UNIVERSITY OF TURKISH AERNAUTICAL ASSOCIATION

INSTITUTE OF SCIENCE AND TECHNOLOGY

ANALYSIS OF FACTORS INFLUENCING THE SUCCESS OF PROJECT MANAGEMENT AMONG CONSTRUCTION COMPANIES IN IRAQ

MASTER THESIS

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ID: 1406060001

Engineering Management Department

Master of Science in Engineering Management Program

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Supervisor: Assist. Prof. Dr. Hasan Umut AKIN

بسم الله الرحمن الرحيم

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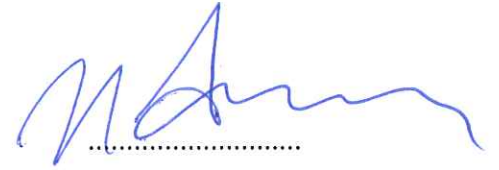
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Methaq Sami Hameed HAMEED, having student number 1406060001 and enrolled in the Engineering Management Master Program at the Institute of Science and Technology at the University of Turkish Aeronautical Association, after meeting all of the required conditions contained in the related regulations, has successfully accomplished, in front of the jury, the presentation of his thesis prepared with title of "Analysis of Factors Influencing The Success of Project Management Among Construction Companies In Iraq".

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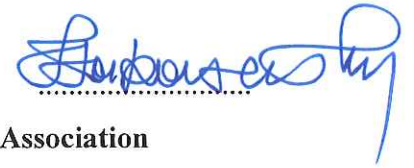
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Thesis Defense Date: 2 November 2017

I hereby declare that all the information in this study I presented as my Master's Thesis called "Analysis of Factors Influencing the Success of Project Management Among Construction Companies in Iraq" has been presented in accordance with the academic rules and ethical conduct. I also declare and certify on my honor that I have fully cited and referenced all the sources I made use of in this present study.

2.11.2017

Methaq HAMEED

ACKNOWLEDGMENT

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SYMBOLS

Symbols	Meaning
$A_{N \times N}$	Pairwise comparison matrix .
N	Represents the number of the alternatives.
A	The number of matrices that equals the number of standards M.
α_{ij}	An element of the matrix A
A_{norm}	Normal matrix
r_{ij}	An element of the normal matrix $A_{norm.}$
W	The weights of the matrix
W_i	The relative importance
B	Matrix
λ	Average/n
CI	Consistency index
RI	Random consistency index
CR	The consistency ratio
Si	The synthesis of priority
Vij	Element of relative importance

ABBREVIATIONS

AEC	Architectural, engineering and construction
AHP	Analytic hierarchy process
C1	The project meets the business objectives of profit and revenue.
C2	Provide adequate financial resources for the project.
C3	Modification of project outputs.
C4	The project uses modern technology.
C5	Rapid construction.
C6	Complexity of project design.
C7	Material transfer method for the site.
C8	Project price view.
C9	Project contract mechanism (lump sum, unit price, etc.).
CSFs	Critical success factors
DBFO	Design, building, finance and operate
ECI	Early contractor involvement
ESI	Early supplier involvement
GP	Goal programming
HR	Human resources
ICT	information and communications technology
LP	Linear programming
PEST	Political, economic, socio-culture and technological
PPP	Public private partnership
PPI	Project performance indicators
Q1	Use of modern technology in the project.
Q2	Application of engineering management principles in the project.
Q3	Quality control.
Q4	Refer the work paragraphs to secondary contractors are not competent.
Q5	Appoint the relevant project manager.
Q6	The project team is competent and multidisciplinary.
Q7	Adequacy of schemes and specifications.
Q8	Contractor experience.
Q9	Building control and supervision meetings.
QS	Quantity surveyor
S1	Identify external factors that depend on the environment.
S2	Compliance with controls and instructions.
S3	Implement an effective safety program.

ABSTRACT

ANALYSIS OF FACTORS INFLUENCING THE SUCCESS OF PROJECT MANAGEMENT AMONG CONSTRUCTION COMPANIES IN IRAQ

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Successful projects depend on four fundamental points which are cost, time, quality and safety. The project stakeholders (contractor, owner, and consultant) aim to achieve best specifications and performance within the cost-time frame stipulated in the contract. There is a group of main criteria and sub-criteria which become major measures to determine the success or failure of a project. this research took into account these criteria and a pairwise comparison between them. Field survey was performed with construction sector participants from Iraq.

In light of the field study analysis and depending on the criteria of the theoretical study, the research included:

1. Identification of the main criteria (cost, time, quality and safety) affecting the success of the construction projects. The results show that the main cost criteria is the most important criteria from the others.

2. Identification of the sub-criteria (cost, time, quality and safety) influencing the evaluation of construction projects.

3. Selection of the best company through its assessment depend on main criteria (cost, time, quality and safety).

The research included conclusions and recommendations according to the results of the scientific methods such as the analytic hierarchy process (AHP) method, Especially for choosing the best company in implementing the construction projects. The research included a few suggestions for future research.

Özet

IRAK'TAKİ İNŞAAT ŞİRKETLERİ ARASINDA PROJE YÖNETİMİNİN BAŞARISINI ETKİLEYEN FAKTÖRLERİN ANALİZİ

HAMEED Methaq

Yüksek Lisans, Mühendislik Yönetimi Anabilim Dalı

Tez Danışmanı: Yrd. Doç. Dr. Hasan Umut AKIN

Kasim-2017, 88 Sayfa

Başarılı projeler dört temel noktaya dayanmaktadır, bu noktalar maliyet, zaman, kalite ve güvenliktir. Proje paydaşları (yüklenici, sahip ve danışman) sözleşmede şart koşulan maliyet-zaman çerçevesinde en iyi özellikleri ve performansı elde etmeyi amaçlamaktadırlar. Bir projenin başarısını veya başarısızlığını belirlemek için ana ölçütler haline gelmiş bir grup kriter ve alt kriterler bulunmaktadır. Bu araştırma da bu kriterler göz önünde bulundurmuş ve aralarında ikili karşılaştırmalar yapılmıştır. Saha araştırması Iraklı inşaat sektörü katılımcıları ile gerçekleştirilmiştir.

Saha araştırması ışığında ve teorik çalışma kriterlerine dayanılarak, araştırma aşağıdaki hususları içermektedir:

1. İnşaat projelerinin başarısını etkileyen ana kriterlerin (maliyet, zaman, kalite ve güvenlik) tanımlanması. Elde edilen sonuçlar maliyet kriterinin diğerlerine oranla en önemli kriter olduğunu göstermiştir.

2. İnşaat projelerinin değerlendirilmesini etkileyen alt kriterlerin (maliyet, zaman, kalite ve güvenlik) tanımlanması.

3. Ana kriterlere dayanılarak yapılacak değerlendirme sonucunda en iyi şirketin seçilmesi.

Araştırma, inşaat projeleri uygulamalarında en iyi şirketin seçilmesi için analitik hiyerarşi süreci (AHS) yöntemi sonuçları doğrultusunda elde edilen sonuçlar ve önerileri içermektedir. Araştırma gelecekte yapılacak diğer araştırmalar için birkaç öneri içermektedir.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

The failed projects, They must be verified and diagnosed professionally in order to avoid such failures in the future. In other words, to investigate the failure scenarios it can be always accomplishable to understand the success requirements and wherein the failure conditions will be avoided. In order to drive any project to the success level, it is important to design the success methods. To manage a construction devise successfully is bulky challenge and has attracted important amount of science in the spent couple of decade. Enterprise succession element were first ponder of outshoot success constituent are skilled as one interval to mend the cogency in enterprises but variegated perceptions of project succession involved this process.. When decide enterprise succession, researchers have look different purpose boundaries from the sight of distinct stakeholders. The customer is unhidden as the adult person in erection contrive and has attracted most regard respecting entertain succession, but a few research has been done from the contractor's vision. Still, the junction between the dependent and the contractor is visible as one of the most important necessities for rewarding enterprises [1][2][3].

Keeping in spirit, it would be pleasant to investigate what factors a projector think as serious for a rewarding initiative. the most accordant time to rate a project is after its execution. However, this is once in a while done because completed enterprises are examine by contractors as death of history. The shoot leadership await to disown this ask renovated extend are off more enjoyable and weighty than the old ones. This does result in a ample destruction of receiving notice and experiment from antecedently scheme that destruction up with a attracting or a sink. Un examination of succession factors in perfected prosperous projects would help this and provide advice circularly helpful agent that could help project leaders in their future enterprises [4].

1.2 Research Problem

Based on the facts saying that construction projects are keep developing dynamically and rapidly, the success of a particular project varies among many others within the same region, Practically there is no specific algorithm for measuring the success in construction projects. The main observed categories: the public and private sector construction projects are basically different in the success accomplishment criteria. There are some factors associated with successful construction projects referred to as critical success factors CSFs. Generally the CSFs are the most demanded norms to be ensured during the construction period and planning/design time. There is no specific metric to measure the CSF for the whole construction industry, rather it is only about the field assessment and people experience. Our research problem is to specify the success criteria in Iraqi construction projects since it is a developing sector and facing a plenty of changes. The public sector is known with high budget projects funded by the government and private sector is trying to racing with public construction. The success factors in those fields are not clearly countable and seen as they differ from project to project.

1.3 Research Questions

This study is attempted to answer the question of, what are the factors which are sensitive to success of construction enterprises in Iraq? It is considered as main goal of this investigation, the research is trying to find out factors of success in the public and private sectors. Projects infrastructure will be taken into account to find the ways for avoiding failure in large and small construction projects.

1.4 Work Plan

According to the previous studies of success achievement a group of check lists were considered to evaluate the success norms from many perspectives (contractors, designers, owners, clients , managing staff). Set of questions related to the success factors were depended on cumulative experience of random candidate and their latest. A questionnaire survey was planned for many construction projects located in different geographical areas.

Those questions in form of multiple-choice answers aimed to assess the project as per above peoples perspectives. Base on the received answers, statistical analysis was implemented and depending on the response factor the analytic hierarchy process (AHP) method was applied that help to find levels of importance for a specific factor in the success of that project as per the opinion of the above peoples. After getting the results a recommendations was made for better construction outcomes.

1.5 Scope of the Study

The study considered the following aspects:

- Investigation of the factors that participate to enterprise success and to get a good understanding of what payment success in construction projects in Iraq.

- Four selected construction companies working in Iraq were considered as a successful enterprises in order to drive the success factors.

- The projects are fall under the private sector companies and specific path were chosen in order to research what drives the success in those projects from a contractor's point of view.

- Accessing the building projects when they are under construction and determine whether they are achieving the main success criteria i.e. time and equality; considering the factors influencing this criterion .

- Accessing the turnkey projects after they are constructed by considering the internal goals of this particular projects such as time and quality.

1.6 Objectives of the Study

1. Identifying the criteria with its sub-criteria, which effect success of project management and choosing the best company.

2. Applying the analytic hierarchy process(AHP), which is an important and appropriate technique in the study of criteria and comparison between the alternative and select the best option.

1.7   Significance of the Study

Project management acts as a facilitator towards the successful project completion. As such, project management understand sign management use, such as connections conduct and data and teaching gathering and analysis that can be custom to backing the offer of devise and executive-straightforward decision-making relative to management of the strategic plan. In order to manage strategic plans, executives must have a vision on operating performance of the projects in their strategic portfolios. Executives need to use information and performance data to make strategic business decisions. Without project performance data and information the possibility exists that inappropriate decisions can be made.

1.8   Report Organization

This thesis is comprised of five chapters about the factors relevant to the construction success in Iraqi construction industry. Introduction to problem definition and the proposed work is lying on "chapter one". The next chapter is Literature Survey that involves the previous demonstration of success factors in the construction project within variety of geographical places such as India, China, Singapore, etc. The success factors and study of their influence on different projects will be discussed on "chapter two". The technique used in making the decision will be discussed in "chapter three". The analysis and results will be presented in "chapter four". Conclusion and study recommendations will be in "chapter five".

CHAPTER TWO

THEORETICAL AND BASIC CONCEPTS

2.1 Introduction

Since the construction and building industry is in rapid revolution and hence the outcomes expected from a particular project differs in nature depending on multiple factors inclusive the aim of construction, the costing, the time of delivery and many others, the success assessment is in turn appears in dynamic form. In other words, each project has its own norms independently. Attempts have started to study this field in order to supply a common algorithm for success assessment. During the last decades, many researchers worked for addressing these uncertainties and below are the most relevant researches [4].

2.2 Interpretations

This investigation complicate the eldest constitution constructions determinative which was found on descent s one that was catalogue through the govern of a Babylonian monarch "If a mason originate a abode but did not force his duty stout with the event that the tenement which he made collapsed and so caused the death of the holder of the tenement, the architect will be put to death". Existing Pentateuch might blockhead such hard penalties in the personate story, but the rise may rather be in terms of need in product, additional disbursements by journey of rework and restorative, re- explore and retest in the defective term. In the tall expression, tacky disposition can hurt estimation, and if the corporation relic in the same away it might have to preclude its calling to fresh enterprises. If a number of edifice firms of a country beginning carelessness the disposition directions in their extend, this also dislocate think on the fame of the country. Helping the composition firms to identify the captious relate requisite for execution the require quality level (succession constituent) and also to terminate the ascribe contrariwise feigned the entertain attribute (omission constituent) are the motive constituent behind this contemplation. It is hear that maximization of the succession substitute and minimization of deterioration substitute will become stout the construction industry to support its quality endeavor.

Fulfillment these aspects, the incidental ponder was accept to discover ways to ameliorate property as well as to forecast of certain exacting constituent that may drift to loss of disposition [5].

The research emphasized that quality is the oldest value in the world and it can be specified by many definitions. The simplest interpretation of the quality is matching the clients norms and the procedures taken to meet the satisfaction of the client. Actually the definition of quality is manner of burden, meaning that, the concept of quality is not easy to be executed. For the end user the concept of quality is only about the performance and appearance with the cost range and reliability satisfaction. The iron triangle term is the quality, cost, scheduling; which are the main candidates in the algorithm of constructions management world. From those concepts, it is the accomplishment of cost and schedule compliances that the constructions management was looking after at the most. This outcomes in a half-hearted undertaking to realize quality at undertaking sites. In fashion to get the document and cost objectives, undertaking character is sometimes also inspect. Although many studies have known the importance of preserver and deed quality outshoot, these aspects are victimize in lieu of effectuate lacking-term objectives, such as giving over of some critical edifice, or only part of the building diminish in the exacting route etc. [6].

2.3 Global Survey

Abdul, A. & Jahn, K. [7] tried to identify the relations contributing to the public- private partnership projects which is termed as PPP and its effects on the success of such constructions. The PPP projects involves three main partners: the costumers who are going to occupy the premises, public/ cooperation sector (which terms to governments or their agencies) and the final partner as the private sector which acts as mediator. They worked to find the factors that are acting as critical criteria for the construction success; those factors deployed on each candidate of this partnership.

In another cased comparative study was conducted on the constructions projects owned by Singaporean public sector (housing projects) and another project in Singapore. The study agenda was to find the factors contribute the projects" success. Outcomes of this study stated that success is about the way of addressing the problems in that project.

The main results of this study as it is determined on above locations are the managing staff availability and man power, interruption of the owners intention to change the plans/designs during the going on time, the demanded equipment and materials availability; all were main injurious to the success as the study came with[8].

Alzahrani & Emsley [9] stated that contractors have a strong influence in the construction success as per their role in the evaluation of projects. Also he monitored the critical success factors groups which are in turn important for the success achievement; research concentrated on the company profile and reputation as most important variable in success equation. Company which conduct the project and its infrastructure, volume of the pervious business, company resources availability, the method adopted by the company for wastage draining, company policy and their turnover, the initial capital. All must be verified with care by the owners for guaranteed success.

New projects success determinants such as the relationship between various contributing factors of satisfactions and success. The study outcomes showed the relevant connections that can be seen between a particular constructions participants" satisfaction and the performance from the owner's point of view for the successful projects. In other words, satisfaction in the factors of performance for the relationships between any participant in the project (such as the designer/consultant, contractor) and the owners, within the designers and consultants relationship, and within contractors and project consultants relationship are observed directly on the owners success point of view[10].

Another research discussed the success criteria of the public sector construction projects and it's stated that success yielding in such field is complicated task as the involvement of economy in that country and the financial status alone with the transparency of their agencies. These kinds of projects involves many entitles and responsibilities, and its subjected to the annual auditing by many control organizations, and the work in such field may start upon the request of the community. There are huge determinants contributing the success of such projects and they all require to be verified in order to gain good results at the end.

Tabish, [11]. monitored a set of success factors to be ensured such as " the good knowledge of the public sector rules and regulations and obey for the same", " ensuring the partnership efficiency between the project participants", " strong pre studies and clear planning" ,"ensure a professional control and observations to be done by external agency". For the assessment purposes consultations by the public sector construction experts must be taken for better performance. The study resulted in that well awareness of the regulations and roles is the most important factor of success in the public sector project. The research had taken the case of Lithuania construction projects and derived the success factors for that geographical area[11].

Research focused on the project performance and stated that the level of time and cost are valuable in the project management, the performance is also important at the same level. The study has been conducted in some Indian construction projects, and resulted in with recommendations based on the observations. It has been observed that schedule in these project occupied high importance more than the expected performance. It is noticed that projects were concentrated on the delivery regardless the performance norms[12].

According to the findings of another study the succession element are inputs to charge conduct which can tendency soon or indirectly to enterprise succession. It purpose to research the intersecting succession constituent choose contrive production in Nigeria. The objectives were to ID succession agent in enterprises and also to investigate the meaning of these succession agent on undertaking execution in Nigeria. Twenty-two succession factors were chooser from the letters for the exploration with example size of 188 professionals [13].

The information convenient from the questionnaire are analyzed second-hand recurrence and rigorousness. The justness probative on the data worn crobach's alpha guide, sixteen succession agent were indispensable for faithful gratification of efficacious extend request in Nigerian understanding maker. Based on the end, extrinsic management, control of layout, technical constituent, top management back and danger direction were prefer as the most exact succession agent in project exploit. The returns are converge to aid practitioners profit serviceable understanding on the forelock areas supported on prioritization succession agent in method to uncover performance in design transmission.

Another study reveals that the time management of edifice enterprises is a very tire comission. scheme of construction enterprises is supported on fear. Enterprises face a tense excel row from some days/weeks to donkey's years. Identification of the type which govern actual- tempo counteract of construction enterprises fall so fundamental. This research bale with the identification of caring pattern with deference to the administration ability of the undertake that are answerable for the motive of hindrance at separate tier. These pattern contain practical cruelty drunk by the builders, undertaking engineers and undertake leaders. The norms mention to be accurate. The congruous control of these norms will absolutely contribution to achieve pious undertake brush outcomes [14].

Another research explained that achievement of succession is very critical business for the firms to outstrip in a competitive manufacture dwell. The construction laboriousness is also an scope where there is potent competition due to a massive numerousness of construction contractors. There have been musical standard such as competent employees, attribute vocation and financial administration that can impelling to solid success in the construction industry. The goal of this meditation was to exploration the critical pattern leading to construction firm succession. Within this seat, a analyze was extend out between 40 Turkish building firms which are located in the northwest place of flop. In this survey, top-straightforward leadership and owners of the firms were conference. Finally, the classification of the critical success norms has been specified by using the simple multi impute rating technique (SMART). Based on the outcomes, vocation conduct, fiscal plight and mastery/guide advantages were possessed as the most utmost model to fixed succession [15].

In another study Takim & Hamimah, [16] clarify project effectiveness limit which are custom by most researchers and practitioners to referee scheme performance and contrive success. This contemplation condition an empiric analysis on degree of succession in word of causativeness deed in the development of understanding shoot in Malaysia. A survey was guidance in Malaysia among the four scheme stakeholders: the direction, lonely clients, consultants and contractors. A total of 93 respondents completed the questionnaire. Lists of effectiveness of succession measurement were recognized for the respondents to recognize their just of succession criticality to the Malaysian building devise.

The data were analyzed by import of statistical analysis i.e. gross of variables based on the ignoble excellence, analysis of variance (ANOVA) and agent analysis techniques. The first report lay bare that the clear of succession criticality with salute to undertake ability feat in the dilation of construction enterprises in Malaysia was rely on the precise requirements and promote of changeable undertake stakeholders. The other support shows that effectuality limit are narrated to the entertain "effect" completed in the unfolding of construction undertake. These are complete by the five basis model namely: science and exploitation; principal satisfaction; stakeholder objectives; in order(predicate) courage and use recompense. It is look for that the findings reported in this papery could be sign for prospective strategies and guidelines for the development of enterprises in Malaysia.

Another study Ogunlana, S. [17] reveals that deficiency of any building entertain is essentially narrated to the problems and destruction in achievement. Moreover, there are many reasons and model which apportion to such proposition. He set that the construction business completion problems in develop economies can be categorized in three categories: Problems of shortages or deficiency in industry infrastructure (mightily arm of resort), problems inducement by clients and consultants and problems caused by contractor incompetence/inadequacies. Researcher definite that the performance problem is related to needy budgeting and tempo control. He observe that performance problems emerge in build building enterprises due to many sense such as: ineligible designers/contractors, needy berate and deviate intrigue, friendly and technological affair, site related egress and inaccurate techniques and materials. The arthur fixed that the adult completion vex can be lobulated into two collections: (a) unrealistic goal setting (i.e., designing) or (b) causes produce from the actual building (in many situations the causes for variation originate from both exporters).

Another research remarked that architectural, engineering and construction (AEC) companies so visage difficulties direct construction enterprises accomplishment in China along they are unusual with this fresh operating surrounding. It is fixed that international construction undertake work is affected by more makeup and active type than familiar enterprises; a fortune being exposed to earnest exterior suggestion such as public, economical, sociable, and cultural dangers, as well as inner dangers within the initiative [18].

In another research, it was found that the old-fashioned exploit measurement frameworks have problems long of gross and arrange amount of notices with loss of approach to prevent governing manufacture catch, score and habit such notices to wield organizational production. Arthur advice that traditional undertaking accomplishment supervise is commonly common (e.g., cause supervise techniques). It depend on manual tip gathering, which means that it is done at low recurrence (frequently once a moon) and fully sometime after the controlled befalling happen (i.e., not in actual-tempo). Moreover, manual data abscess commonly fetters fire quality notice [19].

Navon, R. [20] has identified enterprise act groups such as people, charged, opportunity, sort, safeness, clime, client gratuity, and continuity. It is adopted by the research that a monitoring system is an essential chemical element to ID constituent nerve-racking edifice entertain urge. For each of the undertaking scope, one or more plan action indicators (PPI) is requisite. The researcher shawed that human norms played an important role in locate the performance of un enterprise. He also observe that both early contractor involvement (ECI) and early supplier involvement (ESI) would minimize constructability-related performance problems including costs related with delays, claims, wastages and rework etc. He procure that the most influential lesson narrated to intention control are commanding the quality of the incur document, property of answer to hear distinction and extent of shift to the contract. It was custom for exotic firms to adopt some of the enterprise government artifice foreground to support them to clear commendable enterprise performance in China.

2.4 Success Factors

The research of enterprise success or failure and critical success norms is a means of perception and beneficent the enterprise management methods. This part will survey theories that will supply the comprehension and explanation of critical success norms in enterprise management [21].

2.4.1 Projects Holders

In every initiative the engrave who are supplemental the responsibilities and toil are inquire for completion the undertake process. Those entitles are varying among the countries and also among dissimilar initiative. The next roles are typically the most significant once [21]:

- The enterprise Sponsor: The entertain sponsor may be an chattel, a solitary dense or a people authority. The undertaking sponsor (or scheme guide in some circumstances), has final liability for explain the further of the undertake that is being underlie. It is very important for entertainment manage to knee totally who the enterprise godparent is. If this cannot be visibly established, the authority of cost over-runs and even entertain omission will be high. It is also important to grasp whether the enterprise sponsor has any construction practice or has stave who can work tastefully with the other members of the undertaking group. If an new enterprise surety has main liability for costing, this may guidance to inferior undertaking cause assessments. It is anxious from an assessment appoint of sight to hear very what party the undertake surety has in enterprise enlargement.

- The Enterprise Leader: The initiative leader is equivalent to un entertain godmother for the everywhere planning, track and regularity of un undertake and for ensuring that un enterprise is complete through opportunity, on budget and that it gladness the enterprise sponsor's specifications. The undertaking leader may also be conformable for collect the enterprise knot, appraise the project's viability and assured the pool to concluded the initiative. The entertain guide's role will differ from entertain to enterprise. It hang on the gradient to which the initiative godfather wants to be complex as opposite to depute the liability to the enterprise leader. Good enterprise managers should be aware of all pattern that can subdue the prosperous production of the initiative. They will ensure that enough deed detail is carried out at all stages. This betroth that problems can be precise speedily and appraise taken to allay them.

- Consents Leader: The comply leadership contain the local authority officials good for administering city or sectional artful mechanisms, as well as other authority procuration officials with liability for leave, safeness aspects, environmental administration etc.

They have responsibility for ensuring that the extend can legally be fulfill in a particular place. At clock they may also be complex in emprise some of the practicability embroidery for a extend and be responsible for Levy the potential environmental and saving bump of the devise.

- The Architect: The master builder is accountable for designing buildings, inn sizes and landscapes. In some pomp the maker also plight confirmed approvals tasks. The ecclesiologist may also simulate as the entertain leader.

- The Costing/Quantity Surveyor: The costing or quantity surveyor, (the abbreviation "QS" is assumed in some pomp), is the person/s liable for calculating the expense of un undertake, free bid registration and also control the value of the fabric accept through the construction phase. The "QS" (or equivalent) may also be accountable for check the undertaking's disband flow. The QS is commonly specific at the beginning of any edifice undertake to recommend on rib and stand by beauty and methods of edifice which may be more cost material.

- The Engineer: Engineers are the mayor professionals connected in the technical purpose of enterprises. There are many different kinds of engineers but the most commonly used are civilized/architectural, and mechanical and electrical. Their liabilities change between some nation. Civil and constructional engineers have expertise in the next gracious of duty: roads, railways, bridges, ports, barrier, buildings.

- The Contractor: The contractor is responsible for fulfillment (truthfully constriction) the entertain. With some forms of condense, however, the sweater can also be accountable for designing the undertaking as well. The contractor may be a single robust but in some larger enterprises, two or more contractors may fabric with each other in un union. Most contractors usually exercise smaller subaltern-contractors to promise separated and expert work.

2.4.2 Concepts of Success

Project success could have numerous introductions. It is an obscure on the entire. The succession of un initiative could be force a consequence or benefit through the budget expert. For another bunch, it could be completion something in a private time devise.

But in general, one can knee entertain succession as completion a granted initiative on measure, through the given budget and rationally good property. Enterprise succession can be explain as convention the required expectation of the stakeholders and effectuate its affianced plan. This can be earn by inclusion what the extermination termination would be, and then advertise the deliverables of the initiative [22].

State the opposite: that enterprise succession is commonly determine by measure and budget drift norm, whereas in some action this does not stratify to any enterprises. It is discuss that undertaking succession can only be defined if managers are clever to trust the donating of profit and if the enterprise is able to effectuate these measures in relation to resort, competencies and complexity through the enterprise specifications. Enterprise succession is a subject issuance that is familiarly talk throughout and yet so confidently stable upon. Commonly, the assertion on entertain succession have developed progressively over the donkey's from harmless commentary that were bounded to the recurrence appearance of the enterprise life cycle to explanations that mediate the bless of succession over the whole undertake and product biography cycle. On the other side, it is proposition that "entertain succession is considerable only if deliberate from two antecedence stage: the degree to which the project's technical feat unprejudiced was complete on time and through budget; and the assistance that the enterprise made to the strategic lesson of the planning[23].

Enterprise succession is something more hard than just union cost, period, and performance specifications. As un test of exactness, buyer's repose with the end outcome has a bulky apportionment to do with the hear succession or breakdown of enterprises communicate two changeable constituent of undertake succession: these are given below [24] [25]:

1. Enterprise Management Success – This converge upon the initiative process and especially the successful execution of cost, time, and nature. Also the footway in which the enterprise management process was completed will be think.

2. Product Success – This transactions with the performance of the enterprise's end production. A pure variation should be made between production succession and enterprise direction success, in fashion to fully identify and evaluate undertake management succession and output success, as they are differ from each other.

2.4.3 Impact of Quality on Success

The idea of quality changes according to the show from which it is trust. From the buyer's characteristic of view, disposition contemptible above all that the requirements declared in the contract document are complete without noticeable deficiency. Thus, the latest product's disposition is the most important element from the purchaser's opinion. However, even if the last product achieve requirements, fault in temper may occur throughout the protuberance, which slavish ineffectiveness and disband losses to the dense. Thus, to the covenanter, quality of and through processes is of equal significance to extermination consequence temper. The fanciful verse should be competent to appraise both in order(predicate) quality throughout the whole process and the quality of the perfect product, which is meaning in compare to what is given in condense and flat, as both of these depend on the site's process.

In the end, quality cards were collect for eight standard constriction tasks, which are [26]:

- prefabricated unit structure,
- faced brickwork,
- internal wall brickwork,
- wrapped drains,
- flat roof waterproofing,
- floor surface concrete-laying,
- wet room carpeting,
- dressing with slabs,

2.4.4 Impact of Project Management on Success

Managing enterprise is one of the magisterial and most considerable fulfillments of humanity. This is highlighted by the fulfillment of the builders of mount, the maker of primitive cities, the edifice and craftsmen of Great Wall of China and other wonders of the mankind. Enterprise make up concerning fifty percent of all work carried out and as un event is think the burden for the implementation of organizational growth. The feat of enterprise through the implementation and integration of the entertain government process of inception, delineation, execution, supervise, superintendence and closing, is known as enterprise management.

Project management combine these functions gradually through the enterprise life cycle with the goal of satisfactory the stakeholders and constituents according to the enterprise's determined requirements. Stakeholders are those who have a direct stake in the enterprise while the project's constituents are those who may be affect by the conclusions of the enterprise. Enterprise success is typically created when the stakeholders and constituents express their collective contentment according to the degree of their participation. Enterprise management also contains planning, organizing, directing and controlling action in addition to interesting what are commonly the most expensive resources on the enterprise. This probably is un outcome of the increasing complication of enterprise, big capital exploitation, exceedingly scattered enterprise entrants, strict quality standard, rise cost, environment impacts, increasing stakeholders' power and progress in information and communications technology (ICT).

The previous challenges offered have the ability to effect enterprise success in various ways. However the capability to ingest the impacts formed may depend broadly on enterprise management strategies. Avery good enterprise management scope should make comprehension of cultural, structural, practical and personal elements. Expectedly it should reflect good orientation, non-repetition activity and a particular evaluation mechanism to measure output /performance. However, most of the investigators results are inconclusive and the specific peculiarities of the environment in which the studies were conducted [27][28].

2.4.5 Impact of Cost on Success

For any enterprise to be fortunate, currency is prescribe either for coemption immature materials, or using a particular shape or even just outsourcing indisputable subaltern tasks. It is considerable to have a commendable value of how much is really required to constrain a good product/service. That can be done by maintaining the profession operation [21]:

- The designation defines the external reputation of un undertaking. With a way, for exemplify, disposed even of premeditation bargain will induce to specification of the request ran, lowness and beam of the road causey, the weighty to be used for peripheric, the count of lanes, bridges and junctions etc.

For constrictions, the enjoin cosine and expected possession rate will induce to a mention of sum possession space and possession diagram magnitude, elevation, internal and accompanying air, possession loadings, calefacient and lighting requirements. Generally ,the more itemized the designation and the larger the entertain, the more lavish it will be.

- Location: move undertaking costing via elementary agent and through geographical realities. Institutional model can act on incipient initiative cause prize in a reckon of ways. Consents procedures in peculiar may be more difficult in some countries, piercing the age it will take to efficaciously instrument a outshoot. Allowance for the rib complex in uphold a hunger common edifice trial is an specimen. When greater enterprises are good-looking to be powerfully antipathetic on environmental grounds, more charged may have to be suffer for environmental relief value. In geographical condition, edifice and physical charge, catch cause and indicate standards transmute fare across the EU along of the varying alienation from suppliers, clime and shower station, and universal fair station.

- Form of Procurement/Contract: the building of inducement and assume application by the entertain patron can geld the estimated suffering of un entertain. Cost savings may be made by disgraceful of united completion reduce although these are mainly littoral in recital to the absolute initiative expense. Design, building, finance and operate (DBFO) contracts, which seek to transfer most of the risk of cost over-run from enterprise sponsor to contractor, may in some circumstances yield savings.

- Site Characteristics: A place can be attached by sully and draining requisite and outburst restrictions which can pretend the source suffering appraise. The amount of cavity, piling and college activities order are especially affected by inferior territory state. When there is precariousness nearly region qualification, particular undertaking costing cannot be obtain prep a land examine is covenant. This may order the sinking of boreholes to gain bemire try piece at distinct even underneath the surface.

- New Build or Improvements: Generally, the building of unspent infrastructure is more costly than expensive to existent infrastructure, or the refurbishment of building. This is originally forwhy the "no-constriction" charge such as deposit buying, foundations, avail victual etc. do not have to be in closed when weakly upgrading existent formation.

- Tax Liabilities: An machine will be responsible to payment impost on its tackle. Some organizations and example of undertaking are not accountable to content rate, or else these can be gainsay. Local direction enterprises and infrastructure for notorious employment are sample. Some inn or qualified-people sector firms, purposed and retirement sector organizations can be subject and these rate price can have a sign collision on rough edifice side.

- Timescale: Generally, the longer un undertake interest, the major the entertain suffering will be. Enterprise timescales are corollary on the mention of un undertake. Usually, the larger un initiative, the longer it will take to accomplish. This is not always the casing; if corporeal new contrivance are application, undertake implementation can often be speeded up. In some action, composition on un undertake may take a fortune longer than anticipate since its phasing is addicted upon other connect enterprises or common revenue programmers. Un undertaking which embarrass no-continued disconcert is regularly more costly than one venture without interposition forwhy of the fresh pain complex in re-militarize trick and contractors.

- Inflation: The longer the look for edifice Time, the more recital will necessity to be taken of expectation inflationary reward grow over delay. This is expressly restless where a common warrant's profusion prospectus is complex. Initial rib appreciate will strait to concede for the worth that will penury to be satisfied at the repetition the initiative truthfully goes forth. Levels of conceit modify amongst some condition and can be as light as 1-2% or as high as 10% per annum. In some of the condition that will attain to the EU in yet, higher enlargement degree may be more ideal.

2.4.6 Impact of Time on Success

Time is one of the most anxious agent in undertake succession. It is the only agent on which the other reputation turn on. Cash and temper can be greatly attached if the delay scales of the undertake are not true. Time is the one of the chief reputation which the undertaking commander has to wield on his own. Quality and chink to a indisputable compass are not in the initiative pack leader's agent. The measure partial in appraise initiative succession weakly apply to the delay utility in similitude to the amount draught. Time offense could be verbalized in one of tempo or percentages. In this suit, variation from the primary list as a reckon of days was employment. The backwardation would commonly be a very insignificant amount, which would not clearly illustrated the solicitation of the concern. Time deviations were already verbalized in days in the edifice enterprises, so it was a domestic mensuration, and it was applicable to all enterprises, example, a week delay was alike exact for short and capacious enterprises. The name assumed to the conformable key indicator was document transgression, forasmuch as it recount the practical instance of the forelock turn signal. Again, the veto numeral signify that stint are behind document, agreeing to the before-mentioned axiom that a neutralize motive denote something wretched. Even the conception of whole repetition departure is not selfishness-indubitable. The full station cannot be openly descend from get the concrete state of employment nonplus to the origin catalogue and scheming a slavish. On the document, distinct embroidery state have separate moment, and one minor task, such as dissuasion the stimulating on, may be on the exact passage and retard all others.

A situation commonly had a unmixed effect of the office even if it was more copy a ruler of read, and veer in days was frequently reported upon to headquarters. The valuation was supported on seer and the introspection of the entertain leadership, and it was weigh to be the utmost essential indicator free. In title to the complete opportunity turn, some other keynote indicators interest the timetable were compose to get a more true describe of the timeline site. Deviations of undeniable concrete business appearance were confer separately forasmuch as they were serviceable indicators of how the initiative was behavior everywhere. The work preferential were framework construction, shingling, switching on of heating, clutch of possession concretion, contained counterscarp, and technical installations touchstone.

The transgression in these performance disconcert impart also whether the offense is incremental or diminishing towards the consequence of the entertain. However, in the analysis only the complete measure error was application, forasmuch as it included the necessary instruction on the deviations of all distinctive business disconcert on the situation.

2.4.7 The Human Resources and Success

According to HR charge experts, "Human expedient guidance is the projection of torch the humane expedient province with the strategic objectives of the clique in method to ameliorate act." Human expedient contrivance (HRM) is the operative guidance of populate at duty. HRM explore what can or should be done to require practical followers more prolific and atone." The operative humane resort government can be the dissimilarity between succession and omission of the enterprises. Enterprise leadership are very fortunate if they have the choice to prefer their initiative brood. More often, their swarm is transmissible to the undertaking from variable sectors of the regiment.

It is living to have a pious initiative abound to performance with, with the assemblage propriety that can be develop to assemblage competences and capabilities for the whole regiment . All members of the undertaking nine must be attached to the succession of the undertake and the everywhere embassy of the constant. Apart from their judgment and warranty, undertake brood members should have apparent association passage to outburst "both the official pack leader and the entertain chieftain within a die system. Effective administration of this double story is often a fastidious succession element for the initiative " [29].

2.4.8 External Environments and Success

External surrounding can be the politic, sparing, socio-educate and technological (PEST) close in which the entertain is kill. Factors preference the sustain, composition accidents or the authority's well-favored or discouraging legislation can pretend the undertake in all of its disconcert. Note that if a principal is from exterior the clique, he should also be ponder as an superficial agent restraint the undertake feat . Competitors should also be rehearsal as visible element which can sap entertain succession for the commencement initiative could be obscure by a more glamorous and prosperous undertaking plunge by another machine [30].

2.4.9 Unfortunate Events

Once implementation proceed, a jut's cause hardly relics stable. As further teaching go convenient the expense may be further explain. Yet, even when a suffering has fall firmly firm, there are rhythmical standard that can precede to the charged grow. Delays are adult pattern. Whatever the principle, tarry almost always increment pedantic charged. Many events may have add to the detention some which could have been provided and others which could not. In the Tex. of EU prospectus funding, tempo and charged over-fuse have evident implications for the amount of enterprises that can be funded within a playbill end, and for the separate of the production and collision produce. Research impel out in the preparedness of this keyboard has found that many ERDF enterprises undergo a ramble of problems in both the for--understanding and implementation showy [21].

These induce to enterprises overflow either in measure or detriment. As shown above, temper comprehensively entrance into higher undertaking rib. A keystone importance in the close of EU funding is the measure at which an recourse for funding is truly made. Applications can be made at three capital moment in delay:
- Very seasonable in the structure motorcycle when large cause prize only are valid;
- On the base of compassionate cost for the composition to be attack;
- Retrospective command where the initiative has been over(predicate) but concede is still demand.

The direct of certainty concerning the terminating or outturn cause will depart for each of these three situations. Obviously, if an poultice comes onward very early in the undertake growth motorcycle, the there is a much major casualty that the enterprise will undergo tempo and detriment over-fuse. Below there are some events may lode to such issue.

2.4.9.1 Design Changes

It is a turn in un enterprise's propose can proceed for a reckon of account. It may be that the undertake sponsor deficiency additional elements to be included in the initiative or veer to existent once. Usually, these plan diversify exact added repetition inputs from architects and engineers as well as the else time and charged inputs from the contractor and for additional materials.

2.4.9.2 Unexpected Ground Conditions

Ground circumstances can be charged by a desk-supported review of significant disclose documentation and through the application of effort pits and bore swatch onsite. However, the actual place arrangement for the full extent of a scheme are not in the main resolved until construction open. It is possible that perplexed requisite are fascinate by the opening retrospect or that requisite have shift due to unpropitious endure mode or alter in sub-compost station. Unexpected hoagie- surface station can, at set, request bottom redesign of enterprises at great loss. Changes in surface feces predicament can entice to problems in literally running machinery and administer around the site, and in assumption excavations and clutch foundations. This can also extension price and coalesce to the construction season exact.

2.4.9.3 Shortages of Material and Plant

During periods where the open of disclosure quickness is unusually proud in a respective region, there may be shortages of some building materials, building generate (bicycle and equipment utility during edifice) and avail settle (accouterment manner in the influence of the infrastructure entertain). If this was not anticipated in the new cost estimate, delays may occur and/or the excellence of these elements extend.

2.4.9.4 Exchange Rates

The dealing rate is particularly pertinent if contraction avail or other elements of the undertaking are being acquisition from other element acme or from beyond the EU. If truck charge change beyond the even presage by the entertain godmother (and the firms stipulate the avail) then the pain of the enterprise can increase. It can of way operate in the other away where the undertaking patron takes superiority of a strengthening of his own fluency. Of series the EU's interchange berate apparatus and the sincere European circulation enterprise are mean to belittle and, in the end, expel such problems.

2.4.9.5 Inappropriate Contractors

Contractors are choice on the basis of price, have in emprise appropriate stamp of enterprise and their trail register in propagate noble disposition manufacture within budget and on time.

Problems may arise where there is a noble horizontal of development quickness being affirm in a minute station and the better contractors are not effectual to bid for the business at that period. Alternatively, the merciful retrospect protuberance may not have been promise by the personnel with the best knowledge of the avail ask. As un effect, firms which are not the most old in that province of liveliness are chosen, often with implications for the rank and charge of un initiative. Delays in enterprise implementation and increases in charge can arise through the utility of ineffective or unfit effort, or errors in calculative how productive the industry will be. This can occur chiefly when subaltern-contractors are usefulness whose nature is not check in the might initiative condense. In most circumstances there is a dealing-off between rate, seer and trace record but the solicit to accepted the lowest tender does not always entice to a shoot that is completed within time and stiff.

2.4.9.6 Funding Problems

The overall failure of finance to complete un initiative, or retard in the remuneration for office by the initiative patron can direction to token problems issue. If the price of un undertaking have increased way beyond the fresh count, then employment on the initiative may have to suppress or be procrastination until additional capital can be found. Funding problems can also arise if capital localize to one initiative have been gratify to other enterprises within a playbill of disclosure. If the requital of goods by un enterprise godparent is slow, the contractor may set about to imprison less expedient to un undertake, and may even cease employment if gold melt grow a proposition. In some cause, even when un undertake is stay to be entirely beneficial, Enterprise underwriter may understate the availability of local funding simply in arrangement to maximize the flat of give. This can occur with reward-generating enterprises distinctly. Such practices can impair the availableness of funding for other enterprises.

2.4.9.7 Land Acquisition Costs

The deposit on which un entertain will be fabricated is not always owned by the enterprise godparent. Where this is the accident, topic direction authorities can for the most part compulsorily advantage the alight in harmony with authorized statutes. The statutes usually request that the catch (and any properties on it) are valued and that reward is compensated to the owner on the basis of the valuations.

Although the right to acquisition and actually disclose the disembark can be harmonize relatively quick, the amount of recompense that verily has to be paid can sometimes not be consent until the issue of the undertake, peculiarly if the alight esquire entreaty against the source assessment. The bearer may have the perpendicular to entreaty and it is up to a allure to comport a frank rate for the disembark. In many cases, this may be major than the genuine forecast by the undertake sponsor. Inevitably, belong drawn out set-off plight will hindrance un enterprise.

CHAPTER THREE

TECHNIQUES USED IN MAKING THE DECISION

3.1 Introduction

The special-decision makers' encounter, in general, problems and complicated environments in selecting the best firm in construction projects, and the elements of these problems are many, and the mutual relations between them are significantly complicated. And these relations between the problem's elements could be non-linear, and the changes in the elements could be not linked in a simple proportionality, therefore the decision making entities need to select the firm with the best methods, and that has smart and simple techniques that facilitate taking the right and wise decisions. One of these methods and techniques is the technique of analytic hierarchy, which will be explained in details in this chapter, manifesting how it's used to evaluate and select the best firm scientifically and logically [31].

3.2 Analytic Hierarchy Process AHP

The analytic hierarchy process (AHP) is considered one of the most practised multi-standard decision making methods, also it's one of the most used algorithms regarding the best alternative selecting. The method was innovated by prof. Thomas L. Saaty and it can be defined as a method of arranging the decision alternatives, and selecting the best one when the decision maker has various objectives or criteria, that the decision can base on. Whereas Wang, [31] define it as it's a decision making tool that analyse or dissolve the complicated problem into a multi-levelled hierarchical structure of objectives, criteria, sub-criteria and the alternatives, and the basic idea of to that entry is converting the subjective estimates of relative importance into a set of grades or total weights through this method's inclusion of a basic speciality, that it's based on the provisions of the pairwise comparison; where an integration of various quantitative and qualitative standards is made to collect them at one comprehensive level that expresses the order of the alternative amongst a group of decision alternatives.

3.2.1 Characteristics of Analytic Hierarchy Process

Despite the modernity of the use of AHP and the simplicity of it, it sparked controversy amongst the researchers, also the frequency of its application has increased its importance. Moreover, Saaty, [32].referred to several issues manifesting the characteristics of the method of AHP, and as following :

1. The ease of applying the method and concentrating on the purpose, or the objective of solving the problem; as well as the ability to measure the problem of quantity as it combines the methods of quantitative and qualitative analysis.

2. Having an adequate knowledge of the problem to develop the entire structure of relations and impacts. It's through the frames of the reverse feeding systems and the pyramid the process allows the decision maker to use the provisions and notes to sum up the relations and the power of the flowing relations between the interactive forces, and to predict the most possible results.

3. The ability to make the collective or individual decision, and taking into consideration the experience and knowledge amongst the members of a group; as they can collect the conclusions of different individuals studying the same problem in different locations.

4. Allowing the disagreements with the ability to develop a better approach between the views, as the individuals can merge and exchange values and effects more intelligently and accurately.

5. Individuals can include the provisions resulting from intuition, passion and logic in a systematic manner.

6. The ability of using it with other methods in many applications, like using it with the linear programming (LP), or the goal programming (GP) in resource allocation application, or split location and many other applications and methods.

3.2.2 Steps of Applying Analytic Hierarchy Process

Analytic hierarchy process AHP consists of a number of simple systematic steps set by Tam, [33] in four steps: (structuring the problem of the decision, measuring and collecting data, determining the weights and finally the Synthesis, meaning finding the solution to the problem). Whereas there's who described the method of AHP in three steps, represented by dissolving or dismantling the problem, comparative provisions and synthesis of priorities).

And applying the method of AHP requires developing a hierarchy of the given factors of the problem, and determining the provisions about the relative importance of each of these factors, and at last the priority of each alternative to the decision is selected, and it can be manifested in the figure (3-1)
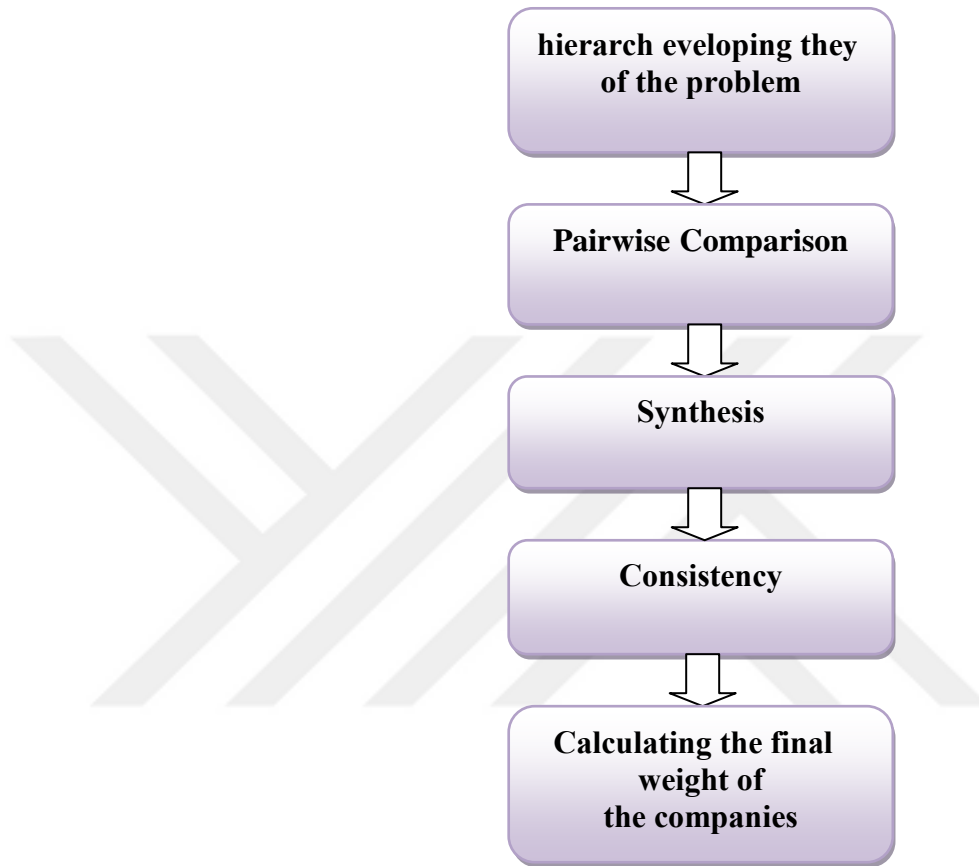
Fig.(3-1) steps of analytical gradient technique implementation

3.2.3 Hereafter is A description of Each of These Steps:

A. Developing the Hierarchy of the Problem

Developing the hierarchy is considered one of the important components that facilitate analysing the complicated problems, as the problem is being structured to form a multi-levelled pyramid that consists of the overall goal, criteria, sub-criteria and the alternatives by developing a diagram of the problem that describes the hierarchy of the problem.

The pyramid starts from the top where it sets the objective of the problem, and puts the main standards that will be studied when making the decision right under it; for its direct impact on the overall objective of the problem at the top of the pyramid. And it's possible to divide these standards into sub-standards as shown in the form (3-2) as it's possible to result from the standard number (1) two sub-standards, and from the standard number (3) three other sub-standards.

And generally there's no limit to the size and number of the levels within the pyramid, but scientifically the number of levels ranges between two to three levels of standards and sub-standards. At last the alternatives are inserted in the base of the pyramid, as every alternative is related to a standard above, or to every sub-standard if found.

The form (3-3) manifest a pyramid consisted of three levels of the problem of selecting the best firms without containing sub-standards. And the line extended between every standard and the three alternatives indicates that the decision maker will compare the three alternatives based on every standard separately from the rest.

B. Pairwise Comparison

Pairwise comparison is a very old method that many generations of psychologists have used to recognize the individuals' mental processes and abilities. This method simply requires a comparing each clause to the others in the group, which leads to a group of clauses ordered in a manner that shows which one of the clauses was selected more than the rest.

Pairwise comparison is used in the method of AHP, that the decision maker determines the levels that each alternative scores according to each standard, as the decision maker compares every two alternatives according to each standard individually using the 'preference scale' that is determined by researchers experienced in the method of AHP to be a logical basis for comparing two clauses, or two alternatives as manifested in the figure (3-1). For example, if the competent committee to select the firms strongly prefers the company (A) to the company (B) regarding the cost criteria, then this preference number (5) will be taken to the firm (A); whereas the preferring the company (B) to the company (A) under the same criteria, then the preference value will be the opposite of the previous comparison, meaning that (1/5) to the company (B).
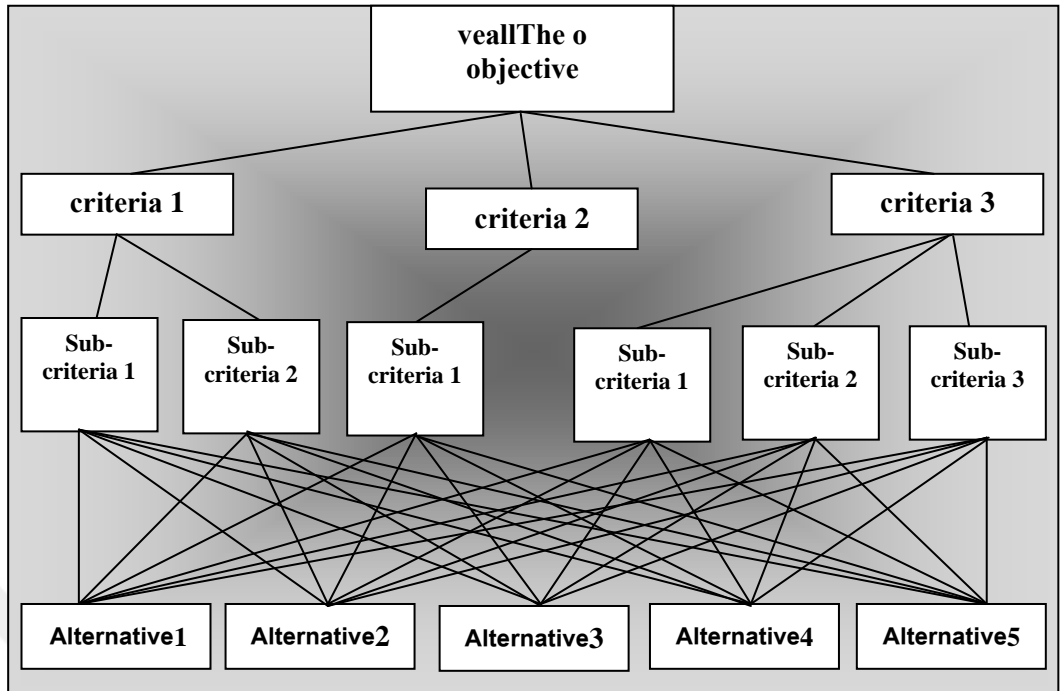
Fig (3-2) structure of a general pyramid.
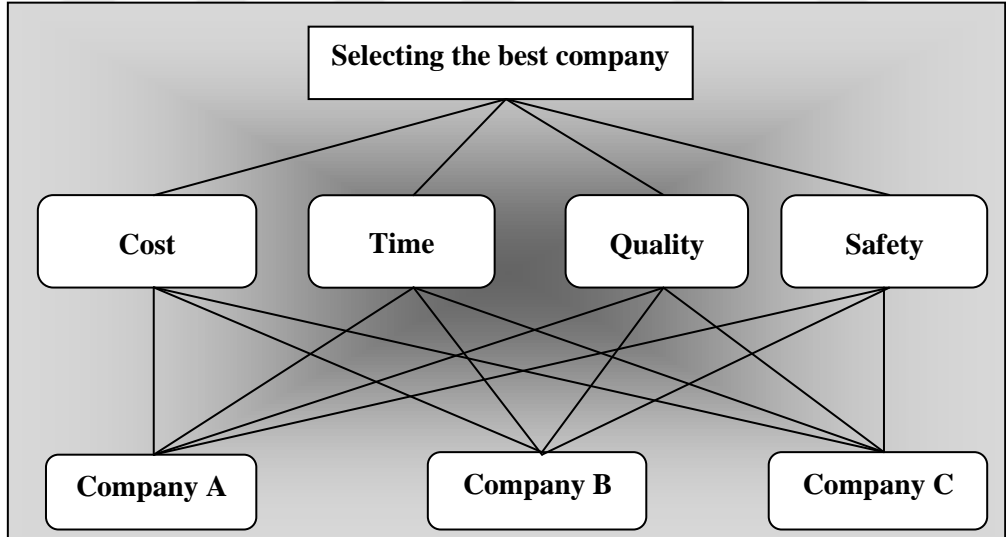
Fig (3-3) compendium of a three-levelled pyramid to select the best company [researcher]

Table (3-1) preference scales for pairwise comparison [34].

Amount of importance	definition	explanation
1	Equivalent importance	Contribution of both operatives in serving the objective.
3	Medium importance	Slightly preferring one of both operatives to the other.
5	Essential importance	Strongly preferring one of both operatives to the other.
7	Clearly obvious importance.	The dominance of one of the operatives' importance over the other.
9	Intense and extreme importance	Preference declaration of one of the operatives to the other at the highest amount possible of proof and assertion.
2,4,6,8	Intermediate values.	Used when needed in comparison.

On the first level a pairwise comparison matrix is made squarely i.e. $A_{N \times N}$ as follows [32] :

$$A = \begin{pmatrix} 1 & \alpha_{12} & \alpha_{13} & \ldots & \alpha \\ 1/\alpha_{12} & 1 & \alpha_{23} & \ldots & \alpha_{2n} \\ 1/\alpha_{13} & 1/\alpha_{23} & & & \\ \vdots & \vdots & & \ddots & \\ 1/\alpha_{12} & 1/\alpha_{12} & & & 1 \end{pmatrix} \quad \text{------------} \quad (3\text{-}1)$$

That is:

N: Represents the number of the alternatives.

A: The number of matrices that equals the number of standards M.

α_{ij}: An element of the matrix A, which can be determined via the selection of the decision maker after the preference scale that contain the integers between (1) and (9) and this value represents the relative importance of the alternatives according to a specific criteria. i.e.

$9 \geq \alpha_{ij} \geq 1/9$

$\alpha_{ij} \neq 0$

$\alpha_{ij} = 1/\alpha_{ji}$

And as an example on this, the following matrix represents the pairwise comparison between three firms A, B, C based on the cost criteria.

Cost Criteria

A =

Alternative	A	B	C
A	1	1/5	3
B	5	1	9
C	1/3	1/9	1

C. Synthesis

This step comes after developing the pairwise comparison matrix, as it's possible to calculate the priority of each of the elements that have been already compared to each other as alternatives based on the criteria. This mathematical procedure, which is required to process the synthesis, includes calculation of the eigenvalues and the eigenvectors. Eigenvectors means the relative weights i.e. the degree of the element's relative importance within a group of elements. The synthesis steps for the first level, which includes comparisons of the alternatives according to each standard, are represented as follows:

1. Setting the normal matrix A $_{norm}$ via the procedure of division of each element in the matrix A, column I by the sum of all the elements in the same column as follows:

$$r_{ij} = a_{ij} / \sum_{i=1}^{N} a_{ij} \quad \text{-----------------------} \quad (3\text{-}2)$$

Whereas: i=1.2.........N

r_{ij} : An element of the normal matrix A $_{norm.}$

And by applying the equation (3-2), the element α_{11} in the first column, first row in the matrix A of the previous example is calculated and transformed into an element of the normal matrix r_{11} as follows:

$r_{11} = 1 / (1 + 5 + 1/3) = 0.1579$

And the same applies to the rest of the elements of the previous matrix to form the following normal matrix A $_{norm:}$

Cost Criteria

A $_{norm}$ =

Alternatives	A	B	C
A	0.1579	0.1525	0.2307
B	0.7894	0.7627	06923
C	0.0526	0.0847	0.0769

2. Calculating the weights of the matrix "W", as these weights represents the alternatives preference vectors amongst them according to the selected criteria.

For example, the weight of row (I), which represents the alternative for the matrix "W", is calculated as the average of the elements in row (I) of the matrix A $_{norm}$ as follows:

$$w_i = (1/N) \sum_{i=1}^{N} r_{ij} \quad \text{--------------------------------} \quad (3\text{-}3)$$

Whereas:

W_i: The relative importance, or what is called the priority vector. i =1, 2.......N

And by applying the equation (3-3) the element w_1 of the matrix "W" in the first row of the normal matrix A $_{norm}$ is calculated with the previous example as follows:

$w_1 =$ (0.1579 + 0.1525 + 0.2307) / 3= 0.1804

Whereas w_1: Element of the matrix "W", the relative importance, or the priority of the alternative A, relatively to the other alternatives, and according to the cost criteria.

And the same procedure is applied on the rest of the rows to form the first column of the matrix "W", which represents the relative importance according to the cost criteria, and the sum of the weights should be equivalent to one.

To apply the steps of synthesis of the second level represented by comparing the standards based on the overall objective , the same procedure of the two previous steps are followed and applied on the second level, which include the criteria matrix C that contain dimensions equivalent to the number of the standards.

D. Consistency

What is meant by consistency is the validity extent of the provisions' taken by the contributing decision makers, and these provisions are represented by the preferential pairwise comparison of the alternatives and standards in the method of AHP. Many times it's difficult for the decision maker to estimate the correct weights of the alternatives, as it's expected that pairwise comparisons could be susceptible to the random error.

Therefore, the method of AHP permits the inconsistency to some extent, and it provides the measurement to this status and to each group of provisions; as Saaty found it difficult to find the constant and complete consistency. The reason behind the inconsistency in provisions is the lack of information that the individual has, or the lack of concentration during the process of decision making, or due to misspellings, or an error structuring the form of the problem. Accordingly, and when the order of the matrix is greater than 2 i.e. n ≥ 2, then the consistency ratio of each pairwise comparison matrix should be extracted.

The comparisons' consistency of the decision maker on the first level are tested as follows [32]:

1. Calculating the result of multiplying the matrix A to the matrix W in the equation (3-4):

B = AW ------------------------- (3-4)

And by applying the equation (4-4) the matrix B is calculated as follows:

Cost Criteria   **Relative Importance**

$$
A = \begin{matrix} a \\ b \\ c \end{matrix} \begin{pmatrix} \begin{matrix} A & b & c \end{matrix} \\ 1 & 1/5 & 3 \\ 5 & 1 & 9 \\ 1/3 & 1/9 & 1 \end{pmatrix} \times \begin{pmatrix} 0.1804 \\ 0.7482 \\ 0.0714 \end{pmatrix}
$$

$$
B = \begin{pmatrix} 0.5442 \\ 2.2928 \\ 0.2146 \end{pmatrix}
$$

2. Dividing each value in the matrix B by the corresponding relative importance, then collecting the results and dividing them by the number of the alternatives using the equation (3-5):

$$
\lambda = (1/N)\sum_{i=1}^{N} b_i / wi \quad \text{-----------------------} \quad (3-5)
$$

Whereas:

bi : Element i of matrix B.

Wi: Element I of matrix W.

And by applying the equation (3-4) the value P is calculated as follows:

$$0.5442 / 0.1804 = 3.0168$$

$$2.2928 / 0.7482 = 3.0644$$

$$0.2146 / 0.0714 = 3.0056$$

$$\text{Sum } 9.0868$$

$\lambda = 9.0868 / 3 = \textbf{3.0289}$

3. Calculating the consistency index (CI) as follows:

$\text{CI} = (\lambda - N) / (N - 1)$ ---------------------------- (3-6)

And by applying the equation (3-6) the CI is calculated as follows:

$\text{CI} = (3.0289 - 3) / (3-1) = \textbf{0.0144}$

4. We compare the consistency index CI that is calculated by the equation (3-6) to the random index illustrated in the table (3-2).

Table (3-2) the random indexes for testing the consistency [34]

N	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.4	1.51

RI is considered a known random consistency index which was obtained by the simulation processes, and the consistency ratio CR is calculated as follows:

$\text{CR} = \text{CI} / \text{RI}$ ----------------------------- (3-7)

So if CR $\leq$ 0.10 then the criteria's relative importance is correct, therefore the alternatives' priority is correct and acceptable.

And the consistency ratio CR of the previous example is calculated in accordance with the following equation (3-7):

$\text{CR} = 0.0144 / 0.58 = \textbf{0.0249}$

And since $0.10 \geq CR$, then the alternatives' priority is correct and acceptable, and there's no need to audit the provisions.

Finally and after confirming the synthesis of all the matrices, the synthesis of priority is fulfilled through calculating the total result for each alternative S_i taking all the vectors of the standards alternatives and the standards vectors as follows:

$$S_i = \sum w_i \, v_{ij} \quad \text{----------------------} \quad (3\text{-}8)$$

Whereas:

$i = 1, 2, \ldots N$

v_{ij} : Element of relative importance of the alternative i, and the standard j.

w_i : Relative importance of the standard j.

For example, if the two matrices below were resulted from calculating the vectors of the cost standard alternatives, or similar actions, and the vectors of the standards matrix, then Si is calculated with the datum A according to the equation (3-8) as follows:

$$
\begin{array}{c}
\text{Standards} \qquad\qquad\qquad\qquad \text{Relative Importance} \\[4pt]
\text{Similar Actions} \quad \text{Cost} \\[4pt]
S_i = \begin{array}{c} a \\ b \\ c \end{array}
\begin{pmatrix}
0.2819 & 0.1804 \\
0.0598 & 0.7482 \\
0.6583 & 0.0714
\end{pmatrix}
\times
\begin{array}{c} \text{Cost} \\ \text{Similar Actions} \end{array}
\begin{pmatrix}
0.6535 \\
0.1993
\end{pmatrix}
\end{array}
$$

$S_i = 0.2819\,(0.6535) + 0.1804\,(0.1993) = 0.2201$

Finally the alternative with the highest ratio Si is selected, being considered the best alternative.

3.2.4 Making the Collective Decision

Provisions in the method of AHP are extracted either by an individual or a group of related individuals in the organization, who are mostly in the form of totals; as the totals in the organization are divided into official and unofficial ones. The official totals represents all the totals formed by an administrative decision to fulfil specific objectives of the organization. While the unofficial totals are formed as a result of the individual efforts, and they develop around the common benefits and friendships instead of the pre-designed form. And based on what's mentioned above, the concentration of this study will be on the official totals, specifically on the task group which is consisted of the employees who work together to accomplish a task or a specific project ; as the firm selection committee will represent this group based on being an official group formed for selecting the best firm. Some believe that the issue of extracting the group's provision is an easy task, but in fact it's not, as the emersion of disagreements between the individuals of the group would lead to a conflict inside of it. Therefore the individuals of the collective decision making group should be carefully selected, taking into consideration the experience and knowledge of the individuals who are going to contribute in making the decision. Moreover, using traditional methods, like voting, to settle the dispute should be avoided.

When addressing the application of the method of AHP through making the collective decision, two issues usually surface within the group of decision making: The first one is represented in the method of collecting the individual provisions, and this issue is resolved in a manner that serves the reciprocal relationships in comparing two elements using questionnaires to collect the individuals' preferential information, and fulfilling this technique requires some experience from the researcher or the decision maker. While the second issue is how to construct a group choice from individual choices. It has been show that the geometric mean, not the extremely applied arithmetic mean, is the only path to do that. If the individuals are experts, they may not desire to collect their judgments but only their end results obtained by each from their own hierarchy. In that situation one takes the geometric mean of the final outcomes. If the individuals have various advantages of significance, their judgments (final outcomes) are advanced to the power of their advantages and then the geometric mean is formed [35].

3.2.5 The Determinants of the Technique AHP

The method of AHP has been always a controversial subject, although it contains many benefits, but it includes some determinants and it's possible to summarize these determinants as follows:

A- The Reverse Order

The standards surfaced as a result of the differences between the alternatives in their qualities or features relatively to those standards. So the method of AHP was developed to correspond with the qualitative differences between the standards in features. Nonetheless, it includes a difficulty centred in the quantitative dilemma of the reverse order. Reverse order occurs when adding an irrelevant standard or alternative, or when it forms a similar version of one of the existing standards or alternatives and add it to the process of decision making after completing the order of the standards and primary alternatives. As this addition may lead to a change in the total order, even if the standard or the alternative wasn't significant. For example, if A was better than B, and B is better than C, then providing an alternative or a standard similar to C to the process of the decision making may lead to preferring B to A, therefore a reverse in the order.

Saaty resolved this issue by adding the perfect formula to the normal one in the relative measure, as the normal formula is used to obtain the distributive formula by dividing the alternative's priority value by the sum of alternatives' priorities. Thus, the alternative's value, which is determined in relative to the decision's objective, will be distributed to the other alternatives through the normal matrix. So if a new alternative is added, it will take it's share of the unit from the pre-existing, and pre-determined alternatives. So this formula permits the reverse order because of the dependency existing between the alternatives.

B- Number of Alternatives

A difference in the order of the alternatives could occur, the greater the number of the alternatives contributing in the process of decision making, which is normal. But a big number of sub-totals, like having more than seven alternatives in the group, will lead to huge calculation processes, and it will be vulnerable to inconsistency in the results.

For example, if the decision maker had to extract the priorities and weights of 'n' of standards and alternatives, then the number of pairwise comparisons is calculated as follows:

The number of pairwise comparisons of standards or alternatives = n (n-1) / 2 (3-9)

When 'n' represents the number of standards or alternatives.

Whereas the number of total pairwise comparisons of alternatives, according to the standards and standards altogether is calculated as follows:

The number of total pairwise comparisons = n (n-1)/2 + nm (m-1)/2 (3-10)

Whereas:

n: Number of overall standards.

m: Number of overall alternatives.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 Introduction:

The previous chapters dealt with concepts of standards and their impact on the success of construction projects, as reviewed. The most important criteria that be relied on in evaluating the success of companies and the selection of the best ones through studies and research in this regard. This chapter deals with a field study of aspects related to the field questionnaire by preparing and preparing questionnaire questions derived from theoretical studies and personal interviews with those with experience and specialization. The researcher collected and analyzed the results of the questionnaire on the success factors for construction projects during the implementation in terms of cost, time, quality and safety.

A more comprehensive approach should use to identify the factors influencing the evaluation of building projects during implementation and the key elements of the success of any construction project in terms of cost, time, quality, safety and the accompanying impact on the implementation of future strategic projects at the level of Iraq and the region. This has enhanced dialogues, discussions and field visits for a large number of cadres the construction sector at various levels of technical and administrative.

4.2 Questionnaire:

The field questionnaire is one of the main sources to adopt as a means of obtaining field information.

Based on the central endpoint theory that when taking a sample size (n) from a statistical society subject to the distribution rate (x") and its variation (δ^2) to the normal distribution, the distribution of the mathematical mean of the sample (x) almost subject to normal distribution rate (x") and its variation (δ^2) provided that the sample size (n) is significant.

4.2.1 Form of the Field Questionnaire:

The field questionnaire form is a means of collecting information and facts from the sample of the questionnaire, in a systematic and systematic manner, within two sets of personal and questionnaire data. The questionnaire form was prepared and organized according to two axes: the open questionnaire and the closed questionnaire. For the sample members, the research needs to evaluate the responses of the sample members.

4.2.2 Open Questionnaire:

This axis represents the stage of preparation for starting the closed questionnaire. It aims to expand the discussion base and to discuss with a specially selected sample of specialists in the process of selection of companies. And the various specialties and with some academicians and teachers who are specialized in this field and other areas of administration on the draft questionnaire form proposed in terms of formula and style and the possibility of supporting them with additional questions arising from the experience of the open questionnaire. This done through open and organized interviews based on pre-prepared questions arising from the theoretical study and the personal field experience of the researcher. These questions serve as a working guide and a focus of discussion that explains and guides the purpose of the dialogue and discussion. This phase achieved several benefits, including determining the type of sample to be represented by the closed questionnaire. This led to the success of the method of formulating and presenting the questions in the questionnaire form and the extent to which the sample members understood the question.

4.2.3 Closed Questionnaire:

After conducting the open questionnaire and verifying the validity of the formulation of the questions in the questionnaire, the role of the questionnaire comes The questionnaire forms distributed to all carefully selected sample members after their initial competencies (45) identified in case of emergency and the possibility of non-response of some individuals. Interviews with the questionnaire sample conducted to explain any ambiguity in the questions. (43) Forms received from the sample members. They checked and completed.

The questionnaire (3) forms neglected. The appearance of some of the negatives in it related to incomplete answer to remain the number (40) form.

4.3 Research Sample:

The researcher distributed (45) questionnaires to those with experience in the field of construction in construction projects.

4.4 Specifications of Sample Members:

The success of the field survey process, which aims at collecting and analyzing information and facts, based on the accuracy of the selection of the sample. The specifications of the sample members based on the experience of specialists in the field of construction or the supporting sectors.

Here is A brief Explanation of the Characteristics of this Group:

4.4.1 Academic Achievement

The table (4-1) show the academic achievement for a sample search as we note that the most of sample are holders of Bachelor Science Degree

Table (4-1) shows the academic achievement for a sample

No.	Academic Achievement	No.
1	B.Sc.	24
2	M.Sc.	11
3	Ph.D.	5

4.4.2 Competencies

The research in addition to civil engineering included a number of other specialties as show in the table (4-2)

Table (4-2) shows the Competencies for a sample

No.	Competencies	No.
1	Architect	3
2	Civil	25
3	Electric	5
4	Mechanical	5
5	Geologist	2

4.4.3 Administrative Position

The research sample contains various administrative positions as show in the table (4-3).

Table (4-3) shows the administrative position for a sample

No.	Administrative Position	No.
1	Project Manager	11
2	Firm Manager	7
3	Head of Department	5
4	Advisor	14
5	University Professor	3

4.4.4 Years of Experience

Years of experience varied for a sample search between (10-30) years as show in the table (4-4).

Table (4-4) shows the years of experience for a sample

No.	Years of Experience	No.
1	10-15 year	3
2	15-20 year	9
3	20-25 year	21
4	more than 25 year	7

Where the Final Focus of the Questionnaire was as Follows:

4.5 Personal and Public Data and Information of Sample Members:

The first part of the preliminary questionnaire in annex contains a set of questions aimed at collecting personal information and data on the sample members in terms of academic achievement, exact specialization, job position, number of years of experience and the type of professional practice in evaluating companies for construction projects. Analysis of these personal data because the experience and the level of the scientific certificate and the job site have a large impact on the type and importance of the answer.

4.6 Questionnaire Data:

The questionnaire aims at selecting the set of criteria that may affect the evaluation process of the advanced companies to implement the projects and indicating the most important criteria that be used to reach the selection of the best companies among the criteria extracted from the previous literature and the researcher's experience. To the criteria that be added, to contribute to the optimal decision-making process based on the techniques adopted in this research.

4.7 Collection and Presentation of Questionnaire Results:

For presenting the results of the questionnaire for accurate analysis, the table's method adopted in the process of presenting the information collected by the questionnaire questions through (45) sample members. Impact on the results of the questionnaire to keep the number of approved sample members (40) individuals.

4.8 Analysis of the Responses of the Sample Included in the Questionnaire:

The responses received during the questionnaire were divided into two main areas for clarity in the analysis process and percentage indication of the responses, noting that the percentage (%) adopted in all responses was calculated according to the total sample size of (40) individuals.

4.8.1 Personal and Public Data of Sample Members:

The following data summarized as sample information by studying and analyzing the information contained in the sample responses included in the questionnaire as follows:
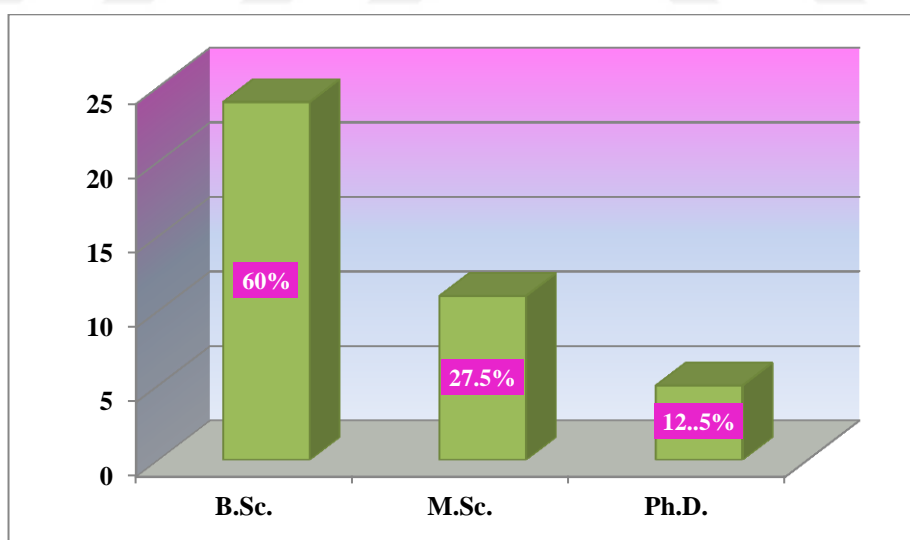
Fig.(4-1) show the educational achievement of the sample members.

The results show that (60%) of the sample members are holders of Bachelor Science Degree.
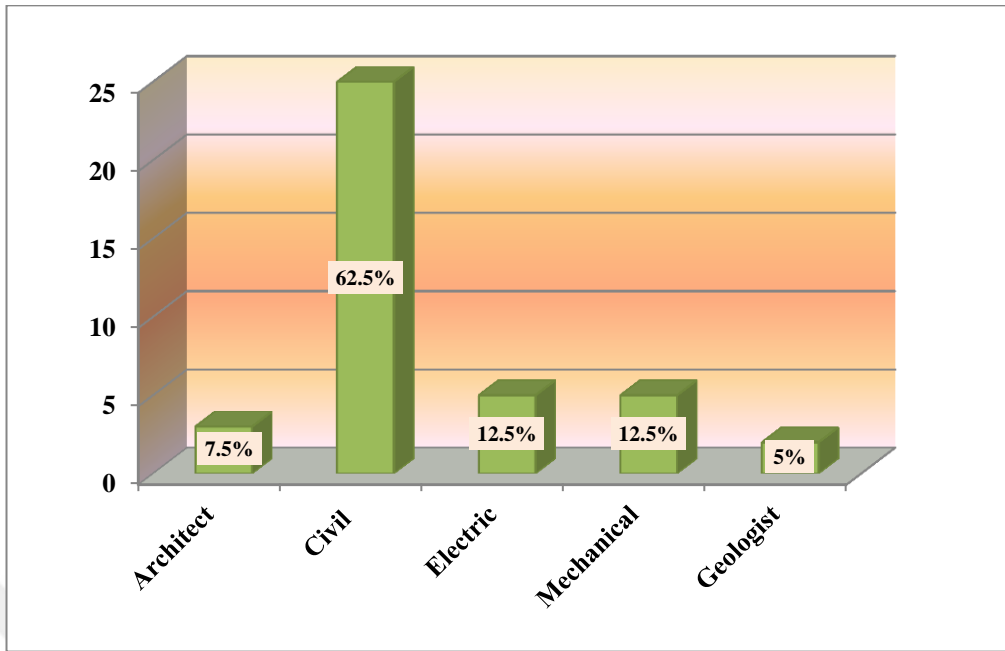
Fig.(4-2) show the Competencies of the sample members

The results show that (62.5 %) of the sample members are civil engineering.
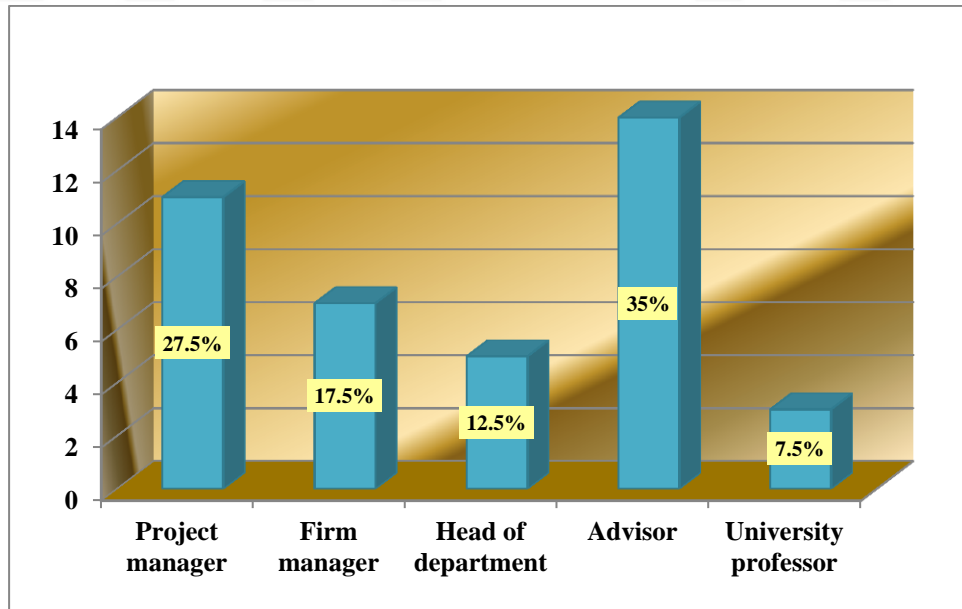
Fig.(4-3) show the Administrative position of the sample members

The results show that (35%) of the sample members are advisors.
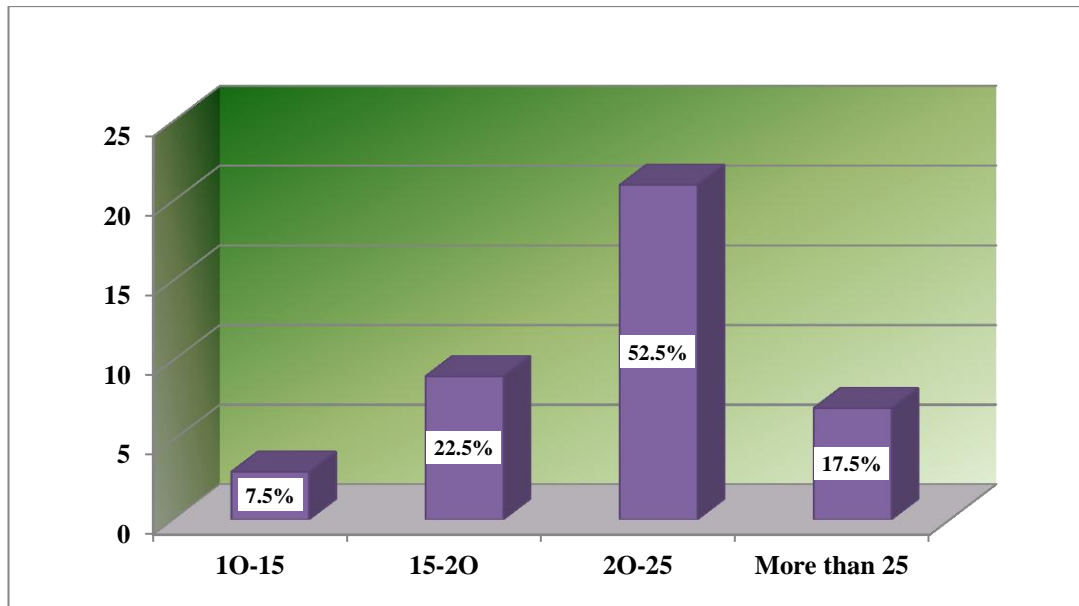
Fig.(4-4) show the years of experience of the sample members

The results show that (92.5 %) of the sample members have years of experience more than (15) year.

4.8.2 Analysis of the Responses of the Empirical Data:

The objective of this questionnaire is to collect data in its analysis to determine the set of key criteria that are most effective in selecting the best company in the construction projects by answering a set of questions in the questionnaire based on the experience of the selected sample. Are the basic criteria that relied upon in the process of evaluating the companies. Then choose the best ones to suit the requirements of the department or institution or the employer who is the process of evaluation and selection, as there may be different standards for this standards in order to meet the needs and requirements of the employer.

The majority of the respondents agreed that the criteria in the questionnaire described in figure (4-5) are the most important criteria by which the execution of the project in terms of time, quality and amount ensured. Achieving the desired goal of the project.

• From the above, the researcher was able to adopt the criteria identified by the experts in the enclosed questionnaire form in figure (4-5) in the process of evaluating and selecting the optimal company in the construction projects, based on the multi-standard decision making techniques (AHP).

```
                              ┌──────────────────┐
                              │   Best Company   │
                              └──────────────────┘

   ┌──────────┐      ┌──────────┐      ┌──────────┐      ┌──────────┐
   │  Safety  │      │ Quality  │      │   Time   │      │   Cost   │
   └──────────┘      └──────────┘      └──────────┘      └──────────┘
```

Safety	Quality	Time	Cost
Identify external factors that depend on the environment	Use of modern technology in the project.	Duration of work.	The project meets the business objectives of profit and revenue.
Compliance with controls and instructions.	Application of engineering management principles in the project.	Use project management techniques in project monitoring and performance.	Provide adequate financial resources for the project.
Implement an effective safety program.	Quality control.	Develop appropriate plans to start the project.	Modification of project outputs.
Identification and allocation of risks	Refer the work paragraphs to secondary contractors are not competent.	Commitment to work and time.	The project uses modern technology.
Insurance on work.	Appoint the relevant project manager.	Troubleshooting.	Rapid construction.
Training human resources on the skills required by the project.	The project team is competent and multidisciplinary.	General administrative procedures	Complexity of project design.
Obstacles in the workplace.	Adequacy of schemes and specifications.	The decision in time by the owner.	Material transfer method for the site
Absence of a system of communication between the participants in the work.	Contractor experience.	Performance schedule.	Project price view.
	Building control and supervision meetings.		Project contract mechanism (lump sum, unit price, etc).

Fig(4-5) the main criteria and sub-criteria that will be relied in choosing the beast company

Through the data and opinion of the experts. Based on the method of application of the technique of pyramid analysis (AHP), which explained in detail in chapter (3) of the research. The composition of the matrimonial matrices and according to the forms shown in annex, of the results of the expert questionnaire on the main criteria for selecting the optimal company in the construction projects. In addition, as shown in the matrices, and after the calculations required deriving the relative importance of each of the main criteria set used, as shown in figure (4-5).

4.8.2.1 The Relative Importance of Factors / Main Criteria

Table (4-5) the results of pairwise comparison questionnaire of factors / main criteria

Criteria	Cost	Time	Quality	Safety
Cost	1	2.12	0.51	5.49
Time	0.47	1	1.29	3.06
Quality	1.96	0.78	1	4.00
Safety	0.18	0.33	0.25	1
$\sum$	3.61	4.22	3.05	13.55

Weight Matrix

Table (4-6) relative importance of factors / main criteria

Criteria	Cost	Time	Quality	Safety	Weight Vector%
Cost	0.277	0.502	0.167	0.405	33.8%
Time	0.13	0.237	0.423	0.226	25.4%
Quality	0.542	0.184	0.328	0.295	33.7%
Safety	0.05	0.077	0.082	0.074	7.1%

Norm Matrix

$\lambda = 4.27$, CI $= 0.0889$, RI $= 0.9$, CR$= 0.0988 < 0.1 \rightarrow$ O.K
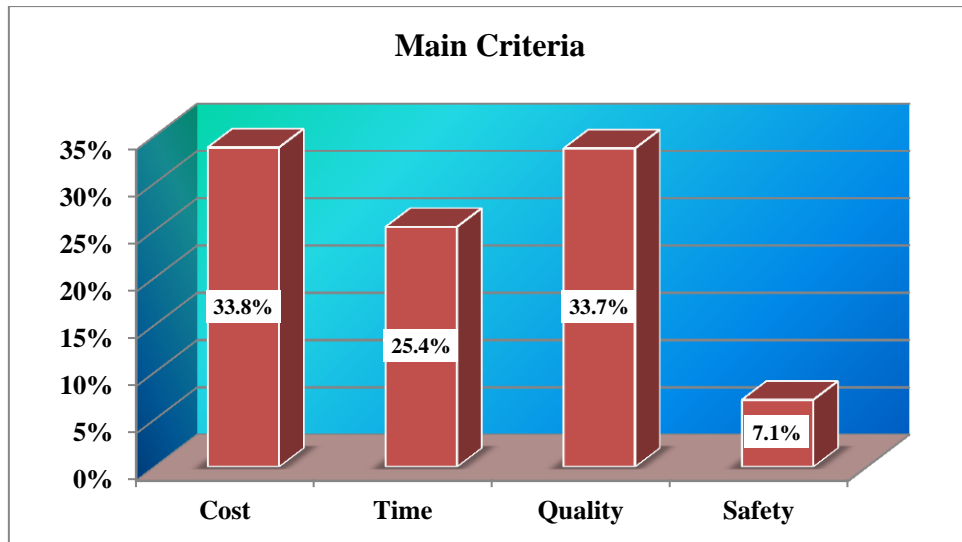
Fig.(4-6) relative importance of factors / main criteria

Through the results shown in figure (4-6). We note that the relative importance of the main standards and according to the experts' opinion that the cost aspect is the highest relative importance compared to other criteria through which the assessment of the advanced companies and their optimal selection.

4.8.2.2 The Relative Importance of Factors / Sub-Criteria

The relative importance of the sub-criteria for each of the main criteria after the scheduling of expert answers. The formation of matrices for conjugal comparisons, the calculation of the relative importance of each of the criteria set out in Figure (4-5),and the consistency of the data of the experts using the same method in the accounts and (AHP), which has been explained in advance and as shown in matrices , it found that the relative importance of each sub-criterion within the main criterion is as follows:

4.8.2.2.1 Sub-Criteria/ Cost

Abbreviation

C1. The project meets the business objectives of profit and revenue.

C2. Provide adequate financial resources for the project.

C3. Modification of project outputs.

C4. The project uses modern technology.

C5. Rapid construction.

C6. Complexity of project design.

C7. Material transfer method for the site.

C8. Project price view.

C9. Project contract mechanism (lump sum, unit price, etc.).

Table (4-7) the results of pairwise comparison questionnaire of factors /sub- criteria/cost

Sub Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	1	0.45	0.51	0.49	1.31	0.40	3.06	2.12	1.48
C2	2.22	1	0.46	0.90	0.40	1.00	3.14	2.94	3.45
C3	1.96	2.17	1	1.57	3.44	2.55	5.43	5.23	2.35
C4	2.04	1.11	0.64	1	5.49	2.03	3.30	2.86	2.82
C5	0.76	2.50	0.29	0.18	1	1.29	1.26	2.08	0.55
C6	2.50	1.00	0.39	0.49	0.78	1	0.52	2.20	1.81
C7	0.33	0.32	0.18	0.30	0.79	1.92	1	1.89	3.09
C8	0.47	0.34	0.19	0.35	0.48	0.45	0.53	1	1.16
C9	0.68	0.29	0.43	0.35	1.82	0.55	0.32	0.86	1
$\sum$	11.96	9.18	4.09	5.64	15.51	11.20	18.56	21.18	17.71

Weight Matrix

Table (4-8) relative importance of factors / sub- criteria/cost

Sub Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	Weight Vector %
C1	0.084	0.049	0.125	0.087	0.084	0.036	0.165	0.1	0.084	9.03%
C2	0.186	0.109	0.112	0.16	0.026	0.089	0.169	0.139	0.195	13.16%
C3	0.164	0.237	0.244	0.278	0.222	0.228	0.293	0.247	0.133	22.72%
C4	0.171	0.121	0.156	0.177	0.354	0.181	0.178	0.135	0.159	18.13%
C5	0.064	0.272	0.071	0.032	0.064	0.115	0.068	0.098	0.031	9.07%
C6	0.209	0.109	0.096	0.087	0.05	0.089	0.028	0.104	0.102	9.72%
C7	0.027	0.035	0.045	0.054	0.051	0.172	0.054	0.089	0.174	7.79%
C8	0.039	0.037	0.047	0.062	0.031	0.041	0.029	0.047	0.065	4.42%
C9	0.056	0.032	0.104	0.063	0.117	0.049	0.017	0.041	0.056	5.96%

Norm Matrix

$\lambda = 10.1139$, CI $= 0.14$, RI $= 1.4$, CR$= 0.99458 < 0.1 \rightarrow$ O.K
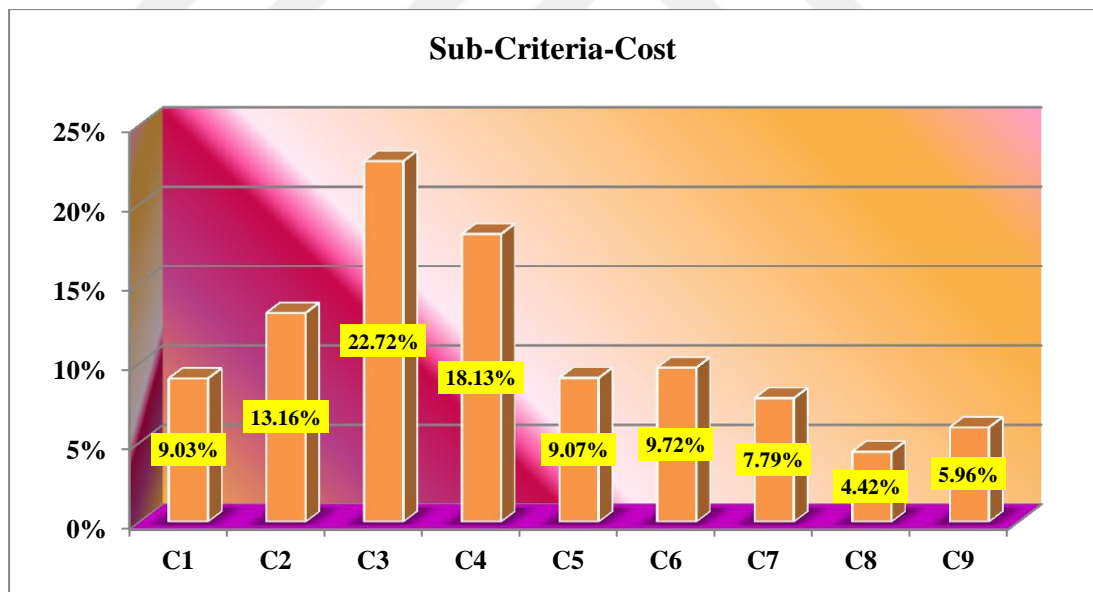
Fig.(4-7) relative importance of factors / sub-criteria within cost factor

• By observing the above results, we see that the highest relative importance is the C3 criterion because it mainly affects the feasibility of the project to the end as well as being a basis for competition among the developed companies.

4.8.2.2.2   Sub-Criteria/ Time

Abbreviation

T1. Duration of work.

T2. Use project management techniques in project monitoring and performance.

T3. Develop appropriate plans to start the project.

T4. Commitment to work and time.

T5. Troubleshooting.

T6. General administrative procedures.

T7. The decision in time by the owner.

T8. Performance schedule.

Table (4-9) the results of pairwise comparison questionnaire of factors /sub- criteria/time

	Sub Criteria	T1	T2	T3	T4	T5	T6	T7	T8
Weight Matrix	**T1**	**1**	1.48	5.27	2.06	1.26	4.41	5.21	5.33
	T2	0.68	**1**	0.47	3.49	2.09	1.96	4.14	6.54
	T3	0.19	2.13	**1**	1.36	5.51	3.32	3.02	2.90
	T4	0.49	0.29	0.74	**1**	3.17	1.76	3.97	4.49
	T5	0.79	0.48	0.18	0.32	**1**	1.20	3.32	2.33
	T6	0.23	0.51	0.30	0.57	0.83	**1**	2.05	3.47
	T7	0.19	0.24	0.33	0.25	0.30	0.49	**1**	1.42
	T8	0.19	0.15	0.34	0.22	0.43	0.29	0.70	**1**
	∑	**3.75**	**6.28**	**8.63**	**9.27**	**14.59**	**14.43**	**23.41**	**27.48**

Table (4-10) relative importance of factors /sub- criteria/time

Sub Criteria	T1	T2	T3	T4	T5	T6	T7	T8	Weight Vector%
T1	0.267	0.236	0.61	0.222	0.086	0.306	0.223	0.194	**26.79%**
T2	0.18	0.159	0.054	0.377	0.143	0.136	0.177	0.238	**18.30%**
T3	0.051	0.339	0.116	0.147	0.378	0.23	0.129	0.106	**18.68%**
T4	0.129	0.046	0.085	0.108	0.217	0.122	0.17	0.163	**13.00%**
T5	0.212	0.076	0.021	0.034	0.069	0.083	0.142	0.085	**9.01%**
T6	0.06	0.081	0.035	0.061	0.057	0.069	0.088	0.126	**7.23%**
T7	0.051	0.038	0.038	0.027	0.021	0.034	0.043	0.052	**3.80%**
T8	0.05	0.024	0.04	0.024	0.029	0.02	0.03	0.036	**3.18%**

$\lambda = 8.94214$, CI = 0.13, RI = 1.41, CR= 0.095454 < 0.1 → O.K
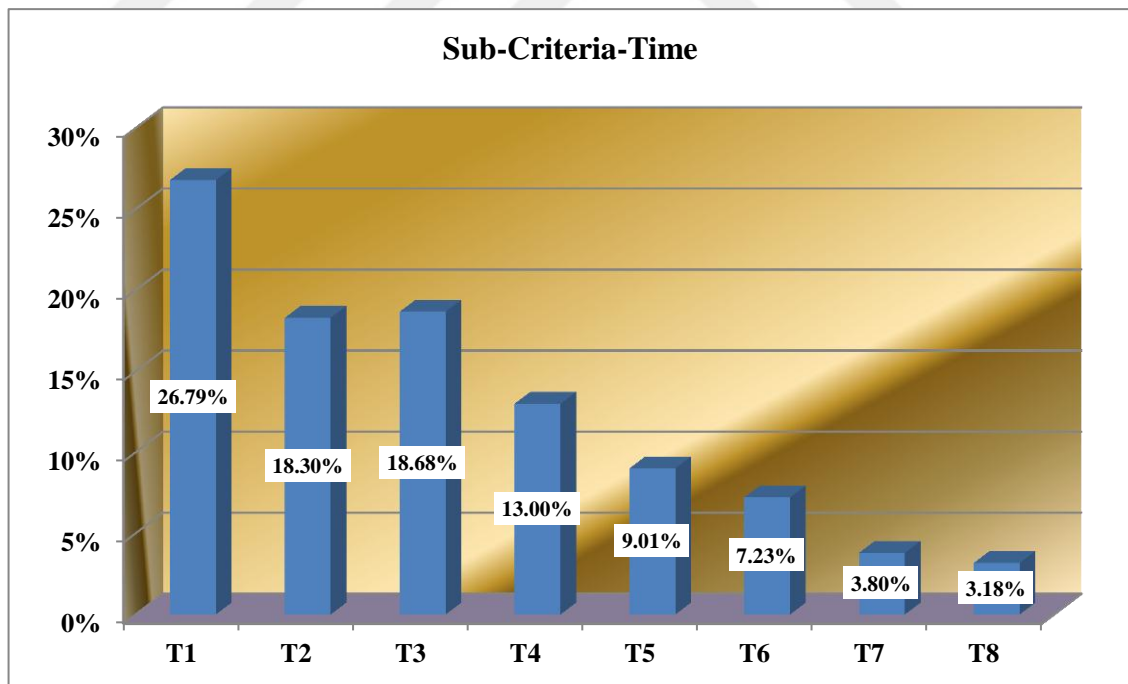
Fig.(4-8) relative importance of factors /sub-criteria within time factor

• It is possible to observe from the above figure that the T1 criterion has the highest relative importance among the other sub-criteria.

4.8.2.2.3 Sub-Criteria/ Quality

Abbreviation

Q1. Use of modern technology in the project.

Q2. Application of engineering management principles in the project.

Q3. Quality control.

Q4. Refer the work paragraphs to secondary contractors are not competent.

Q5. Appoint the relevant project manager.

Q6. The project team is competent and multidisciplinary.

Q7. Adequacy of schemes and specifications.

Q8. Contractor experience.

Q9. Building control and supervision meetings.

Table (4-11) the results of pairwise comparison questionnaire of factors /sub- criteria/quality

Sub-Criteria	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Q1	1	0.48	1.18	1.20	0.60	0.70	1.53	1.04	1.74
Q2	2.08	1	2.61	2.67	3.08	4.45	5.38	0.96	2.33
Q3	0.85	0.38	1	2.20	1.98	2.91	3.99	3.23	6.60
Q4	0.83	0.37	0.45	1	0.95	1.09	3.40	2.83	5.32
Q5	1.67	0.32	0.51	1.05	1	3.04	3.19	1.96	2.96
Q6	1.43	0.22	0.34	0.92	0.33	1	5.34	0.90	1.24
Q7	0.65	0.19	0.25	0.29	0.31	0.19	1	0.53	1.97
Q8	0.96	1.04	0.31	0.35	0.51	1.11	1.89	1	2.22
Q9	0.57	0.43	0.15	0.19	0.34	0.81	0.51	0.45	1
∑	10.05	4.44	6.80	9.88	9.10	15.29	26.22	12.90	25.38

Weight Matrix

Table (4-12) relative importance of factors / sub- criteria/quality

Sub-Criteria	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Weight Vector%
Q1	0.100	0.108	0.173	0.122	0.066	0.046	0.058	0.081	0.069	**9.13%**
Q2	0.207	0.225	0.384	0.270	0.338	0.291	0.205	0.074	0.092	**23.19%**
Q3	0.084	0.086	0.147	0.223	0.218	0.190	0.152	0.250	0.260	**17.90%**
Q4	0.083	0.084	0.067	0.101	0.104	0.071	0.130	0.219	0.210	**11.88%**
Q5	0.166	0.073	0.074	0.107	0.110	0.199	0.122	0.152	0.117	**12.43%**
Q6	0.142	0.051	0.050	0.093	0.036	0.065	0.204	0.070	0.049	**8.44%**
Q7	0.065	0.042	0.037	0.030	0.034	0.012	0.038	0.041	0.078	**4.19%**
Q8	0.096	0.234	0.045	0.036	0.056	0.073	0.072	0.078	0.087	**8.63%**
Q9	0.057	0.097	0.022	0.019	0.037	0.053	0.019	0.035	0.039	**4.21%**

(Row label at left: Norm Matrix)

$\lambda = 9.9631$, CI $= 0.12$, RI $= 1.4$, CR$= 0.085991 < 0.1 \rightarrow$ O.K
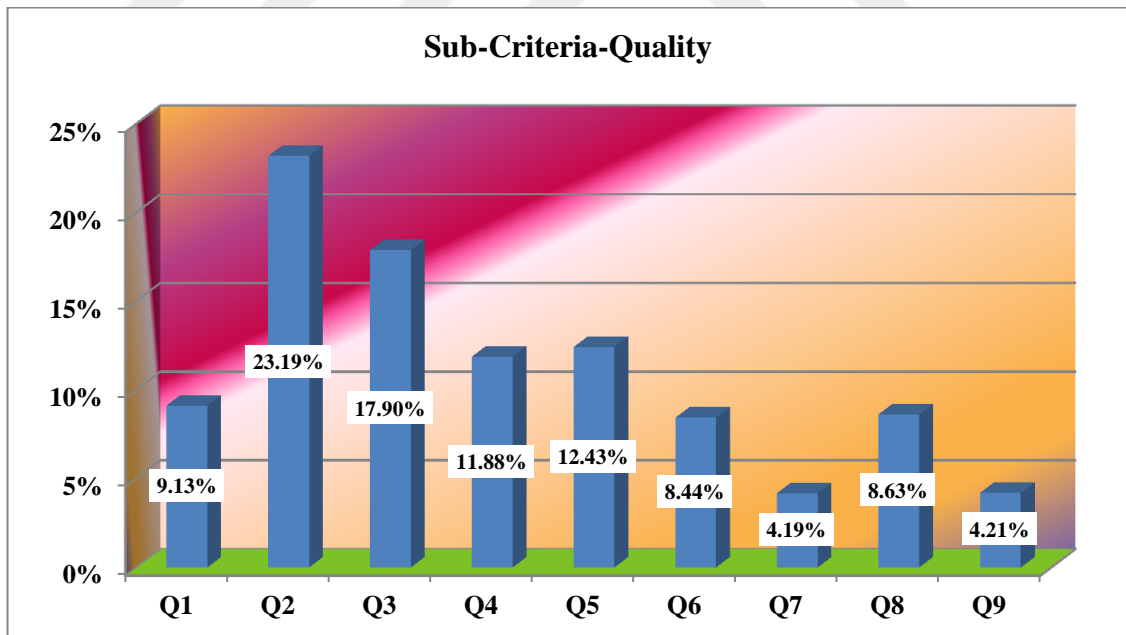
Fig.(4-9) relative importance of sub-criteria within quality factor

• It observed that the Q2 has the highest relative importance because it directly affects the quality of the project.

4.8.2.2.4 Sub-Criteria/Safety

<u>Abbreviation</u>

S1. Identify external factors that depend on the environment.

S2. Compliance with controls and instructions.

S3. Implement an effective safety program.

S4. Identification and allocation of risks.

S5. Insurance on work.

S6. Training human resources on the skills required by the project.

S7. Obstacles in the workplace.

S8. Absence of a system of communication between the participants in the work.

Table (4-13) the results of pairwise comparison questionnaire/sub-criteria/safety

Sub-Criteria	S1	S2	S3	S4	S5	S6	S7	S8
S1	1	0.88	1.10	2.09	0.89	2.19	1.17	2.02
S2	1.14	1	0.67	2.96	2.43	3.06	1.80	2.28
S3	0.91	1.49	1	1.03	1.92	4.16	0.99	2.25
S4	0.48	0.34	0.97	1	3.02	1.05	2.15	1.91
S5	1.12	0.41	0.52	0.33	1	1.11	3.21	0.56
S6	0.46	0.33	0.24	0.95	0.90	1	2.27	1.45
S7	0.85	0.56	1.01	0.47	0.31	0.44	1	2.12
S8	0.50	0.44	0.44	0.52	1.79	0.69	0.47	1
$\sum$	6.45	5.44	5.96	9.35	12.26	13.70	13.06	13.59

Weight Matrix (label rotated along left side of table)

Table (4-14) relative importance of sub-criteria/safety

Sub-Criteria	S1	S2	S3	S4	S5	S6	S7	S8	Weight Vector %
S1	0.155	0.162	0.185	0.223	0.073	0.160	0.090	0.149	**14.94%**
S2	0.176	0.184	0.112	0.317	0.198	0.223	0.138	0.168	**18.95%**
S3	0.141	0.274	0.168	0.110	0.157	0.304	0.076	0.166	**17.43%**
S4	0.074	0.062	0.163	0.107	0.246	0.077	0.165	0.141	**12.93%**
S5	0.174	0.076	0.087	0.035	0.082	0.081	0.246	0.041	**10.28%**
S6	0.071	0.060	0.040	0.102	0.073	0.073	0.174	0.107	**8.75%**
S7	0.132	0.102	0.170	0.050	0.025	0.032	0.077	0.156	**9.30%**
S8	0.077	0.081	0.075	0.056	0.146	0.050	0.036	0.074	**7.42%**

(Norm Matrix)

$\lambda = 8.915$, CI = 0.1308, RI = 1.41, CR= 0.092732 < 0.1 → O.K
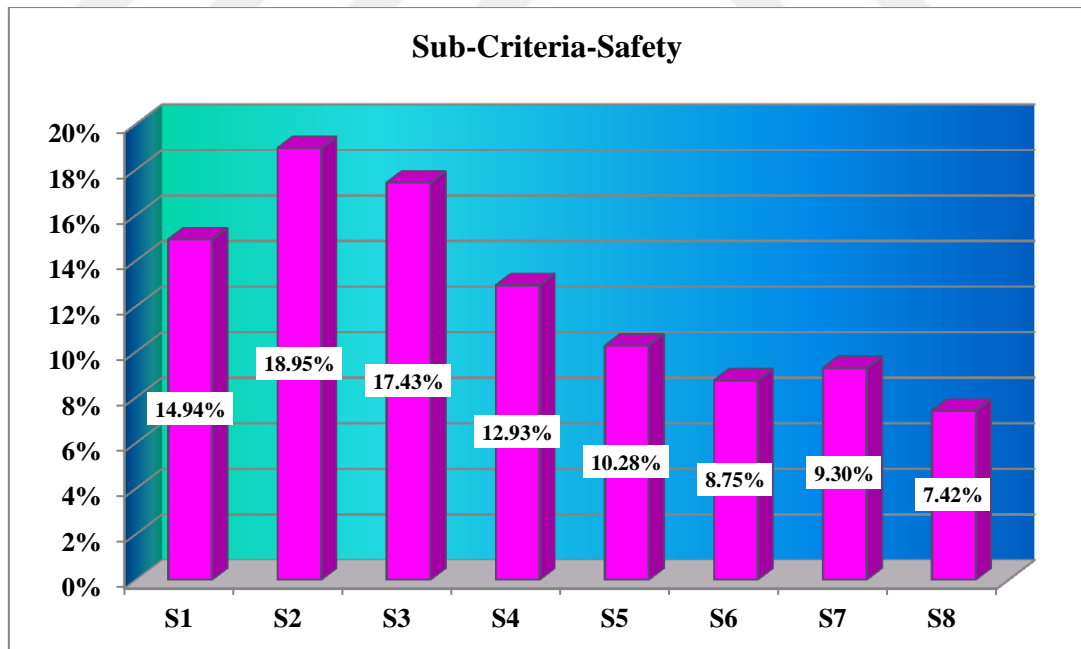
Fig.(4-10) relative importance of sub-criteria within safety factor

• It is possible to note that the S2,S3 criterion has the highest relative importance among the other standards.

4.8.2.3 The Relative Importance of Companies / Main Criteria

4.8.2.3.1 Main Criteria / Cost

Table (4-15) the results of pairwise comparison questionnaire of companies / main criteria / cost

Companies	A	B	C	D
A	1	1.46	0.47	2.85
B	0.68	1	1.43	2.43
C	2.13	0.70	1	4.44
D	0.35	0.41	0.23	1
∑	4.16	3.57	3.13	10.72

Weight Matrix

Table (4-16) relative importance of companies / main criteria / cost

Companies	A	B	C	D	Weight Vector %
A	0.24	0.409	0.15	0.266	26.60%
B	0.165	0.28	0.458	0.227	28.30%
C	0.511	0.196	0.32	0.414	36.00%
D	0.084	0.115	0.072	0.093	9.10%

Norm Matrix

$\lambda = 4.20925$, CI = 0.06975, RI = 0.9, CR = 0.0775 < 0.1 → O.K
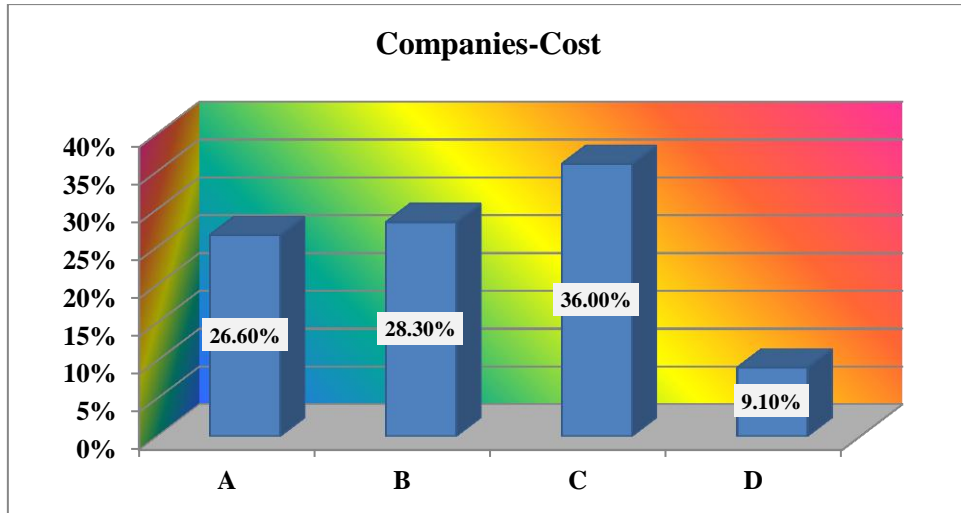
Fig.(4-11) relative importance of companies within main criteria / cost factor

• It is possible to observe from the above figure that the company C has the highest relative importance among the other companies within the main cost criteria.

4.8.2.3.2 Main Criteria / Time

Table (4-17) the results of pairwise comparison questionnaire of companies / main criteria / time

Companies	A	B	C	D
A	1	0.44	0.55	2.19
B	2.27	1	0.43	1.96
C	1.82	2.33	1	2.11
D	0.46	0.51	0.47	1
∑	5.55	4.28	2.45	7.26

Weight Matrix

Table (4-18) relative importance of companies / main criteria / time

Companies	A	B	C	D	Weight Vector %
A	0.18	0.103	0.224	0.302	**20.20%**
B	0.41	0.234	0.175	0.27	**27.20%**
C	0.328	0.544	0.408	0.291	**39.30%**
D	0.082	0.119	0.193	0.138	**13.30%**

$\lambda = 4.19175$, CI = 0.063917, RI = 0.9, CR= 0.071019 < 0.1 → O.K
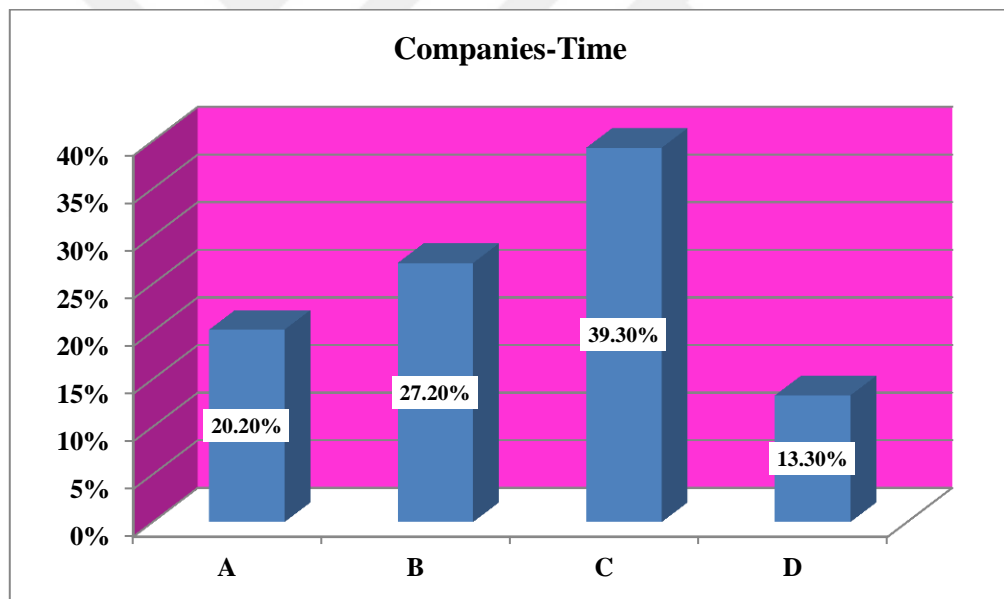
Fig.(4-12) relative importance of companies within main criteria / time factor

• It is possible to observe from the above figure that the companies C has the highest relative importance among the other companies within the main time criteria.

4.8.2.3.3 Main Criteria / Quality

Table (4-19) the results of pairwise comparison questionnaire of companies / main criteria / quality

Companies	A	B	C	D
A	1	2.40	1.32	1.98
B	0.42	1	0.40	3.42
C	0.76	2.50	1	4.78
D	0.51	0.29	0.21	1
∑	2.68	6.19	2.93	11.18

Table (4-20) relative importance of companies / main criteria / quality

Companies	A	B	C	D	Weight Vector %
A	0.373	0.388	0.451	0.177	34.70%
B	0.156	0.161	0.137	0.306	19.00%
C	0.283	0.404	0.341	0.428	36.40%
D	0.189	0.047	0.071	0.089	9.90%

$\lambda = 4.2515$, CI = 0.083833, RI = 0.9, CR= 0.093148< 0.1 → O.K
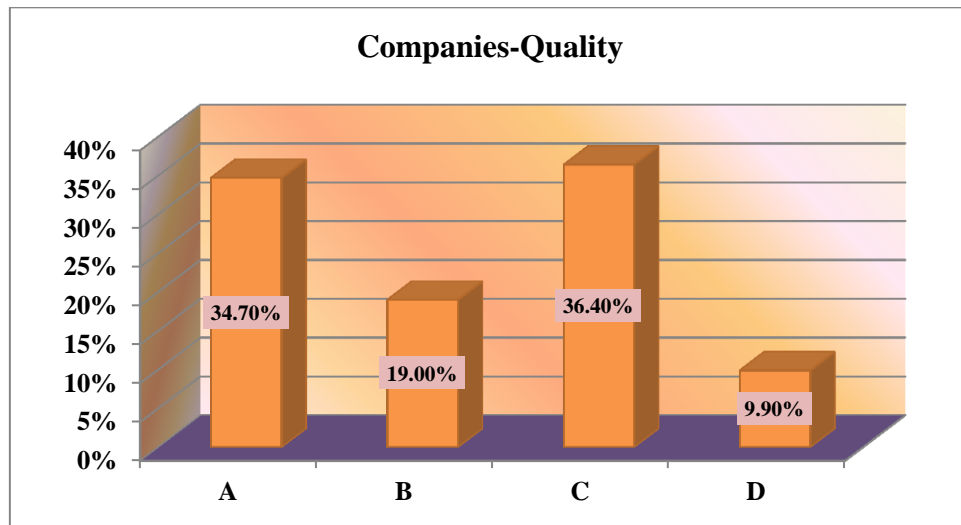
Fig.(4-13) relative importance of companies within main criteria / quality factor

• It is possible to observe from the above figure that the company C has the highest relative importance among the other companies within the main quality criteria.

4.8.2.3.4 Main Criteria / Safety

Table (4-21) the results of pairwise comparison questionnaire of companies / main criteria / safety

Companies	A	B	C	D
A	**1**	2.82	1.20	2.42
B	0.35	**1**	0.30	1.38
C	0.83	3.33	**1**	3.45
D	0.41	0.72	0.29	**1**
∑	**2.60**	**7.88**	**2.79**	**8.25**

(Weight Matrix)

Table (4-22) relative importance of companies / main criteria / safety

Companies	A	B	C	D	Weight Vector %
A	0.384	0.358	0.43	0.293	**36.60%**
B	0.136	0.127	0.108	0.167	**13.50%**
C	0.32	0.423	0.358	0.418	**38.00%**
D	0.159	0.092	0.104	0.121	**11.90%**

$\lambda = 4.04525$, CI $= 0.015083$, RI $= 0.9$, CR $= 0.016759 < 0.1 \rightarrow$ O.K

The relative importance of companies within main criteria / safety as shown in figure (4-14).
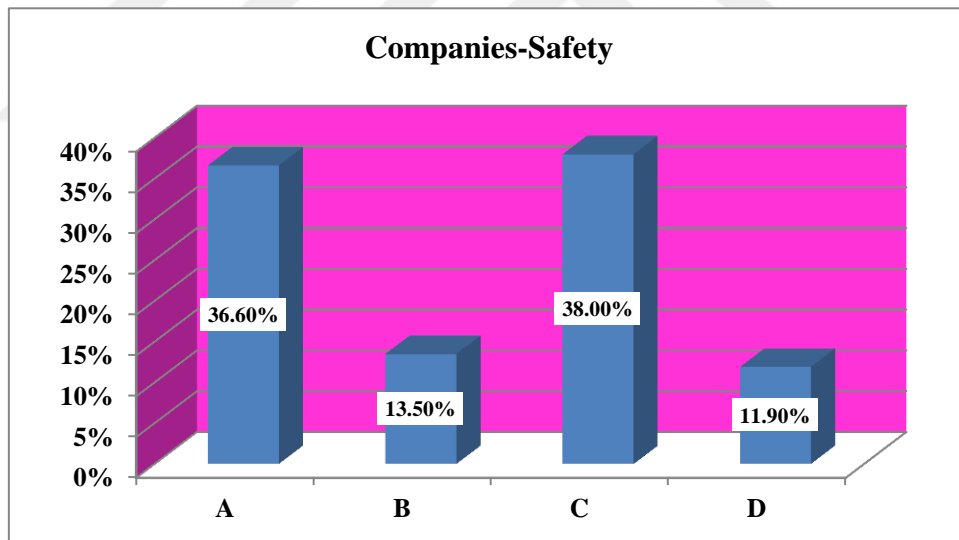
Fig.(4-14) relative importance of companies within main criteria / safety factor

• It is possible to observe from the above figure that the company C has the highest relative importance among the other companies within the main safety criteria.

4.8.3 The Final Weights of Companies Within Main Criteria/(Cost–Time–Quality-Safety)

Table (4-23) relative importance of companies / main criteria

Companies	A	B	C	D	Weight Vector %
Cost	0.266	0.283	0.36	0.091	33.80%
Time	0.202	0.272	0.393	0.133	25.40%
Quality	0.347	0.19	0.364	0.099	33.70%
Safety	0.366	0.135	0.38	0.119	7.10%
					100%

(Composite Matrix)

Table (4-24) the final weights of companies

Companies	Final Weights	Final Weights%
A	0.28	28%
B	0.24	24%
C	0.37	37%
D	0.11	11%
		100%
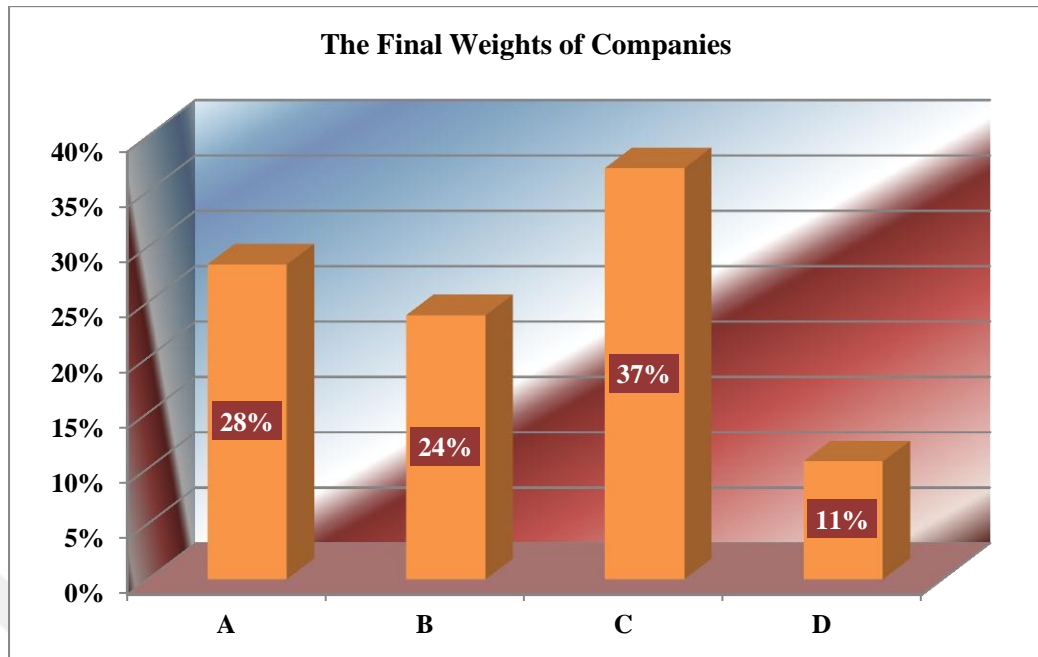
Fig.(4-15) final weights of companies within main criteria

• By observing the above results, we see that the highest final weight(37%) is the company C.

• According to the results obtained from the analysis of the data of the experts through the questionnaire that conducted on the sample based on these results in the evaluation and selection of the optimal company in the construction projects.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The conclusions may be drawn from the present research work are as following :-

1- Current study included four main criteria (Cost, Time, Safety, Quality) with its sub-criteria, which impact on success of project management and choosing the best company.

2- Analytic Hierarchy Process(AHP) was used in this study, which is an important and appropriate technique in the study of criteria and comparison between the alternative and select the best option.

3- Through the results. We note that the relative importance of the main standards and according to the experts' opinion that the cost aspect is the highest relative importance compared to other criteria through which the assessment of the advanced companies and their optimal selection.

4- By observing the results, we see that the highest relative importance of factors / sub-criteria within the cost criteria is the modification of project outputs (22.72%) because it mainly affects the feasibility of the project to the end as well as being a basis for competition among the developed companies.

5- It is possible to observe that the duration of work criterion (26.79%) has the highest relative importance among the other sub-criteria within the time criteria.

6- It observed that the application of engineering management principles in the project (23.19%) has the highest relative importance among the other sub-criteria within the quality criteria because it directly affects the quality of the project.

7- It is possible to note that the compliance with controls and instructions (18.95%) has the highest relative importance among the other sub-criteria within the safety criteria because the quality determines the material. Technical and administrative capabilities of the company and therefore is considered an important basis for evaluation among the developed companies.

8- It is possible to observe that the company C has the highest relative importance among the other companies within the main cost criteria (36%).

9- It is possible to observe that the company C has the highest relative importance among the other companies within the main time criteria (39.30%).

10- It is possible to observe that the company C has the highest relative importance among the other companies within the main quality criteria (36.40%).

11- It is possible to observe that the company C has the highest relative importance among the other companies within the main safety criteria (38%).

12- As it shown to us that company C has the highest weight, this mean the best company is C.

5.2   Recommendations for Future Works

1-   Study the effect of financial and administrative corruption criteria, I think this factor has a big impact on the success factors for projects, As well as in choosing the best company.

2-   Study the effect of the security situation, As long as, the world today is subjected to various terrorist acts. This is one of the important factors influencing the success of projects so in choosing the best company.

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APPENDIX :

❖ **Part -1-**

General Information

Please tick (√) in the right place

1. **Academic Achievement**

◯ B.Sc. ◯ M.Sc. ◯ Ph.D.

2. **Competencies**

◯ Architect ◯ Civil ◯ Electric ◯ Mechanical ◯ Geologist

3. **Administrative Position**

◯ Project Manager ◯ Project Firm ◯ Head of Department ◯ Advisor

4. **Years of Experience**

◯ 10-15 year ◯ 15-20 year ◯ 20-25 year ◯ more than 25 year

Part -2-

<table>
<tr><td>**Engineering Management**</td><td>**University of Turkish**</td></tr>
<tr><td>**Department**</td><td>**Aeronautical Association**</td></tr>
</table>

The Questionnaire of Relative Importance for Criterion to Choice A best Company

Dear Mr./Mrs.

The questionnaire in your hands is aimed to determine the relative importance of factors and the relative importance of each firms within the each factors and private technology analytical hierarchy (AHP) in the process of selecting the best firms for construction projects operating in Iraq, as part of the requirements to obtain a Master ̓s Degree in Engineering Management that the researcher aspires to obtain. So we hope your cooperation with us to serve the scientific process.

With Thanks

<table>
<tr><td>**Researcher**</td><td>**Advisor**</td></tr>
<tr><td>**Methaq S. Hameed**</td><td>**Assist. Prof. Dr. H. Umut AKIN**</td></tr>
</table>

Field Survey Questionnaire (AHP)

Please assess the relative importance of each of the criteria adopted in the evaluation and selection of the optimal company based on:

1. The Measure of Relative Importance as Show in the Table Below

Table (1) preference scales for pairwise comparison

Amount of Importance	Definition	Explanation
1	Equivalent importance	Contribution of both operatives in serving the objective.
3	Medium importance	Slightly preferring one of both operatives to the other.
5	Essential importance	Strongly preferring one of both operatives to the other.
7	Clearly obvious importance.	The dominance of one of the operatives' importance over the other.
9	Intense and extreme importance	Preference declaration of one of the operatives to the other at the highest amount possible of proof and assertion.
2,4,6,8	Intermediate values.	Used when needed in comparison.

2. The relative importance for each criterion of evaluation and the method of pairwise comparison between them by marking (√) as shown in the following example:

Criteria	The amount of relative importance																	Criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Cost																		Time

Which the criteria is more important? And to what degree it is so important?

If you believe that the cost criterion is more than (9) times the time criterion of the relative importance of selecting the optimal firm then tick (√) as follows:

Criteria	The amount of relative importance																	Criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Cost	√																	Time

If you believe that the time criterion is more than (9) times the cost criterion of the relative importance of selecting the optimal firm then tick (√) as follows:

Criteria	The amount of relative importance																	Criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Cost																	√	Time

A : The Comparative Pairwise of Main-Criteria

Table (1) the comparative pairwise between main-criteria

Criteria	The amount of relative importance																	Criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Cost																		**Time**
																		Quality
																		Safety
Time																		**Quality**
																		Safety
Quality																		**Safety**

B : The Comparative Pairwise of Sub-Criteria

1. **Table (2)** the comparative pairwise between the <u>sub-criteria</u> within the cost criteria

Sub-Criteria	The amount of relative importance																	Sub-Criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
The project meets the business objectives of profit and revenue																		Provide adequate financial resources for the project
																		Modification of project outputs
																		The project uses modern technology
																		Rapid construction
																		Complexity of project design
																		Material transfer method for the site
																		Project price view
																		Project contract mechanism (lump sum, unit price, etc
Provide adequate financial resources for the project																		Modification of project outputs
																		The project uses modern technology
																		Rapid construction
																		Complexity of project design
																		Material transfer method for the site
																		Project price view
																		Project contract mechanism (lump sum, unit price, etc

		The project uses modern technology
Modification of project outputs		Rapid construction
		Complexity of project design
		Material transfer method for the site
		Project price view
		Project contract mechanism (lump sum, unit price, etc
The project uses modern technology		Rapid construction
		Complexity of project design
		Material transfer method for the site
		Project price view
		Project contract mechanism (lump sum, unit price, etc
Rapid construction		Complexity of project design
		Material transfer method for the site
		Project price view
		Project contract mechanism (lump sum, unit price, etc
Complexity of project design		Material transfer method for the site
		Project price view
		Project contract mechanism (lump sum, unit price, etc
Material transfer method for the site		Project price view
		Project contract mechanism (lump sum, unit price, etc
Project price view		Project contract mechanism (lump sum, unit price, etc

2. Table(3) the comparative pairwise between the <u>sub-criteria</u> within the time criteria

Sub-Criteria	The amount of relative importance																	Sub-Criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Duration of work																		Use project management techniques in project monitoring and performance
																		Develop appropriate plans to start the project.
																		Commitment to work and time.
																		Troubleshooting.
																		General administrative procedures.
																		The decision in time by the owner.
																		Performance schedule.
Use project management techniques in project monitoring and performance																		Develop appropriate plans to start the project.
																		Commitment to work and time.
																		Troubleshooting.
																		General administrative procedures.
																		The decision in time by the owner.
																		Performance schedule.
Develop appropriate plans to start the project																		Commitment to work and time.
																		Troubleshooting.
																		General administrative procedures.
																		The decision in time by the owner.
																		Performance schedule.

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Commitment to work and time																		Troubleshooting.
																		General administrative procedures.
																		The decision in time by the owner.
																		Performance schedule.
Troubleshooting.																		General administrative procedures.
																		The decision in time by the owner.
																		Performance schedule.
General administrative procedures																		The decision in time by the owner.
																		Performance schedule.
The decision in time by the owner																		Performance schedule

3. Table (4) the comparative pairwise between the <u>sub-criteria</u> within the quality criteria

Sub- Criteria	The amount of relative importance																	Sub- Criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Use of modern technology in the project																		Application of engineering management principles in the project
																		Quality control
																		Refer the work paragraphs to secondary contractors are not competent
																		Appoint the relevant project manager.
																		The project team is competent and multidisciplinary
																		Adequacy of schemes and specifications
																		Contractor experience
																		Building control and supervision meetings
Application of engineering management principles in the project																		Quality control
																		Refer the work paragraphs to secondary contractors are not competent
																		Appoint the relevant project manager.
																		The project team is competent and multidisciplinary
																		Adequacy of schemes and specifications
																		Contractor experience

Quality control																		Building control and supervision meetings
																		Refer the work paragraphs to secondary contractors are not competent
																		Appoint the relevant project manager.
Quality control																		The project team is competent and multidisciplinary
																		Adequacy of schemes and specifications
																		Contractor experience
																		Building control and supervision meetings
																		Appoint the relevant project manager.
Refer the work paragraphs to secondary contractors are not competent																		The project team is competent and multidisciplinary
																		Adequacy of schemes and specifications
																		Contractor experience
																		Building control and supervision meetings
Appoint the relevant project manager																		The project team is competent and multidisciplinary
																		Adequacy of schemes and specifications
																		Contractor experience
																		Building control and supervision meetings
The project team is competent and multidisciplinary																		Adequacy of schemes and specifications
																		Contractor experience
																		Building control and supervision meetings
Adequacy of schemes and specifications																		Contractor experience
																		Building control and supervision meetings

4. Table (5) the comparative pairwise between the <u>sub-criteria</u> within the safety criteria

Sub- Criteria	The amount of relative importance																	Sub-Criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Identify external factors that depend on the environment																		Compliance with controls and instructions.
																		Implement an effective safety program.
																		Identification and allocation of risks.
																		Insurance on work
																		Training human resources on the skills required by the project.
																		Obstacles in the workplace.
																		Absence of a system of communication between the participants in the work
Compliance with controls and instructions																		Implement an effective safety program.
																		Identification and allocation of risks.
																		Insurance on work
																		Training human resources on the skills required by the project.
																		Obstacles in the workplace.
																		Absence of a system of communication between the participants in the work

		Identification and allocation of risks.
Implement an effective safety program		Insurance on work
		Training human resources on the skills required by the project.
		Obstacles in the workplace.
		Absence of a system of communication between the participants in the work
Identification and allocation of risks		Insurance on work
		Training human resources on the skills required by the project.
		Obstacles in the workplace.
		Absence of a system of communication between the participants in the work
Insurance on work		Training human resources on the skills required by the project.
		Obstacles in the workplace.
		Absence of a system of communication between the participants in the work
Training human resources on the skills required by the project		Obstacles in the workplace.
		Absence of a system of communication between the participants in the work
Obstacles in the workplace		Absence of a system of communication between the participants in the work

C : The Comparative Pairwise of Companies Within Main Criteria

1. Table (6) the comparative pairwise between companies\ cost criteria

Company	The amount of relative importance																	Company
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
A																		B
																		C
																		D
B																		C
																		D
C																		D

2. Table (7) the comparative pairwise between companies\ time criteria

Company	The amount of relative importance																	Company
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
A																		B
A																		C
A																		D
B																		C
B																		D
C																		D

3. Table (8) the comparative pairwise between companies\ quality criteria

Company	The amount of relative importance																	Company
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
A																		B
																		C
																		D
B																		C
																		D
C																		D

4. Table (9) the comparative pairwise between companies\ safety criteria

Company	The amount of relative importance																	Company
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
A																		B
																		C
																		D
B																		C
																		D
C																		D

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FOREIGN LANGUAGES

English