronization for all activities, thus eliminating activities that do not add value, such as waiting, storing and reworking processes (Wong & Ahmed, 2018, p. 708).

On the other hand, (Frumusanu, 2009, pp. 4-6) study assumes that the reduction of construction costs takes place through a set of considerations, which can be clarified as follows:

1. **Reducing the cost of building materials:** where building materials occupy a large proportion of the total costs, therefore, reducing their costs contributes to reducing construction costs. This is done through using effective lightweight materials that reduce the loads of the building and thus reduce the amount of concrete and using less expensive construction systems, replacing high-cost materials with low-cost materials at the same efficiency through relationships with suppliers, in addition to reducing costs related to the materials such as transportation warehousing and handling, through establishing warehouses on site and supplying in time.
2. **Reducing labor costs:** By employing machines and automating some project implementation processes, and maintaining, a certain rhythm in production to ensure that work is not interrupted, because workers' salaries are paid during the downtime, and they are not responsible for mismanagement and the resulting interruptions in work. The labor should also be distributed according

to their skills and not waste time in works that are not commensurate with their skills and abilities.

3. **Reducing the costs of the mechanisms used in construction:** This is done through the rational use of machines and employing specialized skilled labor to deal with and manage them because the wrong use leads to large amounts of waste of materials and to the occurrence of malfunctions and others.
4. **Reducing costs by organizing the construction site:** By starting implementing works that are used to organize the construction process, implementing projects for services necessary for construction operations such as water and sewage networks, and working on the use of prefabricated elements for temporary buildings on the site and re-dismantling these buildings and restoring material.

Conclusion

The research concluded by identifying a set of ways to reduce construction costs along with maintaining quality considerations. Where the research found that reducing costs without prejudice to quality is through cost management processes, and making integration between them. In construction projects, the focus is on a set of cost management systems, which have proven effective in reducing construction costs, the most important of which are; Activity Based Costing, Target Costing, Value Engineering, Materials Management, Budgetary control, Cost Optimization Techniques, Cost Reduction Techniques at site, Lean Construction System. These processes can be enhanced through achieving integration between two and more of these systems, to achieve the maximum possible benefit and be able to reduce construction costs without prejudice to the quality of work.

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