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DEVELOPING WSM-AHP METHOD FOR ADAPTIVE CONSTRUCTION PROJECT MANAGEMENT

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Abstract- The management technique to keep the construction project on schedule as much as possible is to boost productivity. The construction industry's poor productivity is due in large part to its fragmented character, as well as the standard usage of Computer Aided Drafting technology, and the scale of construction businesses. This study analyses the effective variables in adaptive project performance in Iraq, which may assist address the problem of project schedule and cost in Iraq based on the nature of the effective building elements. It describes three phases of the project life cycle that affect construction projects. In building projects, prepared surveys and expert opinions were utilized to analyze effective performance elements and the extent of their influence. The information transferred from linked components evaluated by the Weighted Sum Model (WSM) was connected with the Analytic Hierarchy Process (AHP) model. In a cost-based hierarchy, the results identified the primary effective variables influencing the adaptive view and performance of the project. The matrices were designed to facilitate pairwise comparisons by experts. The WSM-AHP ranked the delay in the construction of the structure, design documentation issues, and construction phase hurdles as having a greater impact on the project performance.

Keywords: AHP, WSM, Adaptive Factors.

1. INTRODUCTION

The complexity, dangers, and characteristics of a project make it difficult for project managers to steer them toward completion in a way that advances the organization's strategic goals and competitive advantage. When a manager is faced with making judgments concerning a complicated goal's implementation in the face of uncertainty, an adaptive strategy is necessary [1]. This virtually applies to ecosystem recovery since expected results (like species reactions to remedial activities) and driving forces (like human behavior and weather-dependent processes) are frequently unpredictable. When these elements combine, the level of uncertainty increases. As a result, progress necessitates a systematic 'learn-and-adjust-as-you-go' method known as adaptive management (AM). In order to be successful, AM applications need to be customized for certain regions.

Various qualifiers have been used to specify various forms of AM [2]:

- In management, "evolutionary problem solving" encompasses almost all shifts that come about because of collective learning via observation, evaluation, and iteration.
- For passive' AM to be in effect, the available data at each decision point must be gathered and used to guide subsequent actions. In Puget Sound, for instance, twenty ferry terminals had to be reconstructed or enlarged starting in the mid-1990s.

Saaty developed the Analytical Hierarchy Process (AHP) as a tool to aid in making decisions. With this method, the decision-maker's intuitive judgments are given more weight, and consistent comparisons of alternatives are prioritized so that numerical values may be assigned to the relative importance of various possibilities. The AHP method is consistent with the actions of a decision-maker because judgments are based on knowledge and experience. This method's value lies in the fact that it provides a structured, yet relatively straightforward, answer to the decision-making issues at hand. In addition, one can make the connection between the little and the large by simple paired comparison judgments if a problem is logically broken down from the huge to the smaller and smaller.

This study aims to introduce readers to the AHP and its potential use in project management. This paper will provide a high-level overview of multiple criterion decision analysis, its applications, and the stages involved in implementing AHP, before demonstrating its use in the context of prequalification problem of the contractor. It's hoped that wider use of this approach to project management would result. In the meanwhile, AM has become associated with a programmatic approach to implementation, which often consists of five or six recurrent cycles: analyze alternatives, implementations, planning, monitoring effects, evaluation of impacts, and modifications of tactics accordingly, then come back to step 1. While this programming approach has been used for decades in business management and is extensively implemented in public health management, its widespread adoption in conservation and restoration did not occur until the early 2000s.

In a project-based industry like construction, efficient project management is crucial [3]. Successful projects always focus on finding the most effective methods. According to A Guide to the Project Management Body of Knowledge Guide (PMBOK® Guide) published by the Project Management Institute (PMI), general project management knowledge, methodologies, techniques, tools, and skills may improve project outcomes (such as performance, satisfaction, and success) (PMI, 2008). The PMBOK® Guide is a common resource for businesses of all kinds, including those in the construction sector, since it details the basic, baseline practices that lead to tangible business outcomes. Managers and their teams may increase the likelihood of success for many different types of projects by using the following techniques [3].

2. ADAPTIVE PROJECT FRAMEWORK (APF)

APF is a five-phase, iterative, adaptive strategy created to provide customers with the most business value possible while working within their time and budgetary restrictions. The fundamental tenet of APF is that scope is flexible and constrained by time constraints and financial constraints. By modifying scope at any iteration, APF maximizes the value of the job. It achieves this by placing the client in the spotlight while determining the components with the highest work value. The linked customer has the option to alter the project's course following an iteration based on the lessons learnt from all prior iterations. This with continuous value adjustment means that the course of an APF project is continuously modified to guarantee the delivery of the greatest possible business value. In other words, change is welcomed rather than resisted. In the APF, planning has a completely new meaning. Preliminary planning is carried out at a maximum level and is based on components or functions. Designing TPM is task- and activity-based. In APF, each iteration includes micro-level design work [4]. The APF is more than just a framework. It's a new approach to thinking about customers and how to better serve them. The six essential values listed in the parts that follow represent this way of thinking. These essential principles never change. They predominated to be used in every APF building. Without exceptions the visible application of which of the APF teams' key values is recognized throughout time. We have worked with teams that occasionally provide crew members rewards for upholding the APF basic values. They are so significant. APF starts off with a clearly articulated job opportunity or problem. As a result of our decision to follow the APF trend, a Project Overview Statement (POS), a scoping document for a construction project, is created [5]. A typical cycle lasts between two and six weeks. The cycle length is specified in writing and accepted by all parties, with the understanding that it may alter as project work progresses. Also, there will be a number of cycles of the Cycle Plan phase before this project is finished. The functionality which will be constructed during this cycle, the midlevel WBS, the prioritized scope triangle, and the POS are all included in the start cycle plan pattern. Future Cycle Plan phases will also include a bank of input for the scope. Take the activities that describe the functionality that will be implemented in this cycle and take them out. Non-critical paths need to be calculated and managed. This would cause a difficulty for traditionalists. Their pattern is centered on avoiding navigating the uncertain road. We would compute and keep single here without a doubt, but we think that would be excessive. Because the loop is so short, excessive quantity planning and analysis results in paralysis [6]. Plans, work schedules, scope banks, issues logs, and other information can be posted here by the crew, who can also use it for their weekly client status meetings, daily 15-minute status reports, and problem-solving sessions [7]. To keep track of all requests for changes and suggestions for practical upgrades, a scope bank is established. All problems are documented in an issues log, which also tracks how they are being fixed [8]. A validity evaluation of the functionality created in the most recent cycle is conducted jointly by the team members and client. It is compared to the overall objective, which is of the largest possible business scope, and adjustments are made to the high-level plan and subsequent cycle work as necessary. Cycle Plan-Cycle Build-Client Checkpoint is repeated until the allocated time and money for this version have been used up. Every Cycle Build step is followed by the Client Checkpoint phase, which is a thorough evaluation. All of the clients and the project team will gain something from various discovery and learning experiences throughout the cycle construct. Client-focused means that we always have our clients' best interests in mind. Every time we feel that a challenge is necessary, we have an obligation to do so in an open-minded manner. Being client-focused does not include acting in any other way [13]. Owning co-project managers, one from the client and one from the company, is a successful arrangement. Both parties equally benefit from the project's success or failure under this arrangement. A distinct and established co-ownership exists. Practice has shown us that this is essential for implementation success [9]. Version Scope, including a description of what's expected and what's included in the COS journey. All that the two sides have so far achieved is an educated estimate as to what will be done, despite their best efforts. It's possible that the assumption is correct, but that's not a deal breaker. What matters is that both parties will have a clearer understanding of what should be produced as a result of working with the deliverables from the beginning cycle. They will get wiser as a result of their experiences when it comes to the early deliverables in the future. The project will change moving forward in the following cycle as a result.

2.1. Decision Making

Decision-making entails recognizing a problem, collecting relevant data, and weighing potential solutions. A management may benefit from using a structured approach to decision-making by establishing relevant information and significant options. Using this strategy, the management has a better shot of picking the optimal solution. Certain components of the project may be 'frozen' and change control methods created for those features at each of these phases. For instance, the project brief may be considered "frozen" at completion of the concept design phase. When a project brief is frozen, changes may only be made with the client's permission, and even then, only after the associated costs and disruptions have been weighed and agreed. Scope creep occurs when a customer provides

instructions without first determining whether or not those specific tasks are approved, covered by the current price quote, or even a good use of the client's money. As the end user of the finished product, the client should have final say in all design decisions and be pleased with the project's aesthetics for this to be possible. Consultants and contractors are able to provide advice and bid on projects, but the final decision must be made by the customer. However, the client's identity isn't always obvious. Even on little tasks, there are often several people whose opinions should be considered as he moves forward.

Prequalifying contractors is notoriously difficult to quantify because of the prevalence of imprecise, unreliable, and incomplete data, as well as the subjectivity of human judgment and preference. The qualitative evaluations, prequalification requirements, and experience of contractors and decision-makers are all sources of uncertainty. Many popular approaches to prequalification difficulties, which rely on high-quality data, have been impeded by the prevalence of such considerable uncertainties and subjectivities. Project managers must understand cost management to manage budgets. Thus, construction professionals must understand cost control methods [10]. Some modern approaches to contractor prequalification focus on applicants' linguistic abilities rather than their mathematical ones. It is beneficial to have Fuzzy Set Theory [11], with its ability to qualify imprecise information, to reason and draw conclusions based on ambiguous and partial data, at hand when dealing with judgements when the phenomena are unclear and opaque.

2.2. Current Work

The study used the techniques of Building Information Modeling (BIM) with the Analytic Hierarchy Process (AHP) to build effective analyzing in the way of adaptive construction project management. The study aimed to eliminate the project management challenging and enhance the construction processes sequencing by deriving the management system that can be applied for various construction projects. The study based sustainable economic resources to support the analysis progress toward better results. Choosing the correct contractor is a crucial step in any building project. Clients face a challenging dilemma when trying to select the best contractor from the large pool of candidates now available. Choosing a reliable contractor who can deliver a high-quality finished product is essential when taking care of long-term investments.

In order to reach this objective, the chosen contractor's performance will play a crucial role [12]. Research into the best methods for choosing a contractor goes back to at least the 1960s. Busch, Dickson, Hakansson and Wootz, and Dempsey all wrote seminal works that are still cited today. According to the findings of these research [13-15], the standard of the goods and the timeliness of their delivery are major considerations when choosing a provider. The construction industry is inherently risky. Contractual risk management is a subset of legal risk management that forms part of a company's overall general risk management. When it comes to managing legal risks in contracting, the purposes of contractual risk management are not limiting. Contractual risk management extends beyond just contractual planning and management to incorporate a wider range of business risks. In emerging nations, more issues with construction management are discovered. Most critical issues in a construction management system, as identified by Mohamed [16]:

When problems arise in the administration of a building project, they must be addressed without delay. According to Senaratne and Sexton [17], problem-solving has been viewed as a sort of information processing in modern organizational theories. Knowledge-based perspectives on the organization are now the norm, and as a result, collaborative problem solving is being seen as a key factor in the generation of new insights. When a group works together to solve an issue, everyone involved contributes their own unique expertise, which is then documented, expanded upon, and disseminated to the rest of the group. On-site pragmatic issue solving, in particular change management, is a common method of collaborative problem solving in construction projects.

Razi, et al. [18] presented, in order to ensure the smoothness of the construction project, a multi-criteria decision making (MCDM) technique of a systematic method, namely Analytical Hierarchy Process, has been widely used (AHP). Based on the 40 journal articles, it is possible to answer the question of whether the majority of civil engineering sites use AHP as acting making tools in any of the trouble occurrences. The research indicated that thirteen (13) distinct areas of civil design use the AHP of decision-making rating approach, with the core field attracting the most attention from corporations and managers, as well as those working on highway projects and building construction [18].

Erdogan, et al. [19] showed that this article defines and discusses the concept of construction project management. The main construction control issues have been identified, and solutions are being discussed. Using multi-criteria approaches, a decision-making model for construction management was created and used to a case study. The AHP technique and the "Expert Choice" software were used for the computations. A contractor was chosen using the recommended methodology to build a swimming pool. The best contractor was selected after weighing all of the factors, and they added up to 0.551. This study proposes the use of the Analytical Hierarchy Process (AHP) for making decisions in project management. Take the issue of prequalifying contractors as an example. A tree-like data structure is developed for a project's set of prequalification requirements and, by extension, the prospective contractors who meet those requirements. The 'Expert Choice' professional related software, which is commercially available and built for implementing AHP, will be used to streamline the AHP implementation proposals. Professionals in the field of project management are intended to benefit from this increased exposure to the AHP [4].

Researchers A. Darko and coworkers 2018 The field of construction management (CM) is quickly adopting analytical hierarchy processes (AHP) as a method for understanding complicated circumstances and making well-informed judgments. However, the present literature provides only a shaky definition7 of either AHP in general or its crucial applicability to CM issues. To further understand which of these 18 approaches yields the best outcomes under different decision-making circumstances,

more study is required to evaluate and contrast the 17 AHP with other multicriteria decision-making methods. Fuzzy set theory is an extension of classical set theory and is concerned with sets that have a fuzzy membership-to-nonmember ship transition [20]. The schedule control method is a method for keeping tasks, resources, and time periods balanced in order to achieve the project's goal. With the advancement of construction, the time limit for project management has become more important than ever before. The study concluded which indexes were more important than others based on the analysis of the indexes. The analysis results can be used to guide the plan. And the study provides methods for scheduling control. The outcomes that can be successfully applied in the workplace [21].

Choosing the correct contractor is a crucial step in any building project. Clients face a challenging dilemma when trying to select the best contractor from the large pool of candidates now available. Choosing a reliable contractor who can deliver a high-quality finished product is essential when taking care of long-term investments. In order to reach this objective, the chosen contractor's performance will play a crucial role [22]. Research into the best methods for choosing a contractor goes back to at least the 1960s. Busch, Dickson, Hakansson and Wootz, and Dempsey all wrote seminal works that are still cited today. According to the findings of these research, the standard of the goods and the timeliness of their delivery are major considerations when choosing a provider.

There is always an element of danger involved in building. Companies' comprehensive general risk management includes contractual risk management as one component of their legal risk management. When it comes to managing legal risks in contracting, the purposes of contractual risk management are not limiting. Contractual risk management extends beyond just contractual planning and management to incorporate a wider range of business risks [8]. In emerging nations, more issues with construction management are discovered. Most critical issues in a construction management system, as identified by Mohamed:

When problems arise in the administration of a building project, they must be addressed without delay. According to Senaratne and Sexton [17], problem-solving has been viewed as a sort of information processing in modern organizational theories. Knowledge-based perspectives on the organization are now the norm, and as a result, collaborative problem solving is being seen as a key factor in the generation of new insights. When a group works together to solve an issue, everyone involved contributes their own unique expertise, which is then documented, expanded upon, and disseminated to the rest of the group. On-site pragmatic issue solving, in particular change management, is a common method of collaborative problem solving in construction projects.

The process of designing a building involves coming up with a number of different options and then subjectively evaluating them based on a number of criteria. To show how well the DSS ranks designs in terms of total act scores, we present a case study with five designs that are all equally recommended by experts. The next step in design assessment is a sensitivity analysis, which is used to assess the most concrete design that is being questioned. This file's methodical pattern aids the involved assessment procedure by isolating a single criterion at a time and ultimately determining the optimal design by weighing all criteria together [23].

3. METHODOLOGY

As the name suggests, adaptive project management is a deliberate and structured approach to improving decisions and processes depending on the results of decisions made in earlier phases of the project. As the project progresses, the adaptive method will be tweaked to account for new information. The adaptive strategy is not fixed, but rather evolves during the course of the project. Due to the unique nature of each project, adaptive project managers tailor their approaches accordingly. In the present work, the methodology can be summarized in the drawing as shown in figure 1. When planning and executing a construction project, it is essential to pay special attention to even the tiniest aspects. In construction management, the strategy phase of a project's lifespan considers all aspects of the project, including its design, building processes, logistics, labor deployment, and health and safety.

Workflow in construction project management encompasses a vast array of activities, including resource management, planning each phase of the project lifecycle, determining a set of processes for accomplishing tasks, and monitoring progress in terms of cost, time, and quality assurance. All parties participating in a project can talk to one another and work together smoothly and quickly thanks to the help of project management software.

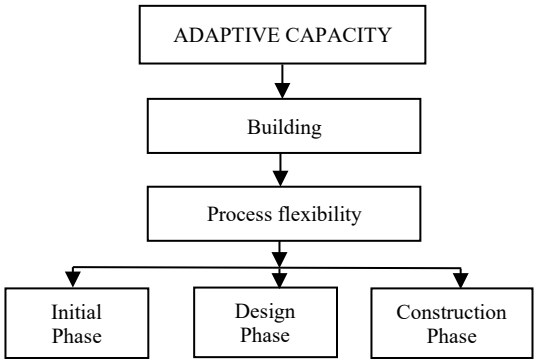

Figure 1. The general methodology of the present thesis

Since planning and the requirement to be flexible and responsive coexist in construction project management, the workflow must be connected across all operations and across all stakeholders. This type of continuous visibility, agile control, and broad connectivity can be achieved using cutting-edge project management software, which can streamline the process. A communications flowchart that promotes continuous planning, which keeps teams informed and eliminates risk, is one of the most essential elements of any automated software system. It is possible to examine and fine-tune a construction project management strategy during the initiation phase and apply it successfully throughout the entire project lifecycle. All stakeholders can agree on the workflow strategy for the building project once the work scope has been completed and the most efficient approach has been determined.

3.1. Processes for Adaptive Model

3.1.1. The Initial Phase

During the initial phase of the life-cycle of a project, the sponsor of Project and the Vice Chancellor/Chief Information Officer define, analyze, and approve the project's concept. Initiating a project is the first stage in turning an idea into a tangible goal. During this stage, a business case and high-level project goals need to be established. This can be done by doing a need analysis and writing a project charter. Important information about the project, such as its scope, objectives, timeframe, budget, and assigned project manager, can be found in the project charter. Once the project's goals and scope have been established, it's time to start thinking about who will be most affected by it. Make a list of everyone who has any kind of say in the matter, and include their titles, roles, any special communication needs, and how influential they are. Although the purpose of the project is defined at this stage, the project charter does not include the technical details of this stage.

3.1.2. Design Phase

During the design phase of a project, key features, structure, success criteria, and main deliverables are outlined. The objective is to develop one or more executable plans for completing the project. The stakeholders can then settle on an optimal plan for carrying out the project. Instead of thorough, procedural planning, the design phase of a project is characterized by strategic, high-level thought. With the assistance of project planning software, both the overall strategy and the specifics of a project's design can be better structured. The new employee was unfamiliar with the context in which the project management methodology approach was created and, as a result, felt uneasy advocating for it. To add insult to injury, he would enter this new environment with the assurance that he is a seasoned professional who does not require assistance to carry out his objectives. The company's techniques would be incomprehensible to him, but he would never confess it. Later, we discovered that he had never handled a project requiring maturity or organization.

3.1.3. Construction Phase

In this stage of the project management lifecycle, the deliverables are actually constructed by the project team. Conventionally, the first step is a meeting where everyone on the team is briefed on what they need to do from the start of the project to the end. The project manager is in charge of making sure that all of the steps outlined in the plans are taken at this stage. Essential phases of the lifecycle management of construction project management include initiation, planning, implementation, monitoring and performance, and closing. Project owners and delivery teams are increasingly tapping into the potential of construction project management software to achieve full transparency, timetable control, risk mitigation, and workforce collaboration. High-performance software can be used to implement and monitor efficiency, document management, and on-site management, three essential aspects of every construction project.

3.2. The Independent Research Factors

This section includes a compilation of assumptions made by separate researchers regarding the significance of project management in light of a variety of overrun factors. It is essential to have a reputation as a dependable construction company that can deliver projects on time and on budget. If a construction company lacks the funds to pay its subcontractors on time, it cannot complete the project on schedule. Table 1 showing the factors of initial phase. This could result in payment delays, which are not only detrimental to your schedule and bottom line but also weaken the faith of your subcontractors and clients. As of 2020, Quoc Vu, et al.

Table 1. factors of initial phase

Contractor-related factors	
F1	Unstable financial situation
F2	Limited experience in the construction organization
F3	Delay in the decision-making process of contractors
F4	Owners' payment delays
F5	Subcontractors' insufficient finance for construction
Redesign and reallocated internal	
F6	Owners' poor qualifications
F7	Poor quality of design documents
F8	Owners' deliberate presentation of incomplete quantities in bidding documents
F9	Delayed and incomplete handover of the construction site
F10	Delays in dealing with design changes
F11	Adoption of different construction codes and standards
implementation influence factors	
F12	Inflation or increased interest rates
F13	Abrupt increases in site worker demand
F14	Unclear and incomplete geological survey documents
F15	Bad weather conditions
F16	Supply of poor-quality materials and supply delays
F17	Bureaucracy, corruption, and bribery of stakeholders
F18	Poor qualifications of site engineers
F19	Untimely instructions and decisions on approval and acceptance of quantities and drawings
F20	Subcontractors' poor construction experience
F21	Differences in culture, working environments and language barriers

Cost, progress, performance, and safety are the typical metrics used to evaluate construction projects [24]. However, the Delphi Method was used to construct an efficient assessment model in an empirical study by Yeung, et al. [25]. Methodology for gauging the success of a project based on eight criteria: (1) satisfaction of customer; (2) Cost; (3) Quality; (4) Time; (5) Effective communication; (6) Safety; (7) respect and trust; and (8) improvement and innovation (Yeung et al., 2009). Numerous additional metrics for gauging project success may emerge during the course of actual project implementation. Ahadzie, et al. [26] identify four types of characteristics that contribute to the success of mass house building projects (MHBPs): environmental effect; client satisfaction with relation to quality; cost; and time. When Enterprise Resource Planning (ERP) was applied to the construction industry, Chung, et al. [27] found that progress control and quality management were the most telling signs of ERP project success. They also discovered that development and quality were crucial to the successful carrying out of the project.

Recent research indicates that materials account for between fifty percent and two-thirds of a construction project's expenditure. Material management is essential for optimizing productivity and lowering costs. Proper management can boost the productivity and cost-effectiveness of a project and help ensure its on-time completion, whereas material mishandling can reduce the contractor's profit, result in massive losses, and leave the project with significant problems. This thesis examines the existing strategies used by construction companies to manage their building materials.

3.3. Techniques for Process of Analysis

Several analytic approaches have been provided for the purpose of analyzing risk management in building projects. It allows for an analysis of the risks associated with a project to be conducted using both objective and subjective criteria. The reasoning problem is first formulated by selecting an appropriate entry point in the hierarchy. The pinnacle of the traditional hierarchy stands for the supreme goal of the decision-making process. Judgement is affected by factors present at the intermediate level. There are several tiers, the most basic of which is the choice for making a decision. Once the hierarchy is in place, decision-makers conduct a thorough examination of all of its subparts, contrasting two at a time in terms of the impact each has on a more fundamental portion of the whole. While decision makers can use hard data on the elements to create comparisons, they typically rely on their personal impressions of the elements' relative importance and usefulness. An approach to solving problems, the Analytic Hierarchy Process (AHP) takes into account both objective data and expert opinion. Once the comparison matrix is built, the weights of each level's components are assigned in proportion to an element in the adjacent level. This is due to the fact that the elements are the normalized eigenvectors associated with the highest Eigenvalue of the comparison matrix. To do this, one must double the weights along each road segment, starting at the top of the hierarchy and working one's way down to the bottom of the options available [28-30].

3.4. Prioritizing and Synthesizing Hierarchy

The approach of weighing and assembly is used to synthesize priorities at a lower level of the hierarchy. This technique shifts focus from establishing priorities locally by elevating the significance of the criterion to establishing priorities globally by collating the priorities of the same component from across the world. The methodology decides the regional priority. A person's judgment is utilized to establish priorities, which are then transmitted downstream. This consistency ratio reflects the discovered consistency in the matched judgments.

3.4.1. Priority Vector Calculation

The first thing that has to be done is to build a general matrix. The generation of a standard matrix is accomplished by first totaling the values found in the columns of each comparison matrix and then dividing that amount by the overall sum of the column total [19]. Figure 2 is the flow chart of interactive construction finance decision model.

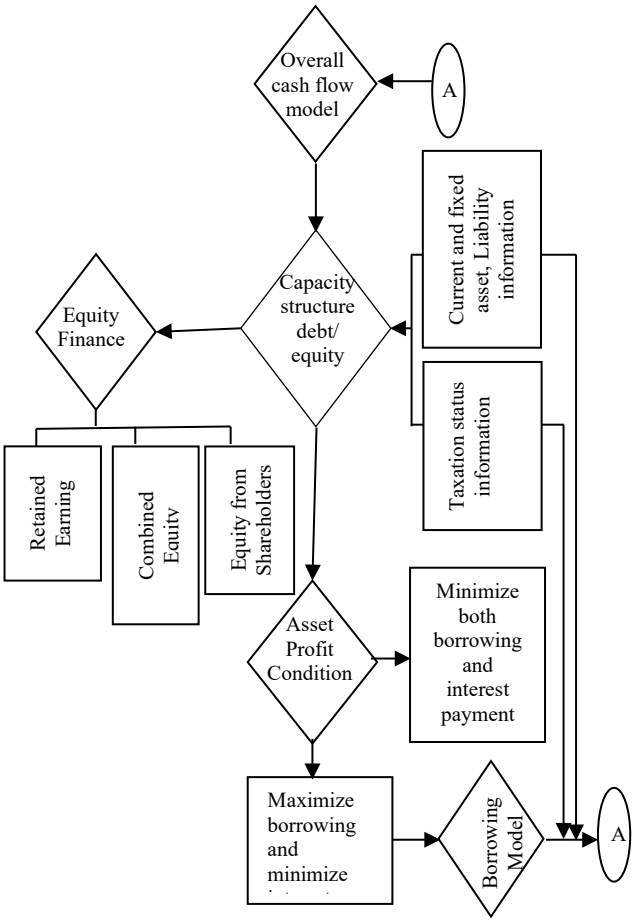

Figure 2. Flow Chart of interactive construction finance decision model

3.4.2. Weighted Sum Model

The weighted sum model (WSM) is the most well-known and straightforward multi-criteria decision analysis (MCDA) / multi-criteria decision-making method in the field of decision theory. It is also known as the weighted linear combination (WLC) or the simple additive weighting (SAW). It is used to rank potential options in light of many criteria for making a call. For the sake of argument, let's say that there are m options and n criteria to consider in each MCDA scenario. In addition, let's presume that all of the criteria are benefit criteria, which means that the better things are when the numbers are higher.

Next suppose that w_j represents the relative weight of importance of the criterion C_j and a_{ij} is the performance value of alternative A_i when it is evaluated in terms of criterion C_j. Then, the total (i.e., when all the criteria are considered simultaneously) importance of alternative A_i, denoted as $A_i^{WSM\text{-}score}$, is defined as follows:

$$A_i^{WSM-score} = \sum_{j=1}^{n} w_j a_{ij} \ , \quad i = 1,2,3,...,m \tag{1}$$

In the maximizing situation, the optimal decision is the one that yields the greatest possible aggregate performance value. It is of the highest significance to emphasize that this only applies if all of the data are provided in the same unit at this time. If this is not the case, the result is comparable to "adding apples and oranges".

4. RESULTS AND DISCUSSION

The final price tag is arrived at by summing the budgeted and actual building expenses. The current study aimed to identify which construction parameters are best suited for application in building endeavors. The adaptive concept failure that happens between the various components that affect the project state is a major obstacle in construction projects. The effectiveness of each component was considered when selecting the building variables for this project. These considerations were applied in a practical setting inside the Iraqi building sector. The case study used here compares the relative costs of several positive factors.

The fundamental goal of this research is to establish the different kinds of adaptive variables that can be chosen at each stage based on the adaptability of the parameters. Each aspect has been broken down into its respective "beginning," "construction," and "design" stages. The current thesis employs the goal of placing a high emphasis on project performance based on the adaptive notion. The concept of adaptation is used extensively in this thesis, most notably in the discussion of selection and alternate variables. The researcher identified the most beneficial factors for each category using Excel's built-in AHP-WSM method. The decision-making process was grounded in the classification of factors.

4.1. Results of Initial Phase

Planning, design, authorizations, and resource gathering are all components of the pre-construction phase. Pre-construction services provide owners with an organized process for estimating the project's cost, scope, and timeline, enabling them to carry out construction efficiently and on schedule. The success of a construction project is primarily dependent on the planning phase. During this phase, the project team establishes its infrastructure, unites around a shared goal, and defines its communication and procedural baseline. A lack of organization can lead to difficulties with communication, procedural consistency, and building timelines. Figure illustrates the results of the current stage's questionnaire regarding the factors.

Project factors that really matter are things like time, money, quality, and security. The importance of the project's factors is evaluated using these standards. The WSM serves as the overarching paradigm for many different kinds of software, including robots and data analysis programs. In one dimension, this method is extremely useful. The best option can be formulated using the aforementioned method if there are multiple criteria to choose from. In the tables below, you'll find the outcomes of the WSM. By multiplying each aim by its weight from the AHP analysis, we may combine all of our goals into a single one using the weighted sum method. By giving each outstanding assignment a numerical value based on cost-benefit and effort-versus-value analyses, weighted scoring provides a framework to assist teams prioritize their work. Table 2 considering the pairwise matrix effect with the parameters that are the consequences of the construction initial phase. Table 3 considering the numerical results of the initial phase of the project with the parameters of construction. Figure 3 showing the results of the questionnaire regarding initial phase of the construction.

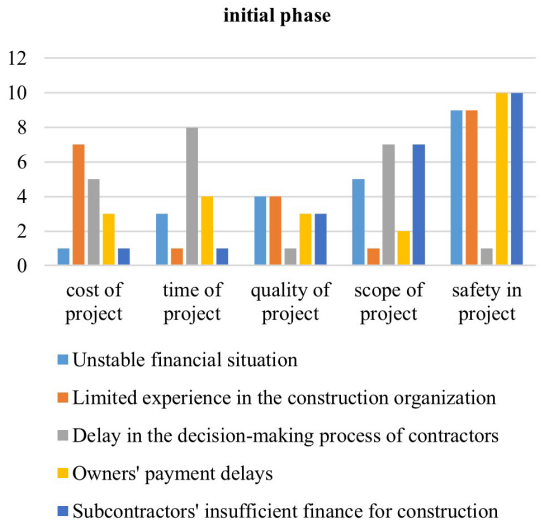

Figure 3. Questionnaire Results of Initial Phase

Table 2. AHP pairwise matrix and parameters weight results of initial phase

cost of project	time of project	quality of project	scope of project	safety in project	cost of project	AHP results
0.059	0.095	0.027	0.043	0.044	0.268	0.054
0.059	0.095	0.044	0.043	0.441	0.683	0.137
0.294	0.286	0.133	0.043	0.221	0.977	0.195
0.294	0.476	0.664	0.217	0.074	1.725	0.345
0.294	0.048	0.133	0.652	0.221	1.347	0.269

Table 3. WSM numerical results of initial phase

WSM Results	cost of project	time of project	quality of project	scope of project	safety in project	cost of project	WSM ranking factors
F1	0.015	0.041	0.039	0.078	0.054	0.228	0.228
F2	0.002	0.014	0.039	0.016	0.054	0.125	0.125
F3	0.003	0.109	0.010	0.110	0.006	0.238	0.238
F4	0.005	0.055	0.029	0.031	0.060	0.180	0.180
F5	0.015	0.014	0.029	0.110	0.060	0.228	0.228

The results show that Delay in the decision-making process of contractors is the main effective factor in this stage. As a consequence of this investigation, it was discovered that lack of decisiveness was the leading cause of building project delays in Iraq. Other key reasons include modification orders, unrealistic time deadlines and requirements in contracts, contractor financial constraints, the type of project bidding and award, and owner delays in progress payments. It was also established that consultants and clients agree with the contractor on some problems, but differ on others. Client-related factors, contract- and relationship-related factors, and contractor-related factors are among the most important types of delay-causing variables. In addition, it was established that the several causes of delay are interrelated and can be grouped into more generalized categories. Contractor-related factors, productivity-related factors, and consultant-related factors comprised the majority of the identified factors.

4.2. Design Phase Results

The goal of the Design Phase is to create detailed specifications that place an emphasis on the real-world implementation of the user's desired information technology features. After a project brief has been written, a feasibility study has been completed, and choices have been evaluated. Even though these steps sometimes entail design activities like sketching and research, they are rarely referred to as "design." When given a project brief, the design team's first reaction is the concept design. There is a difference between "concept design" and "scheme design," according to certain creatives. The phrase "concept" is used to describe the overall idea behind the design, while the term "scheme" describes the more detailed plan for putting the notion into action. These two phases are typically combined into one "concept design" or "concept" stage in modern project planning. The next step after the concept design is the "detailed design" or "developed design," which details all the major architectural components and how they fit together. Upon completion of the detailed design process, the design should be coordinated and feature precise dimensions. However, the design may still need further work on the technical aspects, the design work of specialists may not have been fully integrated, and the design will not have been packaged for tender.

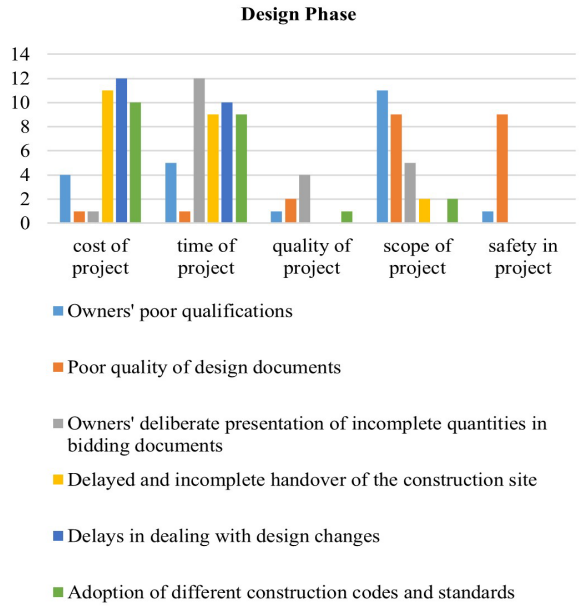

Figure 4. Questionnaire Results of Design Phase

The application for regulatory permits should have all the information necessary from the detailed design (such as building regulations approval). The figure depicts the responses to the factor's questionnaire used in this iteration. Figure 4 considers the results of design phase. In order to assess the weight given to each consideration at this stage, the AHP method can be useful. The AHP integrates quantitative and qualitative methods to evaluate alternatives and pick the most promising one. The technique of pairwise comparisons is used to achieve this goal. Instead of comparing all of the criteria at once, we'll compare and contrast just two at a time. Figure 4 shows the questionnaire results of design phase. Table 4 representing AHP pairwise matrix and parameters weight results of design phase. The process outlined here should make it much simpler to settle on a course of action.

Table 4. AHP pairwise matrix and parameters weight results of design phase

	cost of project	time of project	quality of project	scope of project	safety in project	cost of project	AHP results
cost of project	0.067	0.067	0.057	0.060	0.073	0.323	0.065
time of project	0.067	0.067	0.094	0.036	0.073	0.337	0.067
quality of project	0.333	0.200	0.283	0.181	0.366	1.363	0.273
scope of project	0.200	0.333	0.283	0.181	0.122	1.119	0.224
safety in project	0.333	0.333	0.283	0.542	0.366	1.858	0.372

Through the use of the weighted sum method, we are able to condense our original list of goals down to a single objective by simply multiplying each goal by the AHP weight result. To help teams prioritize the order in which to finish outstanding activities, a mechanism called as weighted scoring might be employed. To do this, we assign a monetary value to each work by weighing the difficulty of the activity against the possible benefit of doing it. Table 5 showing WSM numerical results of design phase.

The particulars of the building were not very complicated at any point. A product that has been thoughtfully developed places a premium on painless communication between the product's designer and the on-site engineer, as well as the satisfaction of the customer. These principles outline Quality by Design, a methodical strategy for growth that centers on clearly defined goals and places an emphasis on scientifically-grounded process knowledge and control.

Table 5. WSM numerical results of design phase

WSM Results	cost of project	time of project	quality of project	scope of project	safety in project	cost of project	WSM rank factor
F6	0.006	0.007	0.034	0.085	0.031	0.164	0.164
F7	0.026	0.001	0.068	0.069	0.279	0.443	0.443
F8	0.026	0.018	0.136	0.039	0.000	0.218	0.218
F9	0.002	0.013	0.000	0.015	0.000	0.031	0.031
F10	0.002	0.015	0.000	0.000	0.000	0.017	0.017
F11	0.003	0.013	0.034	0.015	0.000	0.066	0.066

4.3. Construction Phase Results

During construction, both the physical structure and the outlined goals of the project are completed. Facilities management staff are in charge of overseeing and managing the construction process. Construction administrators, interior designers, project engineers, and architects all make up this team. A construction manager or general contractor is usually hired to oversee a building project, plan out its phases, hire and schedule its subcontractors, and coordinate the overall construction timeline. This individual is also in charge of organizing the schedules of the contractors working under them. The professional service contractor (architect, engineer, etc.) on a project makes sure the construction documents are followed, and then makes any necessary changes to the plans and documents them. It is not unusual for unforeseen

conditions to arise during the Construction Phase, necessitating adjustments to the design document or the set of requirements. Bulletins, submittals, change orders, and shop drawings record these unplanned adjustments, which are then included into the Construction Documents. If these changes require a shift in spending, one of the backup plans will cover the difference. If the safety net is depleted, the budget will have to be readjusted. The picture presents the current results of the factors questionnaire.

When constructing a new building, it is common practice to hire a construction manager or general contractor to supervise all aspects of the project, beginning with the initial planning and ending with the final inspection. This is done in order to ensure that the building is constructed according to code. With the help of our weighted sum technique, we were able to narrow down our extensive list of goals to a more manageable number by multiplying each objective by the AHP weighting result. It is common practice to have a single person oversee all phases of a building project, from the initial planning stages all the way through to the final inspection. This person is known as the construction manager or general contractor. To help teams prioritize the order in which to finish outstanding activities, a mechanism called as weighted scoring might be employed. To do this, we assign a monetary value to each work by weighing the difficulty of the activity against the possible benefit of doing it. Figure 5 illustrates questionnaire results of construction phase and Table 6 showing the AHP pairwise matrix and parameters weight results of construction phase.

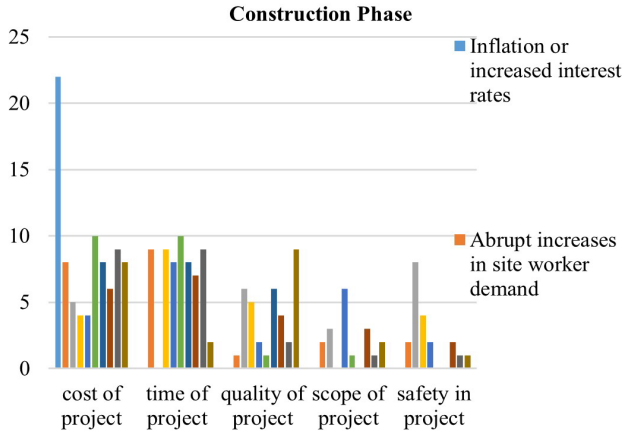

Figure 5. Questionnaire Results of Construction Phase

Table 6. AHP pairwise matrix and parameters weight results of construction phase

	cost of project	time of project	quality of project	scope of project	safety in project	cost of project	AHP results
cost of project	0.059	0.016	0.163	0.094	0.024	0.357	0.071
time of project	0.529	0.148	0.490	0.057	0.221	1.445	0.289
quality of project	0.059	0.049	0.163	0.283	0.608	1.163	0.233
scope of project	0.176	0.738	0.163	0.283	0.073	1.434	0.287
safety in project	0.176	0.049	0.020	0.283	0.073	0.601	0.120

The results show that Supply of poor-quality materials and supply delays is the main effective factor in this stage. The struggle between time, cost, and quality presents difficulties for the construction sector in the form of delayed project completion times. This analysis combines two mathematical methodologies for making decisions: the Analytical Hierarchy Process (AHP) and the WBS. The Table 7 showing the WSM numerical results of construction phase.

Table 7. WSM numerical results of construction phase

WSM Results	cost of project	time of project	quality of project	scope of project	safety in project	WSM rank factor
F12	0.002	0.000	0.000	0.000	0.000	0.002
F13	0.006	0.042	0.006	0.032	0.012	0.098
F14	0.010	0.000	0.039	0.048	0.048	0.144
F15	0.012	0.042	0.032	0.000	0.024	0.110
F16	0.012	0.037	0.013	0.096	0.012	0.170
F17	0.005	0.047	0.006	0.016	0.000	0.074
F18	0.006	0.037	0.039	0.000	0.000	0.082
F19	0.008	0.033	0.026	0.048	0.012	0.126
F20	0.005	0.042	0.013	0.016	0.006	0.082
F21	0.006	0.009	0.058	0.032	0.006	0.111

The goal of this combination is to investigate how the aforementioned factors impact the total amount of time required to complete the project (WBS). Two distinct measures of project success were established: one focused on the end result of the project, or the product, and the other on how the project was managed, or the project management success function. Finally, the constructed model was applied to a real project, allowing for an assessment of the performance indices, weighting factors, product success, and project management success of a contractor firm. The model's results were used identifying the contractor's weaknesses and strengths.

The results of the simulation highlight the significance of avoiding design issues at the outset (or preconstruction stage) of the project to speed up its completion. During the construction process, it is absolutely essential to keep a close check on rework, changes in design, and change orders in order to preserve efficiency and meet deadlines. According to the findings, an improvement in long-term productivity can be achieved by combining highly competent designers with the most advanced design software available. The findings of the simulation show that the overall amount of delay as well as the average length of time needed to complete each project both decrease as the number of projects being worked on grows. This explains why projects that have a history of performance that is comparable to others have a tendency to have superior time performance: more consistency and efficiency in managing delay factors over subsequent executions of the same project. As a result, building projects can reap the benefits of careful research of the causes that cause delays, which reduces both the duration and severity of delays. Long-term construction delays can be reduced by implementing a number of best practices, including effective supervision during construction (owing to knowledgeable supervisors), good project management, and coordination among key stakeholders (owners, consultants, and contractors).

5. CONCLUSIONS AND RECOMMENDATION

Cost-influencing features are the characteristics of a building that serve as an indicator of the building's quality and have an effect on the building's price. The more influential parts of a project there are, the easier it is to characterize it. There will be an extremely large number of examples to approximate if there are multiple causal elements. Since this is the case, increasing the estimate's precision relies heavily on picking the right number of components. Clients of construction companies are more hesitant to initiate new projects, which has hurt the reputation of construction industry experts. The initial estimate will remain in the customer's mind as the foundation around which he builds all subsequent calculations. It's safe to assume that a customer will remember your estimate if you provide one. When working on engineering or construction projects, it is crucial to have precise early adaptive estimates. The primary objective of this strategy is to collect a real-time estimate for the proposed project prior to establishing all of the design and contract specifics. For this reason, a client's preliminary estimate is a crucial piece of paperwork in helping him do a complete examination of the feasibility of his proposed project and determine whether the investment would be profitable. Testing a preliminary budget using a variety of more comprehensive cost prediction methods that parallel the procedure of creating design and construction requirements is crucial. Cost estimates should be produced, either by a member of the design team or by a separate professional estimating firm working directly for the owner. However, the lack of price forecasting theories is a major roadblock to the evolution of empirical methods in this area. Construction cost estimates based on adaptive concepts should be generated during the phase of the project where the original design is being developed. The more data that is collected about the site's specifics and the many options for fixing the problem, the more precise and thorough the adaptive estimates will be. The main conclusion in this research is:

1. The primary cause of the delay in the construction of the structure of the multistorey building is the delay in the contractors' initial decision-making process.
2. The design documentation challenges, the drawing methodologies, and the bill of quantities created by the designers are the primary causes of the project's implementation delay.
3. The building phase obstacles in the structural work cause budgetary challenges.

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