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Deanery of Graduate Studies
Faculty of Engineering
Civil Engineering Department
Construction Management

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عمادة الدراسات العليا
كلية الهندسة
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An Analytical Hierarchy Process (AHP) Based Prequalification System for Gaza Strip Construction Contractors

نظام تأهيل مسبق لمقاولي التشييد في قطاع غزة على أساس عملية التحليل الهرمي

Submitted by:

Salem Yousef Al Wahaidi

Supervised by:

Dr. Nabil El Sawalhi

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An Analytical Hierarchy Process (AHP) Based Prequalification System for Gaza Strip Construction Contractors

وبعد المناقشة العلنية التي تمت اليوم السبت 02 ربيع آخر 1433هـ، الموافق 2012/02/25م الساعة العاشرة صباحًا بمبنى القدس، اجتمعت لجنة الحكم على الأطروحة والمكونة من:

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د. علاء الدين داود الجماصي	مناقشاً داخلياً	.....
د. علاء عبد الحميد شعت	مناقشاً خارجيًا	.....

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واللجنة إذ تمنحه هذه الدرجة فإنها توصيه بتقوى الله ولزوم طاعته وأن يسخر علمه في خدمة دينه ووطنه.

والله ولي التوفيق،،،

عميد الدراسات العليا

أ.د. فؤاد علي العاجز

P.O. Box108, Rimal, Gaza, Palestine fax:+970 (8) 286 0800 فاكس Tel: +970 (8) 286 0700 ص.ب. 108 الرمال، غزة، فلسطين هاتف
public@iugaza.edu.ps www.iugaza.edu.ps

To my parents, my wife and my family

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Abstract

Prequalification is an essential process in developing the construction industry in Gaza Strip. In the prequalification process, the clients save the time, efforts by selecting competent contractors to implement their projects upon their requirements as well as protecting contractors from being awarded work they are incapable of doing it.

Most of the implementing agencies in Gaza Strip depend on the Palestinian Contractors Union (PCU) classification and consider it as a prequalification process. Some agencies adopt specific levels of classification; other has a short list classification of prequalified contractors. However, these procedures have not prevented the continuous failure of firms to complete the projects and achieve the client's goals.

This study aims at investigating the existing prequalification practices in Gaza Strip, setting prequalification criteria, applying the Analytical Hierarchy Process (AHP) to determine its weights, conducting case study by AHP, and developing computerized software based on AHP.

This research has been conducted through literature review of the topics related to prequalification process, followed by a field survey. The field survey consisted of two questionnaires. In the first questionnaire, eighty managers, experts, and engineers were asked to fill in the questionnaire that covers topics related to the prequalification of the contractors in Gaza Strip. In the second questionnaire, a group of experts was asked to fill in the questionnaire that based on AHP to determine the weights of the prequalification criteria and subcriteria.

The results indicated that PCU classification is significant for most implementing agencies in Gaza Strip. In addition, the results showed the high importance of the adopted prequalification criteria of the contractors. Based on AHP, it was found that the financial stability of the company is the most important criterion with respect to its weight. Moreover, technical ability, past performance, management capability, experience and reputation of the company have considerable weights. On the other hand, claims and contractual disputes, health and safety procedures and current workload of the company have relatively low weights. The study also showed that AHP approach is an effective and flexible tool to determine the weights of prequalification criteria as well as the selection of the competent contractors in the prequalification phase.

الملخـــص

إن عملية التأهيل المسبق هي عملية ضرورية لتطوير صناعة الإنشاءات في قطاع غـــزة . فـــي عملية التأهيل المسبق يتمكن المالكين من توفير الوقت والجهد في اختيار المقاولين الأكفاء مـــن أجل تنفيذ مشاريعهم بناء على متطلباتهم وكذلك حماية المقاولين من العمل في مشـــاريع غيـــر قادرين على القيام بها.

معظم الجهات المنفذة في قطاع غزة تعتمد على تصنيف اتحاد المقاولين الفلسطينيين معتبرة هذا التصنيف عملية تأهيل مسبق. بعض الجهات تعتمد مستويات محددة من التصنيف اخذة في عين الاعتبار تصنيف إتحاد المقاولين الفلسطينيين و هناك جهات أخرى لديها قائمـــة قصـــيرة مـــن المقاولين المؤهلين مسبقا بناء على معايير محددة لديها بشرط كونهم مصنفين في اتحاد المقاولين الفلسطينيين. مع ذلك فإن كل هذه الإجراءات المعتمدة لم تمنع الفشل المستمر للشركات في تنفيـــذ المشاريع وتحقيق أهداف المالكين.

تهدف هذه الدراسة إلى فحص ممارسات التأهيل القائمة في قطاع غزة ووضع معـــايير لعمليـــة التأهيل المسبق وتحديد أوزان لها باستخدام عملية التحليل الهرمي. كذلك إجراء دراسة لحالة تأهيل باستخدام عملية التحليل الهرمي و تطوير برنامج حاسوب على أساس عملية التحليل الهرمي.

أجريت هذه الدراسة من خلال استعراض الأدبيات من المواضيع المتعلقة بعملية التأهيل ثم أتبعت بمسح ميداني. عملية المسح الميداني تمت من خلال اثنين من الاستبيانات. في الاســـتبيان الأول طلب من ثمانين من المدراء و أصحاب الخبرة والمهندسين العاملين في صناعة الإنشاءات تعبئة الاستبيان الذي يغطي موضوعات تتعلق بعملية تأهيل المقاولين في قطاع غزة. فـــي الاســـتبيان الثاني طلب من مجموعة من ستة من أصحاب الخبرة في تعبئة الاستبيان على أســـاس عمليـــة التحليل الهرمي من أجل تحديد أوزان معايير التأهيل الرئيسية و الفرعية.

أشارت النتائج إلى أن تصنيف اتحاد المقاولين الفلسطينيين مهم بالنسبة لمعظم الجهات العاملة في قطاع الإنشاءات في قطاع غزة. بناء على عملية التحليل الهرمي وجد أن الاســـتقرار المـــالي للشركة هو المعيار الأهم فيما يتعلق بوزنه. علاوة على ذلك فإن القدرة الفنيـــة والأداء الســـابق والقدرة الإدارية وخبرة وسمعة الشركة لها أوزان كبيرة. من ناحيـــة أخـــرى فـــإن المطالبـــات والمنازعات التعاقدية وإجراءات الأمن والسلامة وحجم الأعمال الحالية للشركة أوزانها منخفضة نسبيا. الدراسة أظهرت أيضا أن عملية التحليل الهرمي هي أداة فعالـــة ومرنـــة لقيـــاس أوزان معايير التأهيل و كذلك اختيار المقاولين في مرحلة التأهيل المسبق.

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List of Abbreviations

AC	Accountant
AHP	Analytical Hierarchy Process
AIP	Amount of Implemented Projects
ANN	Artificial Neural Networks
CBR	Case-Based Reasoning
CCD	The Claims and Contractual Disputes
CI	Consistency Index
COR	Commercial Registration
CPP	Contractors Past Performance
CR	Consistency Ratio
CSP	Contractors Selection Program
CUC	Contractors union classification
CWL	Current Workload
DWA	Dimensional Weighting Aggregation
En	Engineer
ER	Equipment Resources
Exp.	Experience
F	Foreman
FS	Financial Stability of the Company
FSC	Financial Status of the Company
FTS	Financial and Technical Situation of the Company
GPC	Good Performance Certificate of the Company
HS	Health and Safety
KBS	Knowledge Based System
LS	Legal Status of the Company
MAA	Multi-Attribute Analysis
MC	Management Capabilities
MPR	Manpower Resources
MT	Managerial and Technical Team
NAL	Number of Available Loaders

NAT	Number of Available Trucks
NCCC	National Committee of Contractors' Classification
NGOs	Non-Governmental Organizations
PCU	Palestinian Contractors Union
PERT	Program Evaluation and Review Technique
PP	Past Performance
PQC	Prequalification Criteria
PS	Projects Similar to the Nature of the Project
PSFs	Project Success Factors
QP	Quality Performance
R	Reputation
RI	Random Index
RII	Relative Importance Index
RT	Record of the Company Tax
S	Secretary
SL	Skilled Laborer
TA	Technical Ability
TC	Tax Clearance Statement
UK	United Kingdom
USA	United States of America
USL	Unskilled Laborer

CHAPTER ONE
INTRODUCTION

The purpose of this chapter is to introduce the research contents. The concept of prequalification of contractors is briefly discussed. The statement of the problem and the purpose of this research are outlined.

1.1 Background

Prequalification is a process in which the contractors are evaluated by the client or their agent, prior to tender process. Prequalification process is different from the post-qualification in which the client evaluated the contractor following the tender process. Hence, in prequalification process the client save the time and efforts by selecting competent and acknowledged contractors to implement the project upon his requirement.

Prequalification is a process that involves the screening of construction contractors by clients or their representatives, according to a predetermined set of criteria considered essential for the success of the project completion. It was found that that the contractors' work experience and the official requirement are the most frequently used criteria in evaluation and selection. On the other hand, the available resources in terms of personnel, plant, and equipment; financial stability; management capabilities; and organization structure are used with less frequency (Bubshait and Al-Gobali, 1996). Pre-qualification is the process that compares the key contractor-organizational criteria among a group of contractors desirous to tender. Such criteria can be past performance, past experience, and financial stability (Cheng and Li, 2004).

The local practices in Gaza Strip present that failures have inflicted a considerable number of contracting companies during the past few years. Moreover, the recent studies in project management practices, factors affecting contractors cost estimating and reasons of contractor's failure concluded that there is a critical problem in the contractor's prequalification and classification applied by the different clients in Gaza Strip and West Bank. Accordingly, it was recommended that there is a need to apply a modified approach for contractor’s prequalification (El Sawalhi et al., 2007).

In the absence of direct links between client goals and contractor selection criteria in current evaluation procedures, it is assumed that, if contractors comply with the selection criteria, they will automatically be capable of meeting the client's goals. Similarly, the current evaluation procedures also assume that any trade-offs that are made between criteria measures (e.g., where some doubt over a contractor's financial position is compensated by a superior technical capability) will be equally valid in terms of the time, cost, quality etc goals affected (Hatush and Skitmore, 1997a).

The prequalification of contractors to select a suitable and capable contractor for a construction project is not an easy task but it will provides an opportunity to assess contractors' eligibility prior to bidding. In fact, each construction firm has his own strengths and weaknesses, and it is careful for clients to implement an evaluation of these in advance. The prequalification process is aimed at selecting a limited number of contractors who are each financially and technically capable of carrying out and completing the contract work satisfactorily and with whom the client could enter into a contract (Ng et al., 1999). Fong and Choi (2000) stated that the selection of a capable construction contractor is one of the most important tasks faced by a construction client who wishes to achieve successful project outcomes. Often this task is challenging, because the construction industry is volatile and competitive.

Contractors play a major part in any construction project and hence contractor selection constitutes a critical decision for any client/client's representative. The relative complexity and adversity of the construction industry aggravate the various risks and uncertainties faced by contractors, which influence their ultimate performance levels. Clients, in turn, risk shortfalls in meeting their goals and objectives through contractor failures on various performance aspects such as cost, time, and quality. Contractor prequalification is generally preferred by clients to minimize the previously mentioned risks and failures and to enhance the performance levels of selected contractors by means of establishing minimal capacities below which contractors will not be considered (Palaneeswaran and Kumaraswamy, 2001).

The contractor selection process comprises five common process components, for all kinds of procurement arrangement. These are project-packaging, invitation, prequalification, short-listing and bid evaluation (Hatush and Skitmore, 1997b). Prequalification is a pre-tender process used to investigate and evaluate the capabilities of

contractors to execute a contract satisfactorily if it is awarded to them, and has been examined by several researchers. It provides a client with a standing list of potential contractors to invite to tender for similar types of project on a regular basis (Hatush and Skitmore, 1997a).

1.2 Problem Statement

Most of the implementing agencies in the construction industry in Gaza Strip, governmental and non-governmental, depend on the contractors' classification that has been adopted by the National Committee of Contractors' Classification (NCCC) and consider this classification as a prequalification process. The National Committee of Contractors' Classification adopted five levels for contractors' classification. On the other hand, some agencies adopted specific levels of classification taking into consideration NCCC Classification; other has a short list classification of prequalified contractors based on specific criteria provided that the contractors classified by NCCC. However, these adopted procedures have not prevented the continuous failure of firms to complete the projects and achieve the client's goals (El-Sawalhi, 2007b).

It is clear that there is an absence of standardization among clients/owners regarding the issues related to the prequalification process. Therefore, there is significant need to specify prequalification criteria upon its significance to the clients' goal and set its weight upon clear and reasonable basis and procedures instead of judgment and intuition.
For that purpose, the researcher will investigate the prequalification practices in order to set the most important and fit prequalification criteria. Then, the analytical hierarchy process (AHP) will be used to determine the weights of the adopted criteria for different sectors such as housing, sewage, water, and road works projects. Practical and flexible software based on AHP will be developed to facilitate the prequalification process and achieve the clients' goals.

1.3 Research aim

This thesis intends to improve the prequalification practices in Gaza Strip by adopting the AHP approach to achieve clients' goals.

1.4 Research objectives

The specific objectives of this research are:

1. Investigate the local practice of the prequalification process in Gaza Strip.
2. Determine the most efficient and important criteria in the prequalification process.
3. Determine the weights of the prequalification criteria for housing, sewage, water, and road works projects by using AHP.
4. Conduct a case study by using AHP.
5. Develop practical and flexible software based on AHP in order to assist clients in the prequalification process.

1.5 Research Methodology

Stage 1: Literature Review

The research reviewed the relevant literature regarding the prequalification of contractors with respect to prequalification criteria in order to select the eligible contractor through financial stability, experience, managerial skills, past performance, workload, technical ability, safety, and dispute record. Moreover, there will be review for the most used models in the prequalification processes as well as the general prequalification practices around the world.

Stage 2: Structured Interview and Pilot Study

A structured questionnaire with experts in the field of the prequalification practices was conducted. Those experts included project's managers and professionals experienced in prequalification and bid evaluation. This pilot study was the advance phase to develop the final form of questionnaire. In this phase of the pilot study, there was some an amendment, modifications, omission, addition or developments of the questionnaire to be ready for the final phase of distribution.

Stage 3: Final Questionnaire Preparation

After the development of all factors that based on the structured interview and pilot studies, the first questionnaire was distributed among the governmental and non-governmental implementing agencies in this field in order to obtain their perspectives regarding the important prequalification criteria that influence the overall process. Then, a second questionnaire was developed upon the results of the first questionnaire to

determine the weights of the prequalification criteria that essential for all the sides working in the construction field in Gaza Strip.

Target Group: The study focuses on project's managers and professionals experienced in prequalification and bid evaluation in the governmental and non-governmental implementing agencies in the field of the construction in Gaza Strip.

Stage 4: Analysis of Results

- Regarding the first questionnaire, the researcher used Excel software to determine the important and significant criteria that has great impact on the prequalification process.
- Regarding the second questionnaire, the weight of the prequalification criteria was calculated by using AHP approach.

Stage 5: Case Study

An actual case study of real problem in the field of prequalification was used to compare between the traditional process and AHP application to view the importance of the application of AHP in construction.

Stage 5: Software

Practical software based on AHP was developed in order to assist clients in the prequalification process.

Stage 6: Conclusion and Recommendations

This phase involved writing up conclusions and suggesting recommendations and recommendations for further studies.

1.6 Thesis Contents

This thesis consists of six chapters as follow:

Chapter 1: Presents a general introduction to the subject matter of the thesis.

Chapter 2: Presents a literature review for topics related to contractors' prequalification.

Chapter 3: The questionnaire design, pilot study, and method of analysis are presented.

Chapter 4: Presents the results achieved, their analysis, and discussion.

Chapter 5: Presents case study.

Chapter 6: Presents software based on AHP.

Chapter 7: Presents conclusions and recommendations for further studies.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter focuses on subjects that are available in literature and related to the prequalification process. The main topics that are included in the chapter are contractors' prequalification, prequalification criteria, prequalification models, prequalification practices around the world, and Analytic Hierarchy Process.

2.2 Contractors Prequalification

Prequalification is a screening process applied to contractors before tendering to decrease and avoid the risk of project failure. The largest parts of prequalification models apply some form of a weighted scoring system in which the contractors are scored upon weighted criteria that are finally summed to give a single value. The problems inherent in this decision-making procedure are the biases and additive assumptions established in the development of the weights and the evaluation process (McCabe et al., 2005). Sonmez et al. (2002) highlighted that the contractor prequalification process is a typical multiple criteria decision-making problem that includes both quantitative and qualitative criteria. In case of facing such problems, a decision maker may need to provide uncertain, incomplete, or imprecise assessments due to a lack of information, time pressure and/or shortcomings in expertise. A multiple criteria decision-making method is then needed in order to deal with such assessments as well as for the meaningful and robust aggregation.

Hatush and Skitmore (1997b) stated that the contractor selection is one of the key decisions made by the clients. In order to guarantee that the project can be completed successfully, the client must select the most appropriate contractor. This involves a procurement system that consists of five common process elements: project packaging, invitation, prequalification, short-listing, and bid evaluation.

Contractor prequalification is a process to evaluate candidate contractors' ability to complete a contract satisfactorily before they are admitted into the bidding process. The current practice of prequalification is that, by exercising the accumulated experience and judgment in assessing a given set of criteria, such as reputation, past performance,

financial stability, current workload, firm's resource capacity, experience records, and technical expertise, decision-makers draw a conclusion regarding the qualification or disqualification of each contractor. The uncertainty, non-linearity, imprecision, subjectiveness, and the lack of experience and knowledge within the process make the task challenging (Lam et al., 2000).

Khosrowshahi (1999) defined the prequalification as a screening process whereby a number of contractors are selected, by the client/owner, to prepare a bid for a particular project. For any given project, this is a highly significant decision for the client: the ability to optimize the short listing from a larger number of potential contractors can be as important as the final selection of the right bidder. Therefore, an understanding of the client's decision-making behavior during the prequalification process can provide the contractor with the edge required to overcome competitors, or at least to improve their opportunities of doing so by increasing their chances of prequalifying. It is only at this stage that the opportunity can be converted into a contract.

Mills and Skitmore (1999) pointed that the prequalification of contractors is interested in assessing the opportunity of contractors to match client and project requirements. This requires great efforts by contractors in providing what is often similar information but in different formats. Comparing the different attitudes of both prequalifiers and contractors to prequalification criteria, it was found a divergent opinion on the significance and value of the used criteria. Contractors are partial stakeholders in the process and are expected to have some say in the type of criteria used.

Lam et al. (2005) stated that the contractor prequalification could be considered as a complicated, two-group, non-linear classification problem. It involves a variety of subjective and uncertain information obtained from various parties such as contractors, prequalifiers, and project teams. Non-linearity, uncertainty, and subjectivity are the three predominant features of the contractor prequalification process. This makes the process more of an art than a scientific evaluation. In addition to non-linearity, uncertainty, and subjectivity, contractor prequalification is further complicated by the large number of contractor prequalification criteria used in current practice and the multicollinearity existing between contractors attributes.

2.3 Prequalification vs. Postqualification

Bennett (2003) defined the prequalification as the process in which the clients limit the number of contractors allowed to submit bids on a project; some clients require that contractors be pre-qualified. The contractors must submit information regarding their experiences, competences and financial conditions, after which the client/owner decides whether they are qualified. A properly designed prequalification process should:

- Ascertain that the contractor and major subcontractors, vendors, and material supplier will be competent, responsible, and experienced with adequate resources to complete the job.
- Eliminate contractors with limited financial resources, overextended commitments, and/or inadequate or overly inexperience organizations.
- Maximize competition among qualified contractors.

Postqualification approach is another option. If a contactor is the apparent low tenderer for a project, it will then be asked to submit information proving their qualification. The disadvantages of this approach include the potential for wasted effort throughout the tendering process, if the low bidder is found not to be qualified, and the prospect of the favoritism in rejecting the low bidder by claiming unjustly that it is not qualified. However, owners have the right to choose responsive and responsible tenders, according to all well written contract documents, so there is always the chance for claims of unfairness when the owner decides whether the contractor's tender is responsible (Bennett, 2003).

2.4 Periodic Prequalification vs. Project Prequalification

Periodic prequalification domains are mostly related to public and utility clients and characterized by small and medium sized projects. The qualification process is based on overall appropriateness of contractors rather than their ability to meet the specified requirements of a particular project. Furthermore, the data required in the periodic prequalification are relevant to historical data rather than current data. This means periodic prequalification is more concerned with contractors' capability in terms of their financial and technical experience and performance in certain periods of time (Mangitung and Emsley, 2002).

On the other hand, project prequalification is carried out to develop a list for a particular project, on a project-by-project basis, before invitation to bid, which is related to a certain level of contractor capacity and to meet project specific requirements or objectives. In other words, project prequalification is more concerned with contractors' current data in respect of workload, financial position and remaining resources (Mangitung and Emsley, 2002). Hatush and Skitmore (1997a) mentioned that the bid evaluation occurs at the post-tender stage, and involves the consideration of the bid amount in addition to the contractors' capabilities.

2.5 Prequalification Criteria

Ng and Skitmore (2001) stated that the research on prequalification criteria to date focused solely on the benefits to the client, and it has ignored one of the most fundamental purposes of prequalification, i.e., to reduce the cost of bidding. Hence, they suggested that prequalification of the contractors should be based on decision criteria that have important benefits to the decision process but with minimal costs to those involved. Selecting a construction contractor is one of main decisions, which may influence the progress, and success of any construction project. Contractor prequalification is a commonly used process for identifying a qualified, sound, and reliable construction contractor. A general prequalification exercise is carried out to identify an appropriate contractor from the applicants and to evaluate and score them according to their economic and technical aspects, quality standards, past performance and other characteristics (Banaitiene and Banaitis, 2006).

Palaneeswaran and Kumaraswamy (2001) argued that a general prequalification system is performed to identify eligible contractors from a group of interested applicants. In addition to classify them according to their technical and financial capacity, organizational and managerial expertise, track records in terms of past performance, occupational health and safety, environmental concerns, and even at times on their attitudes towards claims.

Most clients wish their projects realized at the cheapest price possible, not minding the consequence on the project life and the real cost to the contractor. However, the empirical studies showed the relationship between performance of construction projects based on utility derived and the capability of the contractors selected. Therefore, a firm relationship

was discovered between performance of construction projects and capability of contractors through prequalification, using criteria like general information about contractors, performance record, technical capability, financial capability, management capability and health and safety management (Alfred, 2006).

Hatush and Skitmore (1997b) interested in identifying universal criteria for prequalification and bid evaluation, and the means by which different emphases can be accommodated to meet the requirements of clients and projects. The information, assessment, and evaluation strategies currently used by procurers for screening contractors are taken into consideration. The findings showed that the most common criteria considered by procurers during the prequalification and bid process are those pertaining to financial soundness, technical ability, management capability, and the health and safety performance of contractors. Ng and Skitmore (2000) pointed that the successful implementation of a construction project depends to a significant extent on the competence of the main contractor. Contractor selection is therefore a decisive aspect of the construction procurement process as different contractors have different levels of financial, technical, and managerial capabilities.

Hatush and Skitmore (1997c) conducted a study examining the perceived relationship among 20 contractor selection criteria and project success factors (PSFs) in terms of time, cost, and quality. Their study suggested that past failure, financial status, financial stability, credit rating, experience, ability, management personnel, and management knowledge are perceived to be the dominant contractor selection criteria affecting all three PSFs (Palaneeswaran and Kumaraswamy, 2001). Tan et al. (2007) mentioned a list of competitiveness indicators for evaluating contractor competitiveness with reference to Hong Kong construction industry. Contractor key competitiveness indicators adopted in the local practice are classified as indicators measuring corporate image; technical ability; financing ability; marketing ability; management skills; and human resources strength.

Lam et al. (2005) stated that there are three main contributing factors that lead to a large number of contractors prequalification and selection criteria being used including (1) the common desire for project success; (2) the variability of the pre-qualifiers' training, background and experience; and (3) the diversity of project requirements. Furthermore, the existence of strong inter-correlations among contractor attributes has been observed by some researchers.

Selecting the best main contractor is a complex decision process for construction clients. It demands a large number of criteria to be simultaneously measured and evaluated. Decision makers, therefore, very often need to think hard, and devote much time and effort to such business problems. This is even more so where subjective criteria have to be considered. In such cases, it would be helpful if a systematic procedure were available to deal with this subjective decision making complexity (Sonmez et al., 2001).

Palaneeswaran and Kumaraswamy (2000) proposed the assessment of tenderers based on ten key pre-selection criteria. They are finance, human resources, organization and management, project specific requirements, past experience, past performance technology, quality system, health and safety system, and equipment. Ng and Skitmore (2000) identified nine decision criteria. These decision criteria are (1) financial stability, (2) quality assurance, (3) health and safety, (4) failed contracts, (5) previous debarment, (6) credit rating, (7) size of project, (8) fraudulent activity, and (9) capacity of work.

Wong et al. (2001) identified thirty-seven project-specific criteria attributed to these nine categories for building and civil engineering works, respectively. The proposed criteria categories were, namely manpower resources; plant and equipment resources; project management capabilities; geographical location knowledge; location of home office; contractor's capacity; project execution capabilities to the proposed project; technical-economic analysis; and other relevant project-specific criteria for particular types of work.

Bubshait and Al-Gobali (1996) presented their findings in four categories depending on their level of significance. The first category includes the contractor's experience and financial stability. The second category includes past performance, quality performance, project management capabilities, contractor failure record, management staff availability, and the contractors capacity. The third category includes contractor organization, workforce availability, equipment recourses, references, amount of work performed earlier, and current workload. The fourth category includes geographical experience in project location and the location of home office.

Al-Dughaither (2006) stated that the project success is the goal of any client. To increase the chance of achieving this goal, it is usual to introduce a procedure to guarantee that only experienced and competitive contractors are permitted to undertake the project in

question. This procedure involves investigating of the contractor's managerial, financial, and technical capabilities and his experience on similar projects through an integrative assessment of the organization. This investigational process is known as contractor prequalification.

Al-Ghobali (1994) surveyed the Saudi construction market and listed a number of factors against which contractors should be taken into consideration for prequalification. This included experience, financial stability, past performance, current workload, management staff, manpower resources availability, contractor organization, familiarity with the project's geographic location, project management capabilities, quality assurance and control, previous failure to complete a contract, equipment resources, purchase expertise and material handling, safety consciousness, claim attitude, planning/scheduling and cost control, and equipment repairing and maintenance yard facilities.

Ng et al (1999) examined the divergence of prequalifiers in the selection of prequalification criteria for the process of contractor prequalification. It is possible, for instance, that civil engineers may be more interested in contractors' technical and managerial capabilities, while quantity surveyors may focus on their financial soundness instead.

The prequalification criteria providing the most to the differences are process of procurement, size of project, standard of quality, financial stability, project's complexity, claim, and contractual dispute and length of time in business (Ng et al., 1999). Egemen and Mohamed (2005) found that contracting organizations have been concentrating on three main criteria for satisfying clients. These are completing the work with a specified quality, within budget and time.

Palaneeswaran et al. (2003) highlighted that the pre-bid contractor selection tasks such as certification, prequalification, short listing to an optimum number of bidders are potentially significant in contributing the ultimate best value. In such pre-bid selection exercise, the contractor's capacities for best delivery could be ensured by assessing promissory factors such as past experience in similar projects; past performance; financial strengths; human resources; equipment resources; technology bases; claims/dispute history; and track records in legal, environmental, safety and health aspects.

Mahdi et al. (2002) identified 127 decision factors in their survey for the evaluation of contractors grouped under five categories, namely (a) experience, (b) past performance, (c) financial stability, (d) current capabilities, and (e) work strategy. The decision criteria thus derived as follows:

- Experience record: This group of criteria is represented in terms of (1) number of years working on similar projects and in construction generally, (2) total work volume on similar projects and in construction generally, (3) average work volume on similar projects and in construction generally, (4) working with different contract types, (5) working in similar geographical conditions, and (6) working in similar weather conditions in similar projects.
- Past performance record: This group of criteria helps to assess how the contractor has met the defined objectives in (a) previous projects, and (b) in similar projects, in terms of (1) cost, (2) quality of work, (3) schedule, (4) safety, (5) client satisfaction, (6) relationship with sub-contractors, (7) relationship with suppliers and (8) relationship with insurance companies.
- Financial stability of the contractor: A bidder's financial longevity and his/her capacity to meet financial obligations, both short-term and long-term, as well as the financial reporting practices represented by: (1) contractor's credit level or payment record to his/her creditors, such as suppliers and subcontractors, (2) quality of financial statements, (3) adequacy of banking arrangements, (4) liquidity ratio, (5) operations ratio, and (6) leverage ratio.
- Current capabilities: Assessment of a contractor's capabilities to perform the proposed project involves the assessment of (1) contractor capacity, (2) management ability/adaptability/co-ordination and (3) current resources/ workloads.
- Contractor work strategy: The adaptability of method statement and submitted plans by a contractor are assessed compared with the specific conditions of the proposed project based on factors such as (1) cash flow, (2) manpower schedule, (3) procurement schedule, (4) equipment schedule, (5) quality assurance and control plan, (6) safety plan, (7) organizational structure/qualifications of the staff and (8) type of work sub-contracted.

Lam et al. (2000) identified nine main criteria for contractor prequalification, namely (a) financial stability, (b) management capabilities, (c) health and safety, (d) reputation, (e)

standard of equality, (f) relationship, (g) claims and contractual disputes, (h) technical ability and (i) project-specific criteria. Table 2.1 shows the main and sub-criteria that utilized in Lam et al. (2000) study.

Hatush & Skitmore (1997a) highlighted five areas where information relating to the contractor should be collected for both prequalification and bid evaluation. These are financial, technical, managerial, health and safety, and reputation. These areas are not definitive, as other researchers have focused on other areas. Table 2.2 shows the main and sub-criteria and their weights adopted by Hatush & Skitmore (1997a).

El-Sawalhi (2007a) established general prequalification criteria that were collected from previous published works by several researchers. However, only the criterion that was recommended by three or more authors was adopted to be included in the research. Some other criteria were added which found of importance to the prequalification process. Table 2.3 illustrates these prequalification criteria.

Table 2.1: The decision criteria (Lam et al., 2000)

Main Criteria	Sub-criteria
Financial stability	1. Financial soundness 2. Credit rating 3. Financial status
Management capabilities	1. Head office organization 2. Past performance and quality 3. Management Knowledge 4. Experience of technical personnel
Health and safety	1. Health and safety standards 2. Occupational safety and health administration 3. incidence rate
Reputation	1. Past failures
Standard of quality	1. Adherence to specification
Relationship	1. Relationship with client's representative, 2. Design team and subcontractors
Claims and contractual disputes	1. Amount of claims
Technical ability	1. Experience 2. Quality of management team
Project–specific criteria	1. Whether or not the contractor has experience with this type of project

Table 2.2: Prequalification criteria and its weights (Hatush and Skitmore, 1997a)

Criteria	Subcriteria	Weight
Financial Soundness	1. Financial stability	0.05175
	2. Credit rating	0.04100
	3. Banking arrangements and bonding	0.04575
	4. Financial status	0.06650
Technical Ability	1. Experience	0.07250
	2. Plant and Equipment	0.03625
	3. Personnel	0.07875
	4. Ability	0.07500
Management Capability	1. Past performance and quality	0.044375
	2. Project management organization	0.040625
	3. Experience of technical personnel	0.046250
	4. Management Knowledge	0.043750
Health and Safety	1. Safety	0.018875
	2. Experience Modification Rating	0.016875
	3. Occupational Safety and Health Administration rate	0.014500
	4. Management safety accountability	0.019750
Reputation	1. Past failures	0.068125
	2. Length of time in business	0.085000
	3. Past client/contractor relationship	0.086250
	4. Other Relationships	0.048125

Table 2.3: Prequalification criteria adopted by El-Sawalhi (2007a)

Group	Attribute
Financial stability	1. Credit rating 2. Turnover 3. Bank arrangement 4. Debit ratio 5. Liquidity 6. Profitability
Management and technical ability	1. Experience of staff 2. Management capability 3. Qualification of staff 4. Past performance 5. Quality performance 6. Company organization 7. Innovate method
Experience	1. Type of projects 2. Size of projects 3. Number of projects 4. Experience in the region 5. Length of time in business
Historical non-performance	1. Company image 2. Skilled manpower 3. Client satisfaction 4. Record of failure 5. Claims and litigation
Resources	1. Equipment 2. Number of staff
Quality	1. Quality control 2. Quality policy 3. Quality assurance
Health and safety	1. Safety performance 2. Accountability 3. Injury and illness

Ng and Skitmore (2001) presented the major findings of previous studies in prequalification criteria as shown in Figure 2.1.

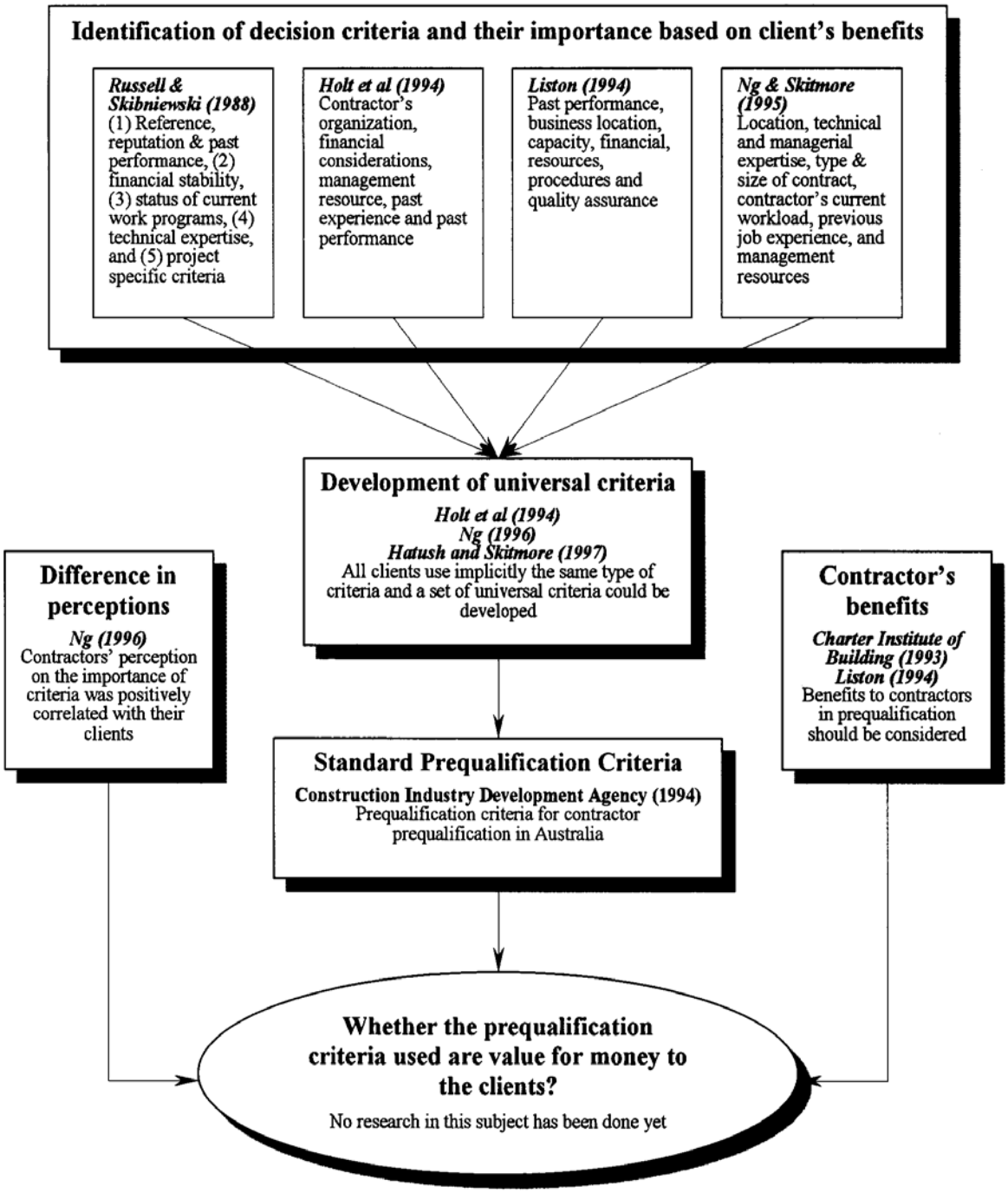

Figure 2.1: Major findings of previous research studies (Ng and Skitmore, 2001)

Table 2.4 shows comparison of prequalification criteria based on the pervious study of the literature review. The researcher depended in this table on six authors as shown in the note at the table bottom. In addition, Table 2.5 presented similar comparison conducted by Gong 1999 (cited in McCabe et al., 2005).

Table 2.4: Comparison of prequalification criteria based on the previous studies

Prequalification Criteria	Authors					
	1	2	3	4	5	6
Financial Soundness/ stability	x	x	x	x	x	x
Experience/Past Experience/Technical Experience	x	x	x		x	x
Management Capability/Management Resources/Management & employees Qualification	x	x	x	x	x	
Health and Safety/Safety Record	x				x	x
Reputation/Information obtained from references	x					x
Past Performance/Performance Record		x	x	x	x	x
Suitable and sufficient resources/Operation and Equipment/Equipment resources/Labor resources					x	x
Current Work Load/Capacity of firm					x	x
Compliance with Regulation		x				
Contractor's Organization			x	x		x
Project control procedures						x
Location of Home office						x
Geographic location of project						x

Note: (1) Hatush and Skitmore (1997); (2) Mangitung and Emsley (2002); (3) Holt et al. (1994); (4) Sonmez et al. (2002); (5) Al-Dughaither (2006); (6) Russell et al. (1992)

Table 2.5: Comparison of prequalification criteria (Gong 1999) – source McCabe et al., 2005.

Prequalification Criteria	Authors							
	1	2	3	4	5	6	7	8
Financial stability	x	x	x	x		x	x	x
Capacity for assuming new projects	x	x	x	x		x	x	x
Safety		x	x	x		x	x	x
Type of contractor and years in business	x			x	x	x	x	x
Percentage of work performed	x			x	x	x	x	x
Location	x	x		x		x	x	x
Past performance	x	x		x		x	x	x
Management		x	x	x		x		x
Bonding	x	x		x	x			x
Key personnel				x	x	x	x	
Experience			x	x		x		x
Failure history		x		x		x	x	
Equipment resources		x		x		x		x
Workforce resources				x		x	x	x
Annual value of work in 5 years					x	x	x	
Third party evaluation	x			x				x
Similar or related projects completed			x		x		x	
Quality assurance and control program				x		x		x
References evaluation			x			x		
Shareholder information			x			x		
Reputation to subs, unions, suppliers			x					x
Time and budget performance				x				x
Principal projects in 5 years					x		x	
Litigation history				x				
Insurance performance							x	

Note: 1, public owner's projects, QUALIFIER-1 (Russell and Skibniewski 1990); 2, private owner's projects, QUALIFIER-1 (Russell and Skibniewski 1990); 3, artificial neural network model (Hanna et al. 1997); 4, fuzzy sets model (Elton et al. 1997); 5, Canada (CCDC-11 1996); 6, Saudi Arabia and United Kingdom (Bubshait and Al-Gobali 1996); 7, Japan (Paulson and Aki 1980); and 8, Australia (Liston 1994).

2.6 Advantages and Disadvantages of Prequalification Practices

Khosrowshahi (1999) pointed that if prequalification is an important subject for the client, then it should also be important for contractors who seek to get work, by directing their attention and resources to qualifying features, some of which may fall under short term programs and others need long term considerations. Furthermore, application of principal component analysis to contractor prequalification reduce the subjectivity to some extent on the sense that the weightings assigned for each criterion, which is required for many contractor prequalification methods, are not crucial in this method (lam et al., 2005).

To prevent wasted effort and time in preparing and tendering bids and to avoid the consequent escalation in bid prices, it is common practice for engineering managers to select and invite a small number of contractors to bid for a project. Contractor prequalification aims to reduce the cost of bidding, while keeping the benefits of pure competition, by screening according to predetermined non-price criteria (Ng and Skitmore, 2001).

There is a need to guarantee that the contractor prequalification process is efficient in its costs of operation. In the past, studies of contractor prequalification have focused solely on the benefits to clients. All decision criteria and associated contractor information took into account relevant to contractor prequalification are suggested for inclusion in the assessment. However, certain decision criteria may only provide limited benefits to the client while involving clients and contractors in considerable costs in their collection, preparation, and evaluation. Such criteria should not be included in the prequalification process. What is desired is the use of decision criteria that significantly support the prequalification decision while costing little to the client and contractor in their application. In short, it is anticipated that the benefits gained from improved prequalification decisions exceed the costs involved (Ng and Skitmore, 2001).

The prequalification system like any other system has its advantages and disadvantages (Bennett, 2003; Palaneeswaran and Kumaraswamy, 2001). A summary of these advantages and disadvantages are as follows:

Advantages:

- On the client's side, it helps eliminate the incompetent, insufficiently financed, and inexperienced contractors from further consideration.

- On the contractor's side, it works as a form of external auditing of a contractor's ability.
- Prequalification process benefits the owner to accomplish his goals.
- Reducing the time required to review and evaluate bids.
- It may save the project costs by assuming the risk and eliminating or reducing the need for surety bonds from prequalified contractors.
- Significantly accelerates evaluation and award process.
- It controls the number of bidders.
- Protects contractors from being awarded work they are incapable of doing.
- Reduces subjectivity in selecting bidders.
- To encourage healthy competition among eligible contractors.
- To optimize the contractor selection in terms of achieving a better balance between price and performance parameters.

Disadvantages:

- Prequalification may concern criteria that do not accurately evaluate a contractor's ability to complete the work successfully.
- Prequalification may be viewed as a subversion of the general competitive bidding procedures. Prospective bidders may be disqualified based on some criteria that could be arbitrary, contrived, or based on a purely speculative concern for avoiding potential project difficulties.
- It may increase project costs by eliminating competition among bidders or by eliminating bidders who might have an innovative and cost-saving approach to executing the work.
- Disqualified bidders may be stifled in their growth if they are eliminated from projects in which they do not have experience even though they may be able to perform adequately.

2.7 General Prequalification Practices around the World

Topcu (2004) conducted an extensive research on global contract selection and prequalification practices. He stated in his findings that one of the most commonly used procedures for selecting contractors is competitive bidding, where the lowest bidder is awarded the contract. In addition, there are some modifications to this single objective decision-making procedure based on lowest bid price. For instance, in France, bid prices

that are considered abnormally low by the client are ruled out. In some countries such as Italy, Portugal, Peru, and Korea the highest and the lowest bid prices are excluded; the closest bid price to the average of the remaining ones is then selected. In Denmark, on the other hand, a similar procedure is used but with the two highest and the two lowest bid prices excluded. The point here is that modifications for selecting a qualified contractor should be clearly defined.

Surveying the previous researches in the prequalification practices around the world shows the different practices among the different countries and clients in the same country. However, studying different contractor selection approaches practiced by various clients around the globe and identifying their relative strengths and weaknesses will be useful for any research in this filed.

2.7.1 United Kingdom (UK) Practice

Mangitung and Emsley (2002) pointed that the contractor prequalification in the UK construction industry can be classified into two categories, that is, periodic prequalification for developing a standing list of contractors and project prequalification for developing a project. The main difference between both kinds is the timing of evaluation and the detailed level of contractors' data obtained. Periodic prequalification, which can be used by a client for short listing or invitation to bid, is carried out for certain periodic time frame. It has been found that standing lists of contractors in the UK were reevaluated annually, or every 2, 3 or 5 years. Moreover, around two thirds of contractors in the UK were re-qualified annually through periodic prequalification.

The identification of a suitable and capable contractor for a construction project is a decisive but difficult task. Each construction company has its own strengths and weaknesses, and it is prudent for owners to carry out an assessment of these in advance. With open tendering, this is necessarily done at bid evaluation stage. In the United Kingdom (UK) and many other countries, selective tendering is preferred. This gives an opportunity to evaluate contractors' eligibility prior to bidding. A formal evaluation made at this time is by a process that is normally known as prequalification (Ng et al., 1999).

2.7.2 Hong Kong Practice

Palaneeswaran and Kumaraswamy (2001) examined prequalification practices in different countries such as Hong Kong, Australia, and United States. Contractor selection

procedure followed by the Works Departments under the Works Bureau, Hong Kong requires that only contractors on the approved lists can tender for contracts. They are categorized into five categories (buildings, port works, roads and drainage, site formation, and waterworks) according to their relevant expertise and managed by the relevant Works Departments. The lists of approved contractors are in three groups (A, B and C) based on their capacity. There are also two status levels termed `probationary' and `confirmed' in each group. The confirmation after probation relies on the satisfactory completion of works with good performance records. The promotion of contractors to a higher group depends on meeting requirements of financial criteria, appropriate technical and management capabilities, and continuous satisfactory completion of contracts under the present group. The lists of approved contractors are published annually, and the amendments are published from time to time. Every department keeps separate approved lists of contractors. The relevant Works Department manages the respective category of contractors.

2.7.3 Australian Practice

The Queensland Government of Australia has a system for prequalification of contractors known as Prequalification Criteria (PQC). All concerned contractors will have to be prequalified and registered on the PQC system, which is managed by the Department of Public Works and Housing, Queensland, Australia, to be eligible to tender for Government building projects with a contract value of more than Australian $100,000. Contractors are evaluated against prescribed criteria including technical capacity, management approach, business relations, and people involvement with commitment to continuous improvement. The PQC is designed with the aim of streamlining the process of contractor selection by ensuring a good match between the size and complexity of projects and the abilities of contractors (Palaneeswaran and Kumaraswamy, 2001).

2.7.4 USA Practice

There is evidence of wide efforts and research in the USA, aimed at structuring and improving contractor prequalification. Many public clients in USA use several prequalification ratings and these ratings are applied to identify parameters such as the maximum dollar amount of work that can be allocated to a prequalified bidder during the prequalification period and the maximum value of work that a contractor can bid for a particular project. These ratings provide the basis for a more structured and dynamic

approach, determining various bidding boundaries for prequalified contractors, as they are not confined to any specific static band width (such as Categories 1, 2, 3 and 4 by Services SA, Australia; or Groups A, B and C by the Works Bureau, Hong Kong). Moreover, this approach will allow some allowance for the possibilities of dissimilar contractor performance levels under different workloads (Palaneeswaran and Kumaraswamy, 2001).

2.7.5 Turkish Practice

Topcu (2004) pointed that all construction project owners in Turkish public sector apply the same contractor selection method as stated in Decree by the Ministry of Public Works and Resettlement as published in the Official Gazette. The rules specified in the previously mentioned Decree are based on the State Tender Law. Only those contractors who match the mandatory requirements can use for tender. These requirements are associated with financial status of the contractors. If the unused portion of any cash credit and/or unused portion of a letter of credit of the contractor are less than 10% of the project owner's cost estimate for the project or if the contractor firm has a tax liability, the contractor cannot use for tender.

There is a two-stage process for the choice of contractors that have passed through mandatory requirements filter: contractor prequalification and determination of lowest bidder among prequalified applicants. At the first stage, applicants are assessed and scored with respect to four main prequalification criteria: ability to timely complete projects; organizational expertise; availability of experienced technical staff; and availability of resources. At the second stage, bid prices are considered. The differences between the project owner's cost estimate and the bid prices are computed. The contractor having the highest value of such difference is awarded the contract. In other words, lowest bidder wins the contract.

2.7.6 Saudi Practice

Saudi contractors are categorized into five grades, and non-Saudi contractors are categorized into six grades. Categorization is based on financial recourses, experience, workforce and equipment, and company specialization. In public work, the contractor classification certificate is the basis for contractor prequalification. It is an essential requirement for public projects with a bid exceeding US$ 1,300,000. However, it is rarely

requested by semi-public and private owners since they have their own procedures (Bubshait and Al-Gobali, 1996).

2.8 Prequalification Models

Prequalifying contractors in a construction project is not an easy task, since the process includes comparing units with multiple criteria and qualitative information. Data envelopment analysis, with its ability to measure the relative performance of organizational units that have multiple inputs and outputs, has been demonstrated as a feasible solution to the contractor prequalification problem (McCabe et al., 2005).

Ng and Smith (1998) pointed that the current practice of contractor prequalification is characterized by the reliance on expert judgment and experiential knowledge. Previous studies identified that the information concerning contactor's' features consists of both quantitative and qualitative types, while the assessment methods used for assessing qualitative information require a predictive judgment of the experts. However, they developed a prototype decision support system based on the case–based reasoning approach to improve and upgrade the reliability and fairness of the prequalification process.

Russell and Skibniewski (1988) pointed that all prequalification systems have the same basic steps: develop the criteria, gather contractor data, verify data, apply contractor data to criteria, and decide whether to prequalify the contractor. Most of the firms and public agencies that perform prequalification have their own model, and the continued interest in the prequalification process by industry is reflected in the array of systems that have been developed through research. The existing prequalification models use frameworks that range from simple weighted scoring systems to complex mathematical formulations.

Shen et al. (2003) presented a computer-aided decision support system for assessing a contractor’s competitiveness, particularly with reference to Chinese construction industry. Measures of competitiveness are utilized to describe a contractor’s strengths and weaknesses, thus to assist project clients in naming proper contractors at the prequalification stage. The findings showed that the identification of a contractor’s weakness can also help the contractor adopt appropriate measures to improve its competitiveness. Based on a competitiveness scoring model, a Windows-standard Decision Support System Contractor’s Competitiveness Assessment Scoring System was

developed for two purposes ;namely , for contractor's self evaluation and to assist clients in making a prequalification assessment.

Construction is a complicated process with a number of phases, which must be appropriately adjusted and managed. The entity that commissions construction must make different multi-aim decisions at various construction stages. Most problems encountered during construction rely on the selected contractor. Therefore, selection of a contractor is a very important issue in carrying out an investment project (Mitkus and Trinkuniene, 2006).

Ncube and Dean (2002) pointed that the basic principles of good decision-making are, first, a clear understanding of the decision itself and second the availability of appropriately focused information to support the decision. Decision-making techniques assist with both these problems. However, the techniques should be considered as aids to decision-making and not the replacements for it. Numerous decision-making techniques have been suggested as effective methods of ranking software products for selection for use as components in large-scale systems.

In practice, a contractor selection issue can be described as a two-stage process. First, a large number of contractors are invited to tender and then a short list of contractors is drawn based on a set of pre-determined criteria (prequalification stage). In the second stage, a contractor is selected from the short list to execute the project (final contractor selection stage). A contractor prequalification problem is a typical multiple criteria decision making problem in which decision criteria are of both quantitative and qualitative natures and the aforementioned problems do occur (Sonmez et al., 2002).

Contractor prequalification is extensively used by clients to select competent contractors by evaluating their ability to meet specific requirements (Ng and Skitmore, 1993). One limitation of client prequalification is that owners have limited access to certain types of information (e.g., financial, banking, accounting) that sureties have. The information used in contractor prequalification is therefore often qualitative, subjective and imprecise (Russell and Skibniewski 1988). Most contractor prequalification decision-making models are used by clients to assess and thereby minimize the risk of contractor default. Since clients defer this risk either partly or completely to surety companies, underwriters can benefit from these types of models when evaluating construction contractors. Models

can be grouped based on the approach used: multi-criteria decision-support, linear, knowledge-based, multi-attribute and utility theory, artificial neural networks, fuzzy set theory, and various other methods (Fayek and Marsh, 2006). However, El-Sawalhi et al. (2007a) summarized all the used models in the prequalification process based on wide study of the previous research in this regard as follows:

- **Dimensional Weighting Aggregation (DWA)**

  In this model, each criterion and its weight of significance are determined based on the decision-maker's requirements. The contractors are rated on a scale of 1-10 (1 – "Unsatisfactory", 10 – Excellent"), subjectively, with respect to these criteria based on the total score, which is calculated as a weighted sum of ratings over all the criteria using the percentages determined by the owners. All the aggregate scores are then ranked.

  This method is considered compensatory since a high score in one criterion can compensate a low score in another criterion. To make a decision, this strategy applies a decision rule if the candidate contractor's score is less than or equal to a certain minimum score, then the prequalification decision is "no" and hence, the contractor is considered unqualified. Accordingly, just the qualified contractors are permitted to submit their proposals. Alternatively, a subjective judgment may be used such as: select the three highest scores to participate in the bidding process.

- **Knowledge Based System (KBS)**

  QUALIFIER-2 is a Knowledge based system in which the decision of prequalification is taken by the model user using the decision rules, not the computed scores. The model depends on engineering judgment and experience. In this system, the client evaluates the input data using heuristic decision rules that suggests prequalification decision (If . . . then) rules. This system gives an opportunity for heuristic decision rules to be applied for better anticipations. The limitation met in this model is the implicit dealing with the uncertainties inherent in the heuristic knowledge.

- **Multi-Attribute Analysis (MAA)**

  Multi-attribute Analysis is regarded as a simple scoring model. It is a quantitative model that facilitates the consideration of multiple attributes. Alternatives being

evaluated may be rated against the client's objectives. Preferences may be incorporated by determining weights, which then combined to give the highest score giving the optimal score.

In fact, this model is commonly used by decision-maker due to its simplicity. The disadvantage of this model is referred to the input variable is often a very subjective measure used by practitioners. On the other hand, the model fails to incorporate systematic checks of the consistency regarding judgment and the uncertainty of the contractor's data is not considered.

- **Fuzzy Set Prequalification**

Fuzzy set theory matches human thinking in its use of approximate information and uncertainty to make decisions. A fuzzy set can be mathematically defined as a collection in which each element is attributed a value representing their grade of membership in the fuzzy set. Since knowledge can be expressed in a more natural by using fuzzy sets, many engineering and decision issues can be greatly simplified. Fuzzy set theory carries out classes or groupings of data with boundaries that are not sharply defined.

The advantage of this model is underlying in its ability to deal with qualitative and quantitative data. On the other hand, there are difficulties related to the formulation of the membership functions for prequalification criteria and the number of parameters and the complexity of the framework. In addition, the user should have extensive mathematical background to comprehend and run the analysis.

- **Program Evaluation and Review Technique (PERT)**

The PERT approach is used to develop a linear model for the evaluation of contractor data. It is regarded as a planning method that takes into account the criteria probability of the criteria. In addition, it is used to evaluate contractor data against client goals of time, cost, and quality. PERT model includes multiple ratings allowing the uncertainty in contractor data to be evaluated.

The disadvantage of this model is underlying in its subjective nature of judgment on the aspiration levels. Moreover, the model is not able to deal with the inherent non-linear relationship between contractor's attributes and their corresponding prequalification decisions.

- **Analytical Hierarchy Process (AHP)**

  The characteristic feature of AHP technique from the other multi criteria decision-making techniques is that it does not necessitate a tangible numerical scale of ratio and can thus be used to the measurement of intangible criteria. The fundamental synthesis technique is additive. It also has a consistency test for encouraging enforcement of judgment transitivity. Moreover, AHP has been well researched and has been applied in hundreds of areas.

- **Multi-Attribute Utility**

  In this model, all decisions include choosing one, from several, alternatives. Typically, each alternative is assessed for desirability on a number of scored criteria. What relates the criteria scores to desirability is the utility function. The most common formulation of a multi-criteria utility function is the additive model. The model permits different kinds of contractor capabilities to be evaluated and deals with uncertain data incorporates the risk of the decision maker.

  On the other hand, it is hard to retrieve the public client's preference via utility function; the decision-making process requires a long time and becomes boring if there are numerous criteria, and demands very good knowledge of probability.

- **Case-Based Reasoning (CBR)**

  The Case-Based Reasoning (CBR) is an artificial intelligence technology, which solves new problems by adapting solutions that were applied to solve old problems. Reasoning by reusing or modifying experience is a commonly applied pattern for human problem solving. This is particularly the case when the domains are not completely realized or when the concept is open-ended.

  In short, the CBR model is a practical solution that can be produced even when knowledge regarding a particular prequalification system is weak. In addition, the solutions obtained from previous cases can be updated to match the current situation through the adaptation functions provided in the system. On the other side, the model requires input of large number of cases when initially operated which may be difficult to achieve in practice.

- **Artificial Neural Networks (ANN)**

  Artificial neural networks are data-driven self-adaptive approaches in which there are few theoretical assumptions regarding the models for problems under study. It is an extremely parallel processor made up of simple processing units, which has a natural tendency for storing experiential knowledge and making it available for use. The approach used to carry out the learning process is called the learning algorithm. It has a large number of nodes and connections. Each connection points from one node to another and is related with a weight.

2.9 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a structured technique for dealing with complex decisions. Rather than prescribing a "correct" decision, the AHP helps the decision makers find the one that best suits their needs and their understanding of the problem.

The Analytic Hierarchy Process (AHP), introduced in the early 1970s by Thomas L. Saaty is used for dealing with complex technological, economic, and socio-political problems. This is done by simplifying and expediting the natural decision making process (Saaty, 1980). The method utilizes pair wise comparison by breaking a complex unstructured situation into its component parts, arranges those parts into a hierarchy, assign numerical values to subjective judgments regarding relative importance (or preference), and synthesize those values to determine which variable has the highest priority and should be acted upon to influence the outcome of the situation.

The distinguishing feature of AHP technique from the other multi criteria decision-making techniques is that it does not necessarily require a tangible numerical scale of ratio and can thus be applied to the measurement of intangible criteria. The fundamental synthesis technique is additive. It also has a consistency check for encouraging enforcement of judgment transitivity. The analytic hierarchy process has been well researched and has been applied in hundreds of areas. The process has been implemented in the commercial software HIPRE, Criterion, and Expert Choice. An application of AHP to contractor prequalification was carried out by Fong et al (2000) and Al-Harbi (2001).

2.9.1 Basics of AHP

In the AHP, the decision-making process starts with dividing the problem into a hierarchy of issues, which should be considered in the work. These hierarchical orders help to simplify the illustration of the problem and bring it to a condition, which is more easily understood. In each hierarchical level, the weights of the elements are calculated. The decision on the final goal is made considering the weights of criteria and alternatives (Bahurmoz, 2006).

2.9.1.1 Structuring the Hierarchy

In applying the AHP to a decision problem one structures the problem in a hierarchy with a goal at the top and then criteria (and often sub criteria at several levels, for additional refinement) and alternatives of choice at the bottom. The criteria can be subjective or objective depending on the means of evaluating the contribution of the elements below them in the hierarchy. Moreover, criteria are mutually exclusive and their priority or importance does not depend on the elements below them in the hierarchy (Bahurmoz, 2006).

In Figure 2.2, where the structure of AHP elements is illustrated, it is shown that the goal is decided through a number of different criteria. These criteria determine the quality of achieving the goal using any of Alternatives (A_i, i=1... k). The A_i is different options, choices, or alternatives that could be used to reach the final aim of the project. Comparing these alternatives and defining their importance over each other are done using the pairwise comparison method. Giving importance ratios for each pair of alternatives, a matrix of pairwise comparison ratios is obtained.

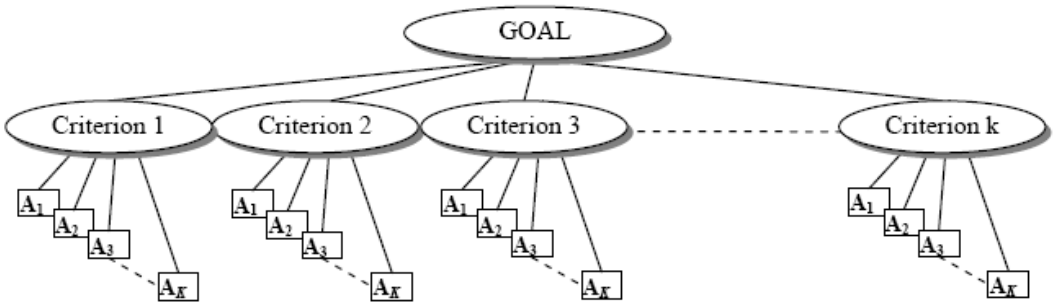

Figure 2.2: Structure of the AHP

In using the AHP, one constructs a hierarchy (consisting of goal, criteria and alternatives), and then makes judgments (or performs measurements) on pairs of elements with respect to a controlling element. Ratio scales are derived from these judgments and then synthesized throughout the structure to select the best alternative (Bahurmoz, 2006).

In short, when constructing hierarchies one must include enough relevant details to represent the problem as thoroughly as possible, but not so much as to include the whole universe in a small decision. One need to consider the environment surrounding the problem, identify the issues or attributes that one feels influence, contribute to the solution, and identify the participants associated with the problem. Arranging the goals, attributes, issues, and stakeholders in a hierarchy serves three purposes:

1. It provides an overall view of the complex relationships inherent in the situation.
2. It captures the spread of influence from the more important and general criteria to the less important ones.
3. It permits the decision maker to assess whether he or she is comparing issues of the same order of magnitude in weight or impact on the solution.

2.9.1.2 The Prioritization Procedure

Elements in each level are compared pairwise with respect to their importance to an element in the next higher level, starting at the top of the hierarchy and working down, a number of square matrices called preference matrices are created in the process of comparing elements at a given level. Judgments of preference are made on pairs of elements in the structure using what Saaty defines as the fundamental scale of AHP, which is reproduced in Table 2.6.

The fundamental scale used in AHP enables the decision maker to incorporate experience and knowledge in an intuitive and natural way. This scale is insensitive to small changes in a decision maker's preference, thereby minimizing the effect of uncertainty in evaluations.

AHP is an absolute scale in which people use numbers to express how much one element dominates another with respect to a common criterion. The scale derived from these absolute numbers is a ratio scale.

The criteria might also have different importance compared to each other. Therefore, a pairwise comparison matrix is considered for the criteria. Elements of this matrix are pairwise or mutual importance ratios between the criteria that are decided on the basis that how well every criterion serves and how important it is in reaching the final goal.

In order to compare homogeneous elements whose comparison falls within one unit, decimals are used. If the elements of the pairwise comparison matrix are shown with c_{ij}, which indicates the importance of i_{th} criterion over j_{th}, then c_{ji} could be calculated as 1/ cij (Boroushaki & Malczewski, 2008).

Table 2.6: The fundamental scale of AHP (Bahurmoz, 2006)

Intensity of importance	Verbal judgment of preference	Explanation
1	Equally preferred	Two activities contribute equally to the objective
2	Equally to moderately	
3	Moderately preferred	Experience and judgment slightly favor one activity over another
4	Moderately to strongly	
5	Strongly preferred	Experience and judgment strongly favor one activity over another
6	Strongly to very strongly	
7	Very strongly preferred	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very strongly to extremely	
9	Extremely preferred	The evidence favoring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	A reasonable assumption

AHP can be used to make relative measurements through paired comparisons of criteria and of alternatives as discussed above, or to make rating measurements of the alternatives with respect to the criteria. The ratings mode includes pairwise comparison of the criteria with respect to the goal. Then rating levels, such as excellent, very good, good, average, poor, and very poor, are specified for each criterion. Pairwise comparisons among the rating levels of each criterion are then conducted to yield a set of priorities (weights) for these levels. For each criterion, the rating level priorities are divided by the maximum rating weight of that criterion to yield scaled weights. Within each criterion, each alternative is assigned a rating level and the associated scaled weights. The final score of an alternative is the sum of the product of the criterion weights times the scaled weight with respect to that criterion, where the sum is taken across all the criteria (Saaty, 1996). The ratings mode is used when the number of alternatives is large and decisions are standardized. The only requirement for the ratings mode is having expert knowledge to be able to compare rating levels with respect to certain criteria.

AHP has two synthesis modes: distributive and ideal. In the distributive mode, one normalizes an alternative's scores under each criterion so that they sum to one. This leads to a dependency that might cause rank reversal. In the ideal mode, one divides the score of each alternative by the score of the best alternative under each criterion, thus it preserves rank if unimportant alternatives are added or deleted. Decision makers must know which mode is appropriate for a particular problem. The decision maker must decide whether to preserve rank or not, which depends on the nature of the problem. Millet and Saaty (2000) provide the following guideline: use the distributive mode to determine the extent to which each alternative dominates all other alternatives under the criterion. Use the ideal mode to determine how well each alternative performs relative to a fixed benchmark. Experiments with the two methods, however, gave different results only eight percent of the time.

2.9.1.3 Calculating Weights

The AHP method employs different techniques to determine the final weights; two of them are explained and used in this thesis. The first is Lambda Max (λ_{max}) technique and the other is geometric mean.

Saaty (1980) used the lambda max technique to obtain the weights of the criteria in the pairwise comparison method. Every matrix has a set of eignevalues, and for every

eignevalue, there is a corresponding eigenvector. In Saaty's lambda max technique, a vector of weights is defined as the normalized eigenvector corresponding to the largest eignevalue λ_{max}. If the weights are shown as a vector *w* consisted of *w*i (i=1…n), then the following formula shows how they are calculated.

$C \times w = \lambda \times w$…… (1)

at which C is the pairwise comparison matrix of the criteria; *w* is the vector of weights and λ is the eignevalue that in this method should be the maximum of them, i.e. λ_{max}.

In this method, special mathematical conditions are required to guarantee that a unique answer is yielded. In addition, difficulties in calculating and finding the eignevalues and vectors have led to use of an approximation to the lambda max method. As Malczewski (1999) used in his book an approximation of the eigenvector associated with the maximum eignevalue is calculated through a simple procedure, which is sometimes referred to as mean of normalized values.

2.9.1.4 Mean of Normalized Values – Lambda Max Method

In mean of normalized values method, which gives an approximation of lambda max method, the sum of elements in each column in pairwise comparison matrix is calculated. Then each column elements is divided by the calculated sum at the previous step. Then the arithmetic average of each row of the normalized matrix gives the weight of the corresponding criterion or alternative. The accuracy of this approximation is increased when the pairwise comparison matrix has a low consistency ratio.

2.9.1.5 Geometric Mean Method

Another method of calculating the weights of criteria in the pairwise comparison matrix is geometric mean method as Buckley (1985) explained, the weights in a pairwise comparison matrix of alternatives, A , are calculated by following formula.

$$r_i = \prod_{j=1}^{n} (a_{ij})^{1/n} \quad \text{..... (2)}$$

and then $$w_i = \frac{ri}{\sum_j rj} \quad \text{.....(3)}$$

at which a_{ij} (i, j=1...n) are the comparison ratios in the pairwise comparison matrix and n is number of alternatives.

2.9.1.6 Consistency Ratio in the AHP

A matrix "M" is called consistent matrix if and only if $m_{ik} .m_{kj} = m_{ij}$ where the ij'th element is element of this matrix (Buckley 1985). However, in practice it is unrealistic to expect the decision-makers provide pairwise comparison matrices, which are exactly consistent especially in the cases with a large number of alternatives. Expressing the real feelings of the decision makers generally lead to matrices that are not quite consistent. However, some matrices might violate consistency very slightly by only two or three elements while others may have values that cannot even be called close to consistency.

A measure of how far a matrix is from consistency is performed by Consistency Ratio (C.R.). Han and Tsay (1998) explained that having the value of λ_{max} is required in calculating the consistency ratio. This is obtained by calculating matrix product of the pairwise comparison matrix and the weight vectors and then adding all elements of the resulting vector. After that, a Consistency Index (C.I.) is introduced as:

$$CI = \frac{\lambda max - n}{n - 1} \quad \text{..... (4)}$$

at which n is the number of criteria and λ_{max} is the biggest eignevalue (Han & Tsay 1998; Malczewski 1999).

Random Index (R.I.) is the consistency index of a pairwise comparison matrix, which is generated randomly. Random index depends on the number of elements, which are compared, and as it is shown in Table 2.7; in each case for every n, the final R.I. is the average of a large numbers of R.I. calculated for a randomly generated matrix. The final consistency ratio is calculated by comparing the C.I. with the Random Index (Malczewski 1999).

$$CR = \frac{CI}{RI} \quad \text{..... (5)}$$

The consistency ratio is designed in such a way that shows a reasonable level of consistency in the pairwise comparisons if C.R. < 0.10. On the other hand, there is inconsistent judgments if C.R. $\geq$ 0.10.

Table 2.7: Random Inconsistency Index (RI) (Adapted from Saaty 1980)

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

2.9.2 Why AHP?

Khosrowshahi (1999) stated that AHP has many advantages to make the decision a basic need for most engineers and professionals. AHP has been widely adopted as a powerful multi-criteria decision-making tool.

Since each construction project is unique, final contractor selection through the AHP provides clients with the flexibility to add or reduce the elements of a problem hierarchy regarding an individual project. In addition, the strengths and weakness of each eligible contractor are exposed. The AHP is therefore applicable as a model for contractor selection (Fong and Choi, 2000).

Al-Besher (1998) stated that AHP has many advantages. Some of them are consistency, measurement, hierarchic structures, interdependence, complexity, unity, process repetition, judgment, consensus, tradeoffs, systematic and synthesis.

Al-Harbi (2001) pointed that AHP permits group decision-making where group members can use their experience, values, and knowledge to decompose the contractor prequalification problem into a hierarchy and solve it by the AHP steps.
El-Sawalhi (2007a) briefed the advantages of the AHP model as follows:

- It permits group decision-making.
- It transfers subjective judgment into meaningful weights and ratios on which to base decisions.
- Various judgments by decision makers can be adapted by this technique, which synthesizes that judgment into a representative outcome.
- It Identifies inconsistencies made in the judgments.

Cheng et al. (2004) highlighted that the AHP is based on pairwise comparisons of elements in the same level of the hierarchical structure according to a nine-point ratio scale for obtaining decision-maker's degree of preferences. This nine-point scale is mainly applied to quantify linguistic preference expressions of the decision-maker and furthermore, comparisons performed by AHP can be valid in both weight elicitation and alternative valuation procedures

AHP permits the decision-maker to compute the consistency of their judgments, because it uses an analytic procedure to process these judgments. Another reason for using this

method is the existence of convenient and user-friendly Expert Choice software (Topcu, 2004). The AHP method evaluates the weights to be assigned for the priorities of functions; subsequently, a consistency index check is conducted to determine whether the assignment of weights is acceptable (Bahurmoz, 2006).

2.10 Conclusion

The literature review highlighted to the following points:

1. Contractor prequalification is a process to evaluate candidate contractors' ability to complete a contract satisfactorily before they are admitted into the bidding process. The prequalification process enables the clients to eliminate contractors who are not responsive, responsible and competent; assure bidding opportunities for eligible contractors; encourage healthy competition among eligible contractors; avoid/minimize risks of contractor failure and improve client satisfaction.
2. Advantages and disadvantages of the prequalification system were presented.
3. A large number of prequalification models and criteria were identified.
4. A brief overview of the prequalification practices worldwide was taken to illustrate the different systems of prequalification being used.
5. Detailed explanation of AHP as decision-making tool indicating its importance in prequalification process.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

This chapter describes the methodology that used in this research. It includes the research strategy, population and sample size, questionnaire design and contents, pilot study, developing and evaluating of the software, and case study.

3.2 Research Strategy

This research is concerned about finding a more accurate and suitable technique to choose the most competent bidder to execute a project through prequalification process. To achieve this, the researcher adopted a strategy that consists of four phases.
The first phase considered a summary of literature review regarding the criteria used in the prequalification process and summary of used models were reviewed.

In the second phase, the researcher found that AHP technique is applicable and adaptable model among other used models in the prequalification process. The researcher determined the criteria of the prequalification and its relevant factors that used in the design of the first questionnaire. The first questionnaire focused on two parts. The first part was general questions and the second part was regarding the main criteria and the relevant factors. In this questionnaire, the most important factors were determined based on the relative importance index.

Then a second questionnaire was developed based on the results of the first questionnaire to determine the weights of the prequalification criteria as well as the relevant factors based on AHP.

In the third phase, simple and flexible software program was developed based on AHP concepts to assist in simple use of this approach by interested parties in the construction industry.

In the fourth phase, a practical case study of prequalification practices in Gaza Strip was analyzed and discussed by using AHP. Figure 3.1 shows the methodology flowchart, which leads to achieve the research.

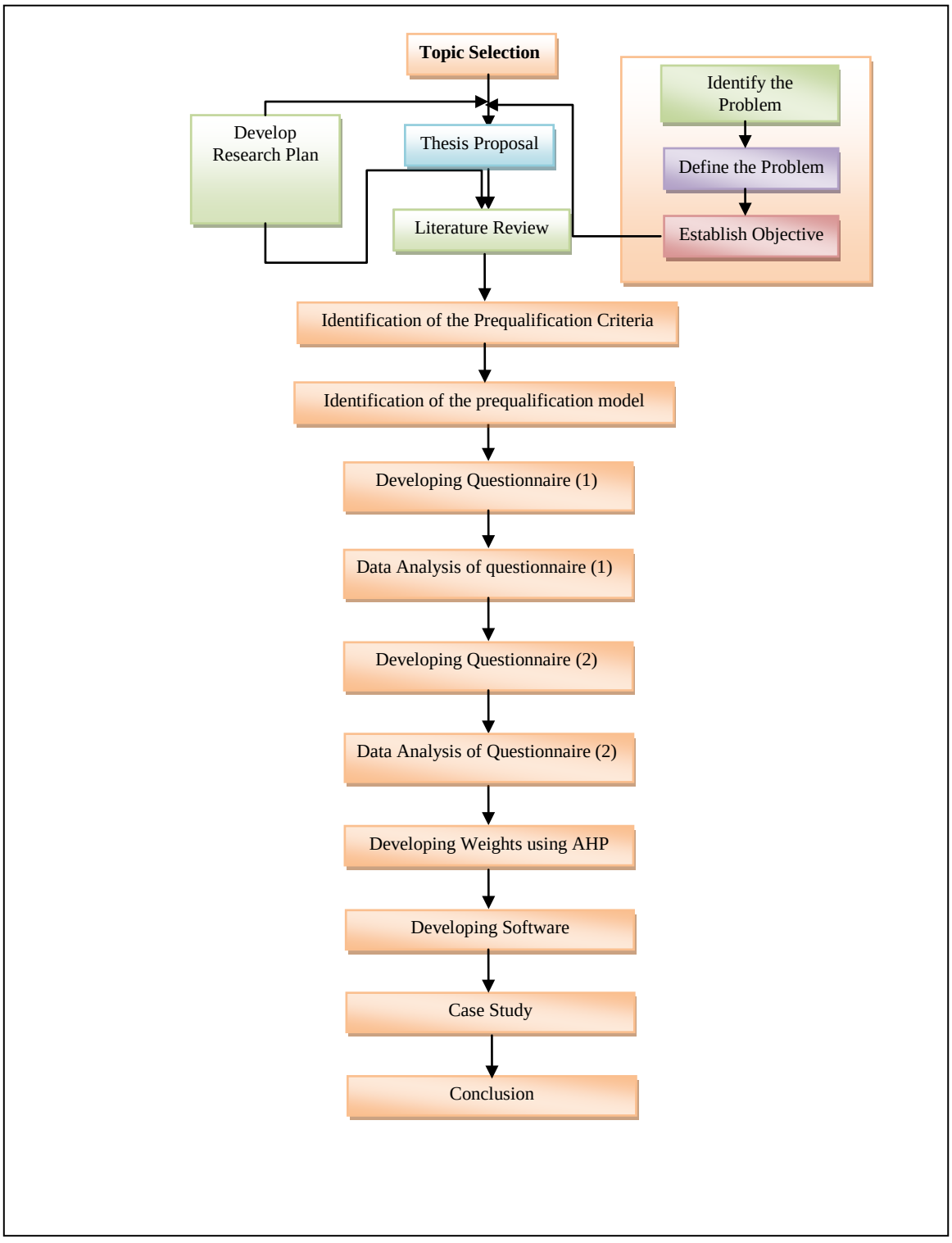

Figure 3.1: Methodology flow chart.

3.3 Population and Sample Size

The targeted population comprises experts, engineers, procurement specialists, and managers from diverse organizations with experience and with direct contacts in their jobs to the contractors' evaluation, awarding committees, and supervision and management of construction projects in Gaza Strip.

The population members got their experiences through their extended career in local institutions or ministries, implementing agencies, donors' representatives or others international agencies that implemented hundreds of projects in Gaza Strip in the past 15 years.

In the first questionnaire, the researcher targeted, as studied population, Governmental Ministries, NGOs, Municipalities, International Organizations, and Consulting Firms related to construction industry. Eighty questionnaires were distributed, however seventy-three (91.25%) respondents returned the questionnaires, and just sixty-five (81.25%) of the received questionnaires were fully completed so they were accepted for the analysis tests, while eight incomplete questionnaires were neglected. Figure 3.2 shows the distribution of targeted members.

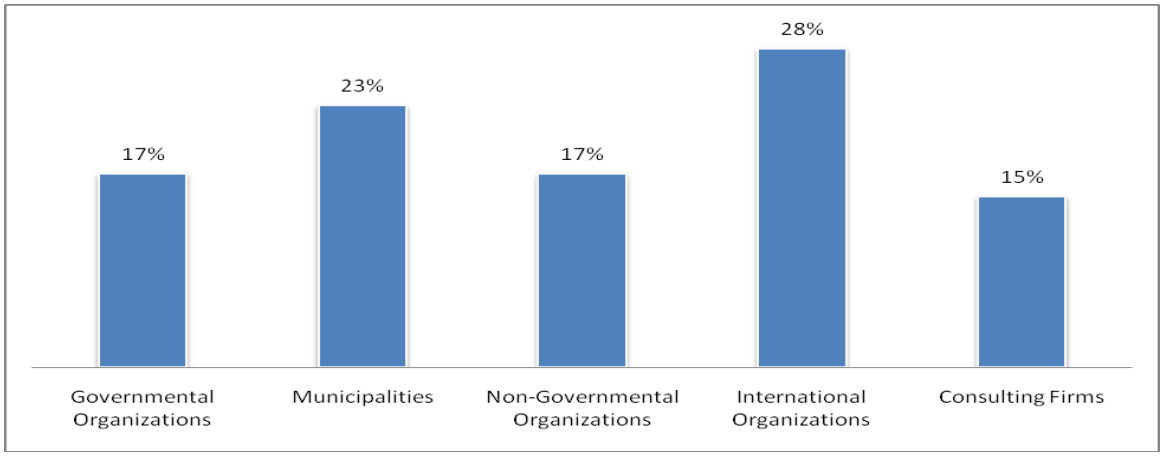

Figure 3.2: Percentages of the sample members of the first questionnaire

3.4 Questionnaires Design and Contents

The first questionnaire was designed based on the ideas extracted from the literature review; in particular from previous studies related to the subject of this research such as El Sawalhi et al. (2007), Al-Dughaither (2006), Alfred (2006), Cheng and Li (2004), Mangitung and Emsley (2002), Mahdi et al. (2002), Ng and Skitmore (2000), Lam et al.

(2000), Hatush and Skitmore (1997b) and Holt et al. (1994). The questionnaire was designed to cover the requirements of the research objectives. All the information that could help in achieving the study objectives, were collected, reviewed, and formalized to be suitable for the study survey. The first questionnaire was discussed thoroughly with the supervisor until a final agreed upon version was reached. The researcher used the questionnaire as a tool to collect primary data directly related to this study. The questionnaire was divided into two sections as the following:

1. First section: It contains general information regarding the respondents' organizations; type of implemented projects; the value of the implemented projects; the respondents' occupation in their organizations; their experience duration; and the prequalification practices.
2. Second section: It comprises nine groups relevant to the adopted main criteria and each group comprises relevant factors in order to determine their importance from the viewpoint of clients and their representatives regarding the prequalification process. All questions follow Likert Scale that gives numerical values range from five to one for the degree of importance of each factor that range from very important to unimportant respectively.

The survey of the first questionnaire was conducted to determine the viewpoint of the studied population sample regarding the prequalification process in construction industry. Seven-page questionnaire accompanied with a covering letter and definitions was designed, prepared, and distributed to the studied population.

The second questionnaire was developed based on the results of the analysis of the first questionnaire and consisted of one section. The researcher used this questionnaire to determine the weights of the nine criteria and their relevant factors based on AHP by conducting pairwise comparison that based on specific scale adopted by Saaty (1980). This questionnaire targeted a group consists of six long-experienced persons in the field of the prequalification process of contractors and the construction industry.

The two questionnaires were prepared in "Arabic Language" in order to avoid any misunderstanding of their topics. A copy of the questionnaire and an English version of it are attached in Annex 1, Annex 2, Annex 3, and Annex 4.

3.5 Pilot Study

It is customary practice that the survey instrument should be piloted to measure its validity. Naoum (2007) stated that the pilot study provides a trial run for the questionnaire that involves testing the wording of questions, identifying ambiguous questions, testing the technique that used to collect the data. The purpose of this step is to find out if the questions are understandable or not, and to find out any problem that may raise while filling in the questionnaire.

Regarding the first questionnaire, the pilot study was conducted by distributing the questionnaire to a group of long-experienced persons in the same field of construction industry as well as prequalification process to have their remarks on it. Those experts were contacted to assess the questionnaire validity and they were asked to verify the validity of the questionnaire topics and its relevance to the research objectives. Expert comments and suggestions were collected and evaluated. All the suggested comments and modifications were discussed with the supervisor and evaluated before considering them. At the end of this process, some minor changes, modifications, and additions were introduced to the questionnaire and the final questionnaire was constructed. It appeared that respondents had no difficulty in understanding the items or the instructions to complete the questionnaire.

Regarding the second questionnaire, the situation is relatively different where the researcher depended on the results of the first questionnaire. The researcher interviewed a group of specialized persons and discussed the questionnaire with them clarifying the used approach and the mechanism of filling in it based on AHP approach. Also as in the first questionnaire, it appeared that respondents had no difficulty in understanding the items or the instructions to fill in the questionnaire.

3.6 Developing and Evaluating the Software

The researcher developed simple software based on AHP approach that can be used in the selection of the contractors in Gaza Strip. This software is flexible and the user can enter any criteria that fit his requirements. The software was developed by using "Visual Basic" programming language, which was originally created to make it easier to write programs

for the Windows computer operating system. In addition, Visual Basic is the most widely used computer programming system in the history of software.

The researcher applied the software on an example of selection contractors found in Al-Harbi (2001) in order to check its results. Then an evaluation of the software was conducted by asking five implementing agencies engineers who are experts in construction projects to fill in a questionnaire for evaluating the software (See annex 5).

3.7 Case Study

The researcher used a case study regarding applying the prequalification of the contractors in Gaza Strip in order to present the mechanism of AHP in the construction industry in Gaza Strip. The background of the project used in this case study presented. The prequalification criteria used also presented as well as all the information regarding the participated contractors in this project.

To show the importance of AHP approach, the researcher used it in this case study to determine the weights of the criteria used also in determining the contractors according to the priorities and goals that set by the project's owner. Also, a comparison was made between the results obtained by the owner and that calculated by AHP.

CHAPTER FOUR
RESULTS AND DISCUSSIONS

4.1 Introduction

In this chapter, the results of the field survey are presented and discussed. This chapter illustrates and discusses the characteristics of the study population, and the applications of analytical hierarchy process (AHP) in order to establish weights for the proposed prequalification criteria regarding the construction industry in Gaza Strip.

4.2 Characteristics of the Study Population

The sample size of this research was selected to cover the study population of various types of project owners, and implementing agencies represented in governmental organizations, municipalities, non-governmental organizations, international organizations, and engineering consulting firms.

4.2.1 Sample Size

Table 4.1 shows the type of organizations and the sample size for the study population.
In addition, it shows number of valid respondents of each organization.
As shown in Table 4.1, the sample size comprises 17% as governmental organizations, 23% as municipalities, 17% as NGOs, 28% as international organizations, and 15% as engineering consulting firms.

Table 4.1: Frequency and percentages organization of the sample members

Organization	Frequency	Percent of Respondents
Governmental Organizations	11	17%
Municipalities	15	23%
Non-Governmental Organizations (NGOs)	11	17%
International Organizations	18	28%
Engineering Consulting Firms	10	15%
Total	**65**	**100%**

4.2.2 Types of Implemented Projects

Figure 4.1 shows that 34% of the implemented projects are buildings, 28% are water and wastewater projects, 30% are roads, and 9% are other projects.

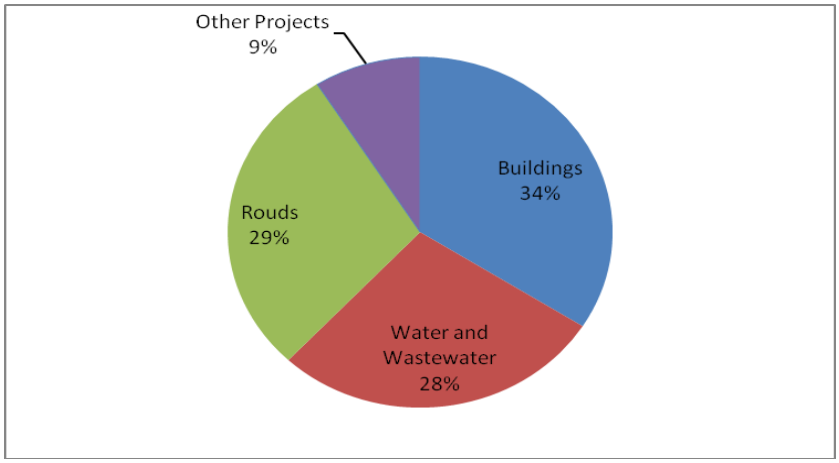

Figure 4.1: Types of implemented projects

4.2.3 Amount of Implemented Projects

Figure 4.2 shows that 12% of the implemented projects value is less than or equal to 1 Million (M) dollars; 11% is between 1.1 M and 3 M dollars; 17% of the implemented projects value is between 3.1 M and 6 M dollars; 11% is between 6.1 M and 12 M dollars; and 49% is more than 12 M dollars. The results show that almost half of the implemented projects by the respondents of value more than 12 M dollars, which means that the total value of the projects implemented is relatively high.

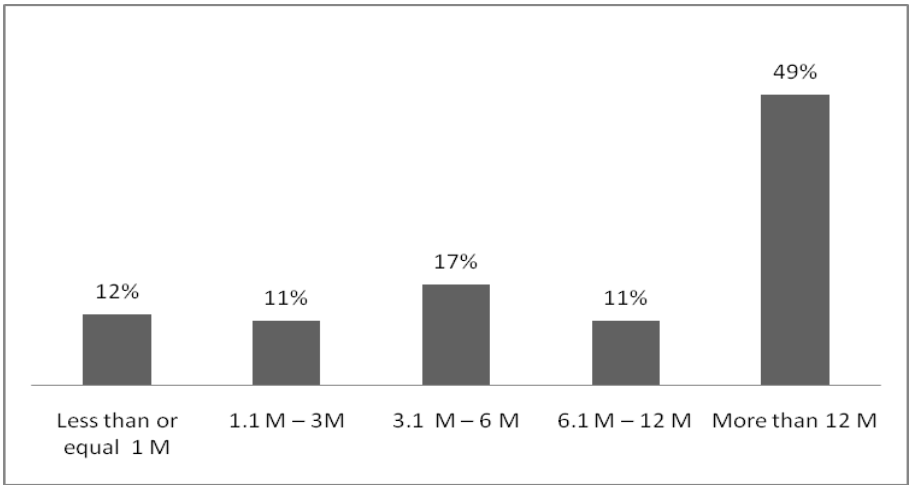

Figure 4.2: Average annual value of the implemented projects

4.2.4 Respondents' Post

Table 4.2 shows that 14% of the respondents' post in their organization is project manager; 22% of the respondents' post is construction supervisor; 26% of the respondents' post is head of department; 5% of the respondents' post is supervisors; 15% of the respondents post is procurement specialist; and 18% of the respondents post is other positions.

The researcher is satisfied with the level of importance the respondents in general give to fill this questionnaire.

Table 4.2: Respondent's occupation

Respondent Post	Frequency	Percent (%)
Project Manager	9	14%
Construction Supervisor	14	22%
Head of Department	17	26%
Consultant	3	5%
Procurement Specialist	10	15%
Others	12	18%
Total	**65**	**100%**

4.2.5 Respondents' Experience

Table 4.3 shows that 5% of the respondents' experience is less than 5 years; 20% of the respondents' experience ranges from 6 to 10 years; 28% of the respondents' experience ranges from 11 to 15 years; 14% of the respondents' experience ranges from 16 to 20 years; and 34% of the respondents' experience is more than 20 years.

The result shows that 75% of respondents have more than 11 years of experience, which gives the researcher more confidence in the results.

Table 4.3: Respondents' experience

Experience duration	Frequency	Percent (%)
Less than 5years	3	5%
6-10 years	13	20%
11-15 years	18	28%
16-20 years	9	14%
More than 20 years	22	34%
Total	**65**	**100%**

4.2.6 Dependence on the Palestinian Contractors Union (PCU) Classification

In Table 4.4, it is clear that 45% of the respondents' organization always depends on PCU classification, while 55% often depends on PCU classification. These results indicate the significance of PCU classification.

Table 4.4: Dependence on PCU classification

Rely on PCU classification	Frequency	Percent (%)
Always	29	45%
Often	36	55%
Total	**65**	**100%**

4.2.7 Exercise the Prequalification Process over the Past Years

In Table 4.5, it is clear that 40% of the respondents' organizations sometimes exercise the prequalification process, 45% rarely exercise the prequalification process, and 15% never exercise the prequalification process. The results show the tendency towards exercising the prequalification process in Gaza Strip.

Table 4.5: Exercise the prequalification process over the past years

Exercise the prequalification over the past years	Frequency	Percent (%)
Sometimes	26	40%
Rarely	29	45%
Never	10	15%
Total	**65**	**100%**

4.3 Factors Influencing the Prequalification Process in Gaza Strip

This part consists of the results and discussion of the factors that influence the prequalification process in Gaza Strip as presented in the first questionnaire. The factors were categorized into nine groups; these groups are financial stability, management capabilities, experience, past performance, technical ability, reputation, health and safety, claims and contractual disputes, and current workload.

The interviewees were asked to provides their opinions on the identification of prequalification criteria for contractors in the construction sector in Gaza Strip companies

in Gaza Strip by scores 1 to 5, where "1" represent very low and "5" the very high. To determine the relative importance index (RII) of the factors, these scores were transformed to importance relative indices based on the formula:

$$\text{Relative Importance Index (RII)} = \frac{\sum w}{AN} = \frac{\sum_{i=1}^{i=5} i * n_i}{5N}$$

Where w is the weight given to each factor by the respondent, ranging from 1 to 5, (n1 = number of respondents for Very Important, n2 = number of respondents for Important, n3 = number of respondents for Medium Importance, n4 = number of respondents for Low Importance, n5 = number of respondents for No Importance). A is the highest weight (i.e. 5 in the study) and N is the total number of samples. The RII equals ranges from 0 to 1.

4.3.1 The Factors Related to the Financial Stability

Table 4.6 shows the respondents' opinion regarding the factors related to the financial stability of the company. The factors' RII is as the following:

1. "The capital of the company" with RII equals 0.92 and rank equals 1.
2. "The annual turnover of the company" with RII equals 0.82 and rank equals 4.
3. "The banking facilities provided by the company" with RII equals 0.75 and rank equals 5.
4. "The liquidity of the company" with RII equals 0.87 and rank equals 2.
5. "The debt volume of the company" with RII equals 0.85 and rank equals 3.

The results indicate the extent of significance of the financial stability in the prequalification process. The contractor's financial stability is an indication of his ability to execute the project and to meet financial obligations where it is considered as one of the most important criteria for evaluating the capability of general contractors.

These findings agree with several previous studies such that conducted by Alfred (2006) in 15 African countries, 4 Asian countries, and 2 South American countries; Tarawneh (2004) in Jordan; Ng and Skitmore (2000) in UK; Ng and Skitmore (1999) in UK; Khosrowshahi (1999) in UK; and Bubshait and Al-Gobali (1996) in Kingdom of Saudi Arabia.

The relative importance index of the capital of the company equals 0.92, which indicates its highest importance. Same thing is valid for the liquidity of the company and debt volume of the company.

Table 4.6: The factors related to the financial stability of the company

No.	Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance	RII	rank
1	The capital of the company	40	24	1	0	0	0.92	1
4	The liquidity of the company	31	28	4	1	1	0.87	2
5	The debt volume of the company	30	24	9	2	0	0.85	3
2	The annual turnover of the company	21	30	13	1	0	0.82	4
3	The banking facilities provided by the company	12	29	21	2	1	0.75	5

4.3.2 The Factors Related to the Management Capabilities

Table 4.7 shows the respondents' opinion regarding the factors related to the management capabilities of the company. The factors' RII is as the following:

1. "The existence of an appropriate organizational structure for the company" with RII equals 0.89 and rank equals 1.
2. "The existence of an integrated strategy for the company" with RII equals 0.76 and rank equals 5.
3. "The qualifications of the managerial staff of the company" with RII equals 0.87 and rank equals 2.
4. "The availability of training system for managerial staff in the company" with RII equals 0.69 and rank equals 6.
5. "The use of computerized systems in the management" with RII equals 0.77 and rank equals 4.
6. "The availability of monitoring, tracking, and evaluation system of the company" with RII equals 0.78 and rank equals 3.

The results indicate the importance of the management capabilities in the prequalification process where RII equals 0.793. These findings agreed with previous studies conducted by Ng and Skitmore (2000), Ng and Skitmore (1999), Bubshait and Al-Gobali (1996).

The existence of an appropriate organizational structure for the company and the qualifications of the managerial staff of the company are with high RII 0.89 and 0.87 respectively, which reflects their importance in the prequalification process. The appropriate organizational structure shows how the information and decision-making processes move between different levels.

The factors related the existence of an integrated strategy for the company and the availability of training system for managerial staff in the company has low RII compared with the other factors. The researcher refers that to the nature of most companies, which considered relatively small and locally competitive and rarely depends on practicing training to develop its performance.

Table 4.7: The factors related to the management capabilities of the company

No.	Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance	RII	Rank
1	The existence of an appropriate organizational structure for the company	32	30	3	0	0	0.89	1
3	The qualifications of the managerial staff of the company	27	33	5	0	0	0.87	2
6	The availability of monitoring , tracking, and evaluation system of the company	19	24	19	3	0	0.78	3
5	The use of computerized systems in the management	11	38	12	4	0	0.77	4
2	The existence of an integrated strategy for the company	15	29	17	2	2	0.76	5
4	The availability of training system for managerial staff in the company	4	27	27	7	0	0.69	6

4.3.3 The Factors Related to the Experience

Table 4.8 shows the respondents' opinion regarding the factors related to the experience of the company. The factors' RII is as the following:

1. "The number of projects implemented by the company" with RII equals 0.84 and rank equals 5.
2. "The amount of projects implemented by the company" with RII equals 0.86 and rank equals 3.
3. "The type of projects implemented by the company" with RII equals 0.91 and rank equals 2.
4. "The experience of the company in implementing similar projects" with RII equals 0.93 and rank equals 1.
5. "The ability of the company to cope with the problems of implementation" with RII equals 0.85 and rank equals 4.
6. "The ability of the company to identify and manage risks" with RII equals 0.81 and rank equals 6.
7. "The number of years in construction" with RII equals 0.79 and rank equals 7.
8. "The local experience of the company" with RII equals 0.79 and rank equals 8.

The results indicate the high importance of the experience of the company in the prequalification process where RII equals 0.845. The experience is an essential criterion to ensure that the contractors have the skills to implement the project in terms of time, quality, and cost. Fortunately, the findings are consistent with the previous studies conducted by Alfred (2006), Ng and Skitmore (1999), and Bubshait and Al-Gobali (1996).

The experience of the company in implementing similar projects has been ranked in the first position. This indicates the high tendency of the owners to select the contractors who have this kind of experience in order to guarantee the success of their projects. In addition, the type of projects implemented by the company has high relative importance index, which confirms the desire of the owners to deal with qualified contractors engaged with construction industry. The number of years in construction and local experience has reasonable relative importance index 0.79.

Table 4.8: The factors related to the experience of the company

No.	Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance	RII	Rank
4	The experience of the company in implementing similar projects	43	20	2	0	0	0.93	1
3	The type of projects implemented by the company	37	25	3	0	0	0.91	2
2	The amount of projects implemented by the company	26	32	7	0	0	0.86	3
5	The ability of the company to cope with the problems of implementation	26	31	6	2	0	0.85	4
1	The number of projects implemented by the company	25	30	9	1	0	0.84	5
6	The ability of the company to identify and manage risks	24	24	13	4	0	0.81	6
7	The number of years in construction	13	36	14	2	0	0.79	7
8	The local experience of the company	10	41	13	1	0	0.79	8

4.3.4 The Factors Related to the Past Performance

Table 4.9 shows the respondents' opinion regarding the factors related to the past performance of the company. The factors' RII is as the following:

1. "The adherence to the contractual period in the implementation of projects" with RII equals 0.923 and rank equals 1.
2. "The adherence to the allocated budget the implementation of projects" with RII equals 0.80 and rank equals 5.
3. "The track records of the company in the implementation of projects" with RII equals 0.83 and rank equals 4.
4. "The adherence to the specifications in the implementation of projects" with RII equals 0.920 and rank equals 2.

5. "The adherence to the contractual obligations in the implementation of projects" with RII equals 0.917 and rank equals 3.

Table 4.9: The factors related to the past performance of the company

No.	Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance	RII	Rank
1	The adherence to the contractual period in the implementation of projects	43	19	3	0	0	0.923	1
4	The adherence to the specifications in the implementation of projects	41	23	0	1	0	0.92	2
5	The adherence to the contractual obligations	40	23	2	0	0	0.917	3
3	The track Records of the company in the implementation of projects	20	36	9	0	0	0.83	4
2	The adherence to the allocated budget in the implementation of projects	15	38	9	2	1	0.80	5

The results indicate the high importance of the past performance of the company in the prequalification process. The past performance of the contractors will enable the clients to assess the companies' ability to manage and deliver projects with specified quality, time, and cost. The findings are consistent with the findings of previous studies conducted by Alfred (2006), Ng and Skitmore (1999), and Bubshait and Al-Gobali (1996).

4.3.5 The Factors Related to the Technical Ability

Table 4.10 shows the respondents' opinion regarding the factors related to technical ability of the company. The factors' RII is as the following:

1. "The number, type, and condition of equipment and machinery" with RII equals 0.85 and rank equals 2.
2. "The capital of equipment and machinery" with RII equals 0.754 and rank equals 4
3. "The number of the technical staff" with RII equals 0.76 and rank equals 3.

4. "The experience of the technical staff" with RII equals 0.87 and rank equals 1.
5. "The existence of training system for labor" with RII equals 0.67 and rank equals 6.
6. "The technological means used by the company in the implementation of projects" with RII equals 0.751 and rank equals 5.

Table 4 .10: The factors related to the technical ability of the company

No.	Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance	RII	Rank
1	The number , type , and condition of equipment and machinery	24	33	8	0	0	0.85	2
2	The capital of equipment and machinery	13	27	22	3	0	0.754	4
3	The number of the technical staff	12	31	20	2	0	0.76	3
4	The experience of the technical staff	31	27	5	2	0	0.87	1
5	The existence of training system for labor	5	24	26	7	3	0.67	6
6	The technological means used by the company in the implementation of projects	8	37	16	4	0	0.751	5

The results indicate the importance of the technical ability of the company to enable the contractors to demonstrate that it has the technical capacity to perform the work for which it is seeking prequalification for specific project. The first two factors related to "the experience of the technical staff" and "the number, type, and condition of equipment and machinery" have high relative importance index, which show the importance of the experience of the technical staff as well as the availability of the equipments and machinery.

On the other hand, the existence of training system for labor has relatively low relative importance index and that refers to the nature of companies in Gaza Strip, which are mostly depends on subcontracting.

4.3.6 The Factors Related to the Reputation

Table 4.11 shows the respondents' opinion regarding the factors related to the reputation of the company. The factors' RII is as the following:

1. "The company classification" with RII equals 0.90 and rank equals 1.
2. "The diversity of specialization fields of the company" with RII equals 0.797 and rank equals 2.
3. "The size of the company" with RII equals 0.754 and rank equals 5.
4. "The previous relationship between the company and the owner" with RII equals 0.769 and rank equals 3.
5. "The previous relationship between the company and other owners" with RII equals 0.757 and rank equals 4.

The results indicate the high importance of the reputation of the company in the prequalification process. Also, it is consistent with the findings of previous studies conducted by Alfred (2006), and Ng and Skitmore (1999).

It is clear the extent of importance of the company classification in the prequalification process, which is interpreted as the high tendency of projects' owners to stipulate the high grades to be eligible to execute the projects. The factors that related to the contractors relationship with the owner and other owners have reasonable relative importance index, which confirms the necessity of owners and other owners to deal with contractors who showed high level of cooperation in implementing of the previous projects.

With regard to the size of the company , RII equals 0.75 while 44 out of 65 respondents said its importance ranges from very important to important and 21 said it is medium important. The researcher refers this to the being of most companies are relatively small companies despite their classification.

Table 4.11: The factors related to reputation of the company

No.	Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance	RII	Rank
1	The company classification	32	32	1	0	0	0.900	1
2	The previous relationship between the company and the owner	16	35	11	3	0	0.797	2
3	The size of the company	8	36	19	2	0	0.754	5
4	The diversity of specialization fields of the company	18	25	17	4	1	0.769	3
5	The previous relationship between the company and other owners	13	29	20	2	1	0.757	4

4.3.7 The Factors Related to the Health and Safety Procedures

Table 4.12 shows the respondents' opinion regarding the factors related to health and safety procedures in the company. The factors' RII is as the following:

1. "The existence of policy for the company in the field of health and safety standards to control the work" with RII equals 0.83 and rank equals 1.
2. "The existence of training programs in the field of health and safety" with RII equals 0.70 and rank equals 3.
3. "Health and safety records of the company in the implementation of previous projects" with RII equals 0.74 and rank equals 2.

The results indicate the importance of the health and safety procedures in the prequalification process where RII equals 0.757. The importance of health and safety is to encourage companies to establish and maintain effective systems to manage the risks arising from the nature of the work performed. These findings also agreed with several previous studies conducted by Alfred (2006), Ng and Skitmore (2000), and Ng and Skitmore (1999).

The first factor that related to "the existence of policy for the company in the field of health and safety standards to control the work" has reasonable RII 0.83 where 55out of 65 respondents said its importance ranges from very important to important. On the other hand, the remaining two factors regarding safety records and training programs in the field of health and safety have low RII and that reflects the lack of interest of owners towards this issue and consider it just a complementary formality.

Table 4.12: The factors related to the health and safety procedures in the company

No.	Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance	RII	Rank
1	The existence of policy for the company in the field of health and safety standards to control the work	21	34	9	1	0	0.83	1
2	The existence of training programs in the field of health and safety	7	25	27	6	0	0.70	3
3	Health and safety records of the company in the implementation of previous projects	14	27	17	4	3	0.74	2

4.3.8 The Factors Related to the Claims and Contractual Disputes

Table 4.13 shows the respondents' opinion regarding the factors related to the claims and contractual disputes. The factors' RII is as the following:

1. "The tendency of company towards the claims and intransigence in contractual issues" with RII equals 0.766 and rank equals 2.
2. "The company response in finding solutions to claims and disputes" with RII equals 0.855 and rank equals 1.
3. "The number of the claims in the previous projects" with RII equals 0.738 and rank equals 3.

The results indicate the importance of the claims and contractual disputes in the prequalification process where RII equals 0.786 while Ng and Skitmore (2000) found RII 0.72. The researcher refers this increase in RII to the latest situation in Gaza Strip due to

the siege that forces most the owners to terminate the projects and enter in claims stage with contractors.

The factor related to the company response in finding solutions to claims and disputes reflects the interest of owners in future to deal with the flexible contractors. The remaining two factors regarding the tendency of company towards the claims and intransigence in contractual issues and the number of claims reflects the high tendency of owners in dealing with inflexible and empty-headed contractors.

Table 4.13: The factors related to the claims and contractual disputes

No.	Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance	RII	Rank
1	The tendency of company towards the claims and intransigence in contractual issues	15	31	12	7	0	0.766	2
2	The company response in finding solutions to claims and disputes	30	24	10	1	0	0.855	1
3	The number of the claims in the previous projects	11	35	11	4	4	0.738	3

4.3.9 The Factors Related to the Current Workload

Table 4.14 shows the respondents' opinion regarding the factors related to the current workload of the company. The factors' RII is as the following:

1. "The number of the current projects implemented by the company" with RII equals 0.81 and rank equals 1.
2. "The type of the current projects implemented by the company" with RII equals 0.757 and rank equals 3.
3. "The amount of the current projects implemented by the company" with RII equals 0.75 and rank equals 2.
4. "The percentage of the current projects subcontracted" with RII equals 0.69 and rank equals 4.

The results indicate the importance of the current workload in the prequalification process where RII equals 0.758 and this agreed with the study conducted by Tarawnah (2004). The researcher refers the low value of RII of current workload compared with the other criteria to the fact of being most projects are relatively small in Gaza Strip and not represent an overburden for companies that enjoined sound financial resources and management capabilities.

The first three factor regarding the number, amount, and type of current implemented projects are very close in their relative importance index. On the other hand, the percentage of projects subcontracted is ranked in the third position with RII o.69 and that may reflects the nature of implementation projects in Gaza Strip where sizeable parts of project are subcontracted.

Table 4.14: The factors related to current workload of the company

No.	Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance	RII	Rank
1	Number of the current projects implemented by the company	20	31	10	4	0	0.81	1
3	Amount of the current projects implemented by the company	15	35	9	4	2	0.775	2
2	Type of the current projects implemented by the company	10	43	6	0	6	0.757	3
4	Percentage of the current projects subcontracted	9	28	15	10	3	0.69	4

4.3.10 The Prequalification Groups

Table 4.15 shows the respondents' opinion regarding the prequalification groups of the contractors. The groups' RII is as the following:

1. "Financial stability of the company" with RII equals 0.842 and rank equals 3.
2. "Management capabilities of the company" with RII equals 0.793 and rank equals 5.
3. "Experience of the company" with RII equals 0.845 and rank equals 2.
4. "Past performance of the company" with RII equals 0.878 and rank equals 1.
5. "Technical ability of the company" with RII equals 0.775 and rank equals 7.
6. "Reputation of the company" with RII equals 0.795 and rank equals 4.
7. "Health and safety procedures in the company" with RII 0.757 and rank equals 9.

8. "Claims and contractual disputes" with RII equals 0.786 and rank equals 6.
9. "Current work load of the company" with RII equals 0.758 and rank equals 8.

Table 4.15: The prequalification groups

No.	Prequalification Criteria	RII	Rank
4	The past performance of the company	0.878	1
3	The experience of the company	0.845	2
1	The financial stability of the company	0.842	3
6	The reputation of the company	0.795	4
2	The management capabilities of the company	0.793	5
8	The claims and contractual disputes	0.786	6
5	The technical ability of the company	0.775	7
9	The current workload of the company	0.758	8
7	The health and safety procedures in the company	0.757	9

4.4 The Prequalification Criteria Weights

This part deals with the steps of establishing the prequalification model of selection contractors prior the bidding stage. Accordingly, the prequalification criteria and subcriteria have been identified based on the statistical analysis results of questionnaire (1) to be the base for establishing the selection model in order to determine its weights by using questionnaire (2) based on AHP.

The main criteria and subcriteria were identified based on the results of questionnaire (1). Then, the researcher paraphrased the influencing factors in the form of subcriteria and excluded all the influencing factors that have RII less than 0.70 where all the values above this value ranges in its importance from that above the medium important to very important. The steps of this survey are summarized as follows:

1. Level 1: Identify the main criteria to be used in the prequalification process of contractors. The nine main criteria suitable for the construction industry in Gaza Strip were adopted.
2. Level 2: Divide each main criterion into many sub-criteria, which help to make practical and quantitative method of contractors' prequalification on the

prequalification stage: 42 subcriteria suitable for the construction industry in Gaza Strip were adopted.

3. Level 3: Determine the weights of the nine main criteria by AHP.
4. Level 4: Determine weights of 42 sub criteria relevant to the main criteria by AHP.

The weights obtained here represent the opinion of six professionals interviewed in this study through questionnaire (2), and not necessarily be taken as a default values. The respondents in the first stage were asked to determine the priorities of main criteria and subcriteria relative in pairwise comparison using the numerical rating for the three adopted sectors in the research, namely, public building and housing, water and sewage networks, and roads.

Table 4.16 shows the paraphrased main criteria and subcriteria, which have been adopted upon the high degree of RII equals or greater than 0.70 in order to prepare questionnaire (2) and AHP model. Accordingly, the main criteria RII have been recalculated for the groups after ruling out the factors less than 0.70.

Figure 4.3 shows AHP model. The main target "Prequalification of the contractors" was identified at the top of the hierarchy on level one. In the second level, the main criteria adopted in this research was identified, namely, Past Performance (P.P); Experience (E); Financial stability (F.S); Management Capabilities (M.C); Technical Ability (T.A); Reputation (R); Claims and Contractual Disputes (C.C.D); Current Work Load (C.W.L); and Health and Safety (H.S). In the third level, the related subcriteria were identified. At level four, the alternatives representing the contractors to be prequalified were determined.

The group of the six experts filled in questionnaire (2) based on the recommended scale used to quantify the relative importance. Accordingly, the nine main criteria were pairwise compared as well as the relevant subcriteria and the geometric average was adopted to avoid any differences in the group opinions regarding the priorities. The consistency ratio (CR) was manually calculated at each stage in order to be sure that CR not exceeding 10% according to AHP for sound judgments. However, in case that CR exceeds 10%, the entries reviewed with the group.

AHP steps are drawn in order to establish weights for the proposed prequalification criteria in Housing, Water and Sewage, and Roads Sectors as follows:

1. Synthesizing the pairwise comparison matrix;
2. Calculating the priority vector for a criterion such as past performance;
3. Calculating the consistency ratio;
4. Calculating λ_{max};
5. Calculating the consistency index, CI;
6. Selecting appropriate value of the random consistency ratio from Table 2.7; and
7. Checking the consistency of the pairwise comparison matrix to check whether the decision-maker were consistent or not.

Table 4.16: The relative importance index of the prequalification criteria

Main Criteria	**RII**
G1 : The Past Performance (P.P)	0.878
G2 : The Experience (Exp)	0.845
G3 : The Financial Stability (F.S)	0.842
G4 : The Management Capabilities (M.C)	0.814
G5 : The Technical Ability (T.A)	0.797
G6 : The Reputation (R)	0.795
G7 : The Claims and Contractual Disputes (C.C.D)	0.786
G8 : The Current Workload (C.W.L)	0.779
G9 : The Health and Safety Procedures (H.S)	0.757
Subcriteria **The Past Performance (P.P)**	
G11 :The adherence to the contractual period	0.923
G12 :The adherence to the specifications	0.92
G13 :The adherence to the contractual obligations	0.917
G14 :The track record of the company	0.83
G15 :The adherence to the allocated budget	0.80
The Experience (Exp)	
G21 :The number of similar projects	0.93
G22 :The type of projects implemented	0.90
G23 :The amount of projects implemented	0.86
G24 :The ability to cope with the problems of implementation	0.85
G25 :The number of projects implemented	0.84
G26 :The ability to identify and manage risks	0.81
G27 :The number of years in construction	0.79
G28 :The local experience of the company	0.79

Sub criteria The Financial Stability (F.S)	Weight
G31 :The capital of the company	0.92
G32 :The liquidity of the company	0.87
G33 :The debt volume of the company	0.85
G34 :The annual turnover of the company	0.82
G35 :The banking facilities provided by of the company	0.75
The Management Capabilities(M.C)	
G41 :The company organizational structure	0.89
G42 :The qualifications of the managerial staff	0.87
G43 :The availability of monitoring , tracking, and evaluation system	0.78
G44 :The use of computerized systems in the management	0.77
G45 :The existence of an integrated strategy for the company	0.76
The Technical Ability (T.A)	
G51 :The experience of the technical staff	0.87
G52 :The number , type , and condition of equipment and machinery	0.85
G53 :The number of the technical staff	0.76
G54 :The capital of equipment and machinery	0.754
G55 :The technological means used in the implementation of projects	0.751
The Reputation (R)	
G61 :The company classification	0.90
G62 :The previous relationship between the company and the owner	0.797
G63 :The diversity of areas of specialization	0.769
G64 :The previous relationship between the company and other owners	0.757
G65 :The size of the company	0.754
The Claims and Contractual Disputes (C.C.D)	
G71 :The company response in finding solutions to claims and disputes	0.855
G72 :The tendency of the company towards the claims	0.766
G73 :The number of claims in the previous projects	0.738
The Current Work Load (C.W.L)	
G81 :The number of the current projects	0.81
G82 :The amount of the current projects	0.775
G83 :The type of the current projects	0.757
The Health and Safety Procedures (H.S)	
G91 :The health and safety policy	0.83
G92 :The health and safety records in the previous projects	0.74
G93 :The health and safety training programs	0.70

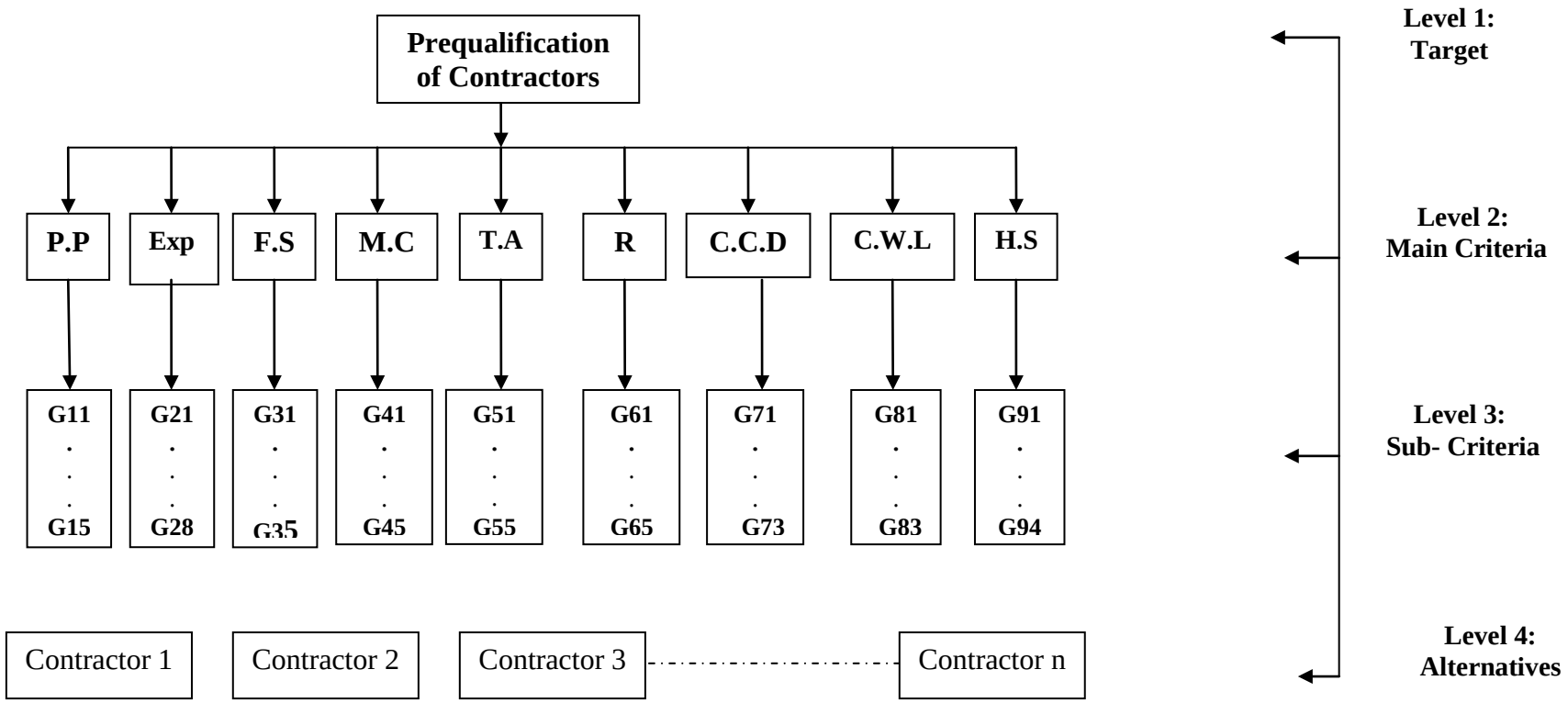

Figure 4.3: AHP model of contractors' prequalification

4.4.1 Main Criteria Weights

By following AHP steps described in the Section 4.4, the hierarchy of the problem can be developed as shown in Figure 4.3. The decision-makers have to indicate preferences or priorities for each decision alternative in terms of how it contributes to each criterion as shown in Table 4.17.

Table 4.17: Pairwise comparison matrix of the prequalification criteria

	P.P	Exp	F.S	M.C	T.A	R	C.C.D	C.W.L	H.S
P.P	1	3	1/3	1/2	1/2	1	3	5	3
Exp	1/3	1	1	1/2	1/2	1/3	2	4	2
F.S	3	1	1	2	1	3	3	5	3
M.C	2	2	1/2	1	1/2	1	2	3	2
T.A	2	2	1	2	1	2	2	5	3
R	1	3	1/3	1	1/2	1	1	2	1
C.C.D	1/3	1/2	1/3	1/2	1/2	1	1	1	1
C.W.L	1/5	1/4	1/5	1/3	1/5	1/2	1	1	1
H.S	1/3	1/2	1/3	1/2	1/3	1	1	1	1

The calculations for these items will be explained next for illustration purposes. Synthesizing the pairwise comparison matrix is performed by dividing each element of the matrix by its column total. For example, the value 0.10 in the first row in Table 4.18 is obtained by dividing 1 (from Table 4.17) by the sum of the first column items in Table 4.17 and so forth.

The priority vector in Table 4.18 can be obtained by finding the row averages. For example, the priority vector of the "Past Performance" in Table 4.18 is calculated by dividing the sum of the first row in Table 4.18 (0.10+.0.23+0.07+0.06+0.10 +0.09+0.19+0.18+0.18+0.13) by the number of criterion (columns), i.e., 9, in order to obtain the value 0.13. The priority vectors for all the nine criteria indicated in Table 4.18, is given below which represent their weights from the decision-makers viewpoint.

Table 4.18: Synthesized matrix of the main criteria

	PP	Exp	FS	MC	TA	R	CCD	CWL	HS	Priority Vector
P.P	0.10	0.23	0.07	0.06	0.10	0.09	0.19	0.18	0.18	0.13
Exp	0.03	0.08	0.20	0.06	0.10	0.03	0.13	0.15	0.12	0.10
F.S	0.29	0.08	0.20	0.24	0.20	0.28	0.19	0.18	0.18	0.20
M.C	0.20	0.15	0.10	0.12	0.10	0.09	0.13	0.11	0.12	0.12
T.A	0.20	0.15	0.20	0.24	0.20	0.18	0.13	0.18	0.18	0.18
R	0.10	0.23	0.07	0.12	0.10	0.09	0.06	0.07	0.06	0.10
C.C.D	0.03	0.04	0.07	0.06	0.10	0.09	0.06	0.04	0.06	0.06
C.W.L	0.02	0.02	0.04	0.04	0.04	0.05	0.06	0.04	0.06	0.04
H.S	0.03	0.04	0.07	0.06	0.07	0.09	0.06	0.04	0.06	0.06

The next step is to calculate the consistency ratio as follows:

	1		3		1/3		1/2		1/2
	1/3		1		1		1/2		1/2
	3		1		1		2		1
	2		2		1/2		1		1/2
0.13	2	+ 0.10	2	+ 0.20	1	+0.12	2	+.18	1
	1		3		1/3		1		1/2
	1/3		1/2		1/3		1/2		1/2
	1/5		1/4		1/5		1/3		1/5
	1/3		1/2		1/3		1/2		1/3

	1		3		5		3		1.30
	1/3		2		4		2		0.93
	3		3		5		3		1.98
	1		2		3		2		1.24
+ 0.10	2	+ 0.06	2	+0.04	5	+0.06	3	=	1.79
	1		1		2		1		1.01
	1		1		1		1		0.57
	1/2		1		1		1		0.37
	1		1		1		1		0.54

(Weighted sum matrix)

Dividing all the elements of the weighted sum matrices by their respective priority vector element, we obtain:

$$\begin{vmatrix} 1.30 \\ 0.93 \\ 1.98 \\ 1.24 \\ 1.79 \\ 1.01 \\ 0.57 \\ 0.37 \\ 0.54 \end{vmatrix} \div \begin{vmatrix} 0.13 \\ 0.10 \\ 0.20 \\ 0.12 \\ 0.18 \\ 0.10 \\ 0.06 \\ 0.04 \\ 0.06 \end{vmatrix} = \begin{vmatrix} 9.85 \\ 9.42 \\ 9.74 \\ 10.00 \\ 9.73 \\ 10.12 \\ 9.43 \\ 9.38 \\ 9.50 \end{vmatrix}$$

(λ matrix)

Calculating λ max by taking the average of all elements in λ matrix as follows:

- $\lambda \text{ max} = \frac{(9.85 + 9.42 + 9.74 + 10.00 + 9.73 + 10.12 + 9.43 + 9.38 + 9.5)}{9}$
- $\lambda \text{ max} = 9.68$

Now, we find the consistency index, CI, as follows:

- $CI = \frac{\lambda \text{max} - n}{n - 1}$
- $CI = \frac{9.68 - 9}{9 - 1} = 0.09$

Selecting appropriate value of random consistency ratio, RI, for a matrix size of nine using Table 2.7, we find RI = 1.45. Then the consistency ratio, CR, is calculated as follows:

- $CR = \frac{CI}{RI} = \frac{0.09}{1.45} = 0.06.$

As the value of CR is less than 0.1, the judgments are acceptable. Similarly, the pairwise comparison matrices and priority vectors for the remaining sub-criteria can be found as shown in Tables 4.19 to 4.26 respectively.

Table 4.18 shows the weights of the main criteria of the prequalification process for the contractors in Gaza Strip. The criteria were ranked according to its weight from highest to lowest as the following:

1. The financial stability with weight equals 20%.
2. The technical ability with weight equals 18%.
3. The past performance with weight equals 13%.
4. The management capabilities with weight equal 12%.
5. The experience with weight equals 10%.

6. The reputation with weight equals 10%.
7. The claims and contractual disputes with weight equal 6%.
8. The health and safety procedure with weight equals 6%.
9. The current workload with weight equals 4%.

The results indicated that the major decision criteria include financial stability; technical ability; past performance; management capabilities; experience; and reputation of the company. Thus, it is concluded that these six criteria are important and should be applied when performing contractor prequalification practice.

It is also obvious from the findings that the financial stability obtained a reasonable weight of 20% that agreed to some extent with previous studies conducted by Hatush & Skitmore (1997a) and Sawalhi et al. 2007 (cited in Medoukh, 2008) with weights 20.5% and 25% respectively. The researcher refers the relatively high weight of the financial to the necessity for sound financial contractors in order to implement the projects and avoid all kinds of risk such as insolvency and bankruptcy, which undoubtedly has negative impact on the success of the project.

Moreover, the weights of the other criterion are reasonable and anticipated by the researcher. The technical ability of the contractor is also has weight equals 18% which indicates to the extent of its importance in the whole process and agreed also with Hatush & Skitmore (1997a) where its weight was 19% excluding the weight of experience which presented as sub criterion of weight 7.25% and that indicate the importance of the results in this research.

The past performance significance has weight equals 13% and that agreed to some extent with Holt et al. 1994 (cited in Sonmez et al. 2002) that reaches 19%. The management capabilities has also considerable weight in this research reaches related 13% and that agreed with Hatush & Skitmore (1997a) if sub criterion that related the past performance and quality is excluded. Hence, the management capabilities are considered as milestone criterion in the prequalification process.

It is noticed that the experience has a satisfactory weight equals 10% that meet to some extent with that found by Hatush & Skitmore (1997a) where its weight was 7.25%. On the other hand, the low weight of the criteria relevant to claims and contractual disputes was anticipated due to the Palestinian culture in dealing with such issues in settling any

claims and the absence of a judicial system specialized in the construction industry in Gaza Strip. Moreover, most projects are with restricted budgets and subject to specific terms and conditions of donors' policies. However, the results obtained is not widely different from that found by Sawalhi et al. 2007 (cited in Medoukh, 2008) with weight equals 1.6% as sub criterion as well as Holt et al. 1994 (cited in Sonmez et al. 2002) with weight equals 2.6%. The slight increase in the weight of this criterion is attributed to the prevailing situation Gaza Strip since June 2007 that forces most implementing agencies to terminate its contracts with contractors and owners' mechanism in dealing with the resulted claims.

It is noticed that the low weight of health and safety and this may refer to the weakness of procedures adopted by clients towards their contractors and absence of awareness and consequences of such issue. Due to the increase of accidents in construction industry in Gaza strip in 2011, health and safety criteria must be reconsidered where the research survey conducted in August 2009, so any future study must highlight on health and safety.

In addition, the low weight of current workload refers to the nature of construction industry in Gaza Strip where in most cases the main contractors subcontract significant parts of their project with which lessens their workload and enables them to implement any other project with normal capacity.

Finally, these results represent the opinion of the six professionals (Procurement Analysts, Project Managers, and Consultants) who were interviewed in this study through questionnaire (2), and not necessarily to be taken as a default values.

4.4.2 The Past Performance Subcriteria Weight

The decision-makers indicated their preferences regarding the past performance subcriteria as shown in Table 4.19.

Table 4.19 shows the weights of the subcriteria related to past performance of the company. The subcriteria are ranked according to its weight from highest to lowest as the following:

1. "The adherence to the contractual obligations" with weight equals 32%.
2. "The adherence to the specifications" with weight equals 32%.
3. "The track record of the company" with weight equals 17%.

4. "The adherence to the contractual period" weight equals 11%.
5. "The adherence to the allocated budget" with weight equals 7%.

Table 4.19: Pairwise comparison matrix of the past performance subcriteria[a]

	G11	G12	G13	G14	G15	Priority vector
G11	1	1/4	1/3	1/3	3	0.11
G12	4	1	1/2	3	5	0.32
G13	3	2	1	2	3	0.34
G14	3	1/3	1/2	1	2	0.17
G15	1/3	1/5	1/3	1/2	1	0.07
						$\sum = 1.01$

[a] λ max = 5.38 , CI= 0.0955 , RI= 1.12 , CR= 0.0853 < 0.1 OK.

4.4.3 The Experience Subcriteria Weight

The decision-makers indicated their preferences regarding the factors related to the past performance as shown in Table 4.20.

Table 4.20: Pairwise comparison matrix of the factors related to the experience[a]

	G21	G22	G23	G24	G25	G26	G27	G28	Priority vector
G21	1	3	3	5	2	5	3	4	0.31
G22	1/3	1	2	2	2	3	3	3	0.18
G23	1/3	1/2	1	2	2	2	3	3	0.14
G24	1/5	1/2	1/2	1	1/2	1	2	2	0.08
G25	1/2	1/2	1/2	2	1	2	2	3	0.12
G26	1/5	1/3	1/2	1	1/2	1	2	2	0.07
G27	1/3	1/3	1/3	1/2	1/2	1/2	1	2	0.06
G28	1/4	1/3	1/3	1/2	1/3	1/2	1/2	1	0.04
									$\sum = 1.0$

[a] λ max = 8.36 , CI= 0.0516 , RI= 1.41 , CR= 0.0366 < 0.1 OK.

Table 4.20 shows the weights of the subcriteria related to experience of the company. The subcriteria are ranked according to its weight from highest to lowest as the following:

1. "The number of similar projects" with weight equals 31%
2. "The type of projects implemented" with weight equals 18%.
3. "The amount of projects implemented" with weight equals 14%.
4. " The number of projects implemented" with weight equals 12%
5. " The ability to cope with the problems of implementation" with weight equals 8%

6. " The ability to identify and manage risks" with weight equals 7%
7. " The number of years in construction" with weight equals 6%
8. "The local experience of the company" with weight equals 4%.

4.4.4 The Financial Stability Subcriteria Weight

The decision-makers indicated their preferences regarding the factors related to the financial stability as shown in Table 4.21

Table 4.21: Pairwise comparison matrix of the factors related to the financial stability[a]

	G31	G32	G33	G34	G35	Priority vector
G31	1	1/3	3	2	1/2	0.16
G32	3	1	5	5	5	0.50
G33	1/3	1/5	1	1/2	1/3	0.06
G34	1/2	1/5	2	1	1	0.11
G35	2	1/5	3	1	1	0.17
						$\sum = 1.0$

[a] λ max = 5.26 , CI= 0..0649 , RI= 1.12 , CR= 0.058 < 0.1 OK.

Table 4.21 shows the weights of the subcriteria related to financial stability of the company. The subcriteria were ranked according to its weight from highest to lowest as the following:

1. "Liquidity of the company" with weight equals 50%
2. "Banking facilities provided by the company" with weight equals 17%
3. "Capital of the company" with weight equals 16%
4. "Annual Turnover" with weight equals 11%.
5. "Debt volume" with weight equals 6%.

4.4.5 The Management Capabilities Subcriteria Weight

The decision-makers indicated their preferences regarding the factors related to the management capabilities as shown in Table 4.22.

Table 4.22 shows the weights of the subcriteria related to management capabilities of the company. The subcriteria were ranked according to its weight from highest to lowest as the following:

1. "Company organizational structure" with weight equals 42%.
2. "Qualifications of the managerial staff" with weight equal 30%.

3. "Availability of monitoring, tracking, and evaluation system" with weight equals 16%.
4. "The use of computerized systems in the management" with weight equals 8%.
5. "Existence of an integrated strategy for the company" with weight equals 4%.

Table 4.22: Pairwise comparison matrix of the factors related to the management capabilities[a]

	G41	G42	G43	G44	G45	Priority vector
G41	1	2	3	5	9	0.42
G42	1/2	1	4	3	7	0.30
G43	1/3	1/4	1	3	5	0.16
G44	1/5	1/3	1/3	1	3	0.08
G45	1/9	1/7	1/5	1/3	1	0.04
						$\sum = 1.0$

[a] λ max = 5.24 , CI= 0..0606 , RI= 1.12 , CR= 0.0541 < 0.1 OK.

4.4.6 The Technical Ability Subcriteria Weight

The decision-makers indicated their preferences regarding the factors related to the Technical ability shown in Table 4.23.

Table 4.23: Pairwise comparison matrix of the factors related to the technical ability[a]

	G51	G52	G53	G54	G55	Priority vector
G51	1	3	2	5	7	0.41
G52	1/3	1	3	5	9	0.31
G53	1/2	1/3	1	2	7	0.17
G54	1/5	1/5	1/2	1	3	0.08
G55	1/7	1/9	1/7	1/3	1	0.03
						$\sum = 1.0$

[a] λ max = 5.80 , CI= 0..0805 , RI= 1.12 , CR= 0.0718 < 0.1 OK.

Table 4.23 shows the weights of the subcriteria related to experience of the company. The subcriteria were ranked according to its weight from highest to lowest as the following:

1. "Experience of the technical staff" with weight equals 41%.
2. "Number, type, and condition of equipment and machinery" with weight equal 31%.
3. "Number of the technical staff" with weight equals 17%.

4. "Capital of equipment and machinery" with weight equals 8%.
5. "Technological means used in the implementation of projects" with weight equals 3%.

4.4.7 The Reputation Subcriteria Weight

The decision-makers indicated their preferences regarding the factors related to the reputation shown in Table 4.24.

Table 4.24: Pairwise comparison matrix of the factors related to the reputation[a]

	G61	G62	G63	G64	G65	Priority vector
G61	1	1/3	2	1/2	1	0.13
G62	3	1	3	2	5	0.41
G63	1/2	1/3	1	1/2	1/3	0.09
G64	2	1/2	2	1	3	0.24
G65	1	1/5	3	1/3	1	0.13
						$\sum = 1.0$

[a] λ max = 5.28 , CI= 0..0708 , RI= 1.12 , CR= 0.0632 < 0.1 OK.

Table 4.24 shows the weights of the subcriteria related to reputation of the company. The subcriteria were ranked according to its weight from highest to lowest as the following:

1. "The previous relationship between the company and the owner" with weight equals 41%
2. "The previous relationship between the company and other owners" with weight equal 24%
3. "Company classification" with weight equal 13%
4. "Size of the company" with weight equals 13%
5. "The diversity of areas of specialization" with weight equals 9%

4.4.8 The Claims and Contractual Disputes Subcriteria Weight

The decision-makers indicated their preferences regarding the factors related to the claims and contractual disputes shown in Table 4.25.

Table 4.25 shows the weights of the subcriteria related to the claims and contractual disputes. The subcriteria were ranked according to its weight from highest to lowest as the following:

1. "Company response in finding solutions to claims and disputes" with weight equals 49%
2. "Tendency of the company towards the claims" with weight equals 31%
3. "Number of claims in the previous projects" with weight equals 20%

Table 4.25: Pairwise comparison of the factors related to the claims and contractual disputes[a]

	G71	G72	G73	Priority vector
G71	1	2	2	0.49
G72	1/2	1	2	0.31
G73	1/2	1/2	1	0.20
				$\sum = 1.0$

[a] λ max = 3.05 , CI= 0.0270 , RI= 0.58 , CR= .0466 < 0.1 OK.

4.4.9 The Current Workload Subcriteria Weight

The decision-makers indicated their preferences regarding the factors related to the current workload shown in Table 4.26.

Table 4.26: Pairwise comparison matrix of the factors related to the current workload[a]

	G81	G82	G83	Priority vector
G81	1	2	3	0.52
G82	1/2	1	3	0.33
G83	1/3	1/3	1	0.14
				$\sum = 1.0$

[a] λ max = 3.05 , CI= 0.0269 , RI= 0.58 , CR= .0464 < 0.1 OK.

Table 4.26 shows the weights of the subcriteria related to the current workload of the company. The subcriteria were ranked according to its weight from highest to lowest as the following:

1. "Number of the current projects" with weight equals 52%
2. "Amount of the current projects" with weight equals 33%
3. "Type of the current projects" with weight equals 14%

4.4.10 The Health and Safety Subcriteria Weight

The decision-makers indicated their preferences regarding the factors related to the health and safety shown in Table 4.27.

Table 4.27 shows the weights of the subcriteria related to the health and safety. The subcriteria were ranked according to its weight from highest to lowest as the following:

1. "Health and safety policy" with weight equals 52%
2. "Health and safety training programs" with weight equals 33%
3. "Health and safety records in the previous projects" with weight equals 14%

Table 4.27: Pairwise comparison matrix of the factors related to the health and safety[a]

	G91	G92	G93	Priority vector
G91	1	3	2	0.52
G92	1/3	1	1/3	0.14
G93	1/2	3	1	0.33
				$\sum = 1.0$

[a] λ max = 3.05 , CI= 0.0269 , RI= 0.58 , CR= .0464 < 0.1 OK.

Table 4.28: The weights of main criteria and subcriteria based on AHP

Main Criteria	Weight
G1 :Past Performance (P.P)	13%
G2 :Experience (Exp)	10%
G3 :Financial Stability (F.S)	20%
G4 :Management Capabilities (M.C)	12%
G5 :Technical ability (T.A)	18%
G6 :Reputation (R)	10%
G7 :Claims and contractual disputes (C.C.D)	6%
G8 :Current work load (C.W.L)	4%
G9 :Health and safety (H.S)	6%
	$\sum = 100\%$
Subcriteria Past Performance (P.P)	
G11 : Adherence to the contractual period	1.43%
G12 :Adherence to the specifications	4.16%
G13 :Adherence to the contractual obligations	4.42%
G14 :Track Record of the company	2.21%
G15 :Adherence to the allocated budget	0.91%
	$\sum = 13\%$
Subcriteria Experience (Exp)	
G21 :Number of similar projects	3.1%
G22 :Type of projects implemented	1.8%
G23 :Amount of projects implemented	1.4%
G24 :Ability to cope with the problems of implementation	0.8%
G25 :Number of projects implemented	1.2%
G26 :Ability to identify and manage risks	0.7%
G27 :Number of years in construction	0.6%
G28 :Local experience of the company	0.4%
	$\sum = 10\%$

Subcriteria	**Financial Stability (F.S)**
G31 :Capital of the company	3.20%
G32 :Liquidity of the Company	10.00%
G33 :Debt volume	1.20%
G34 :Annual Turnover	2.20%
G35 :Banking Facilities	3.40%
	$\sum = 20\%$
Subcriteria	**Management Capabilities(M.C)**
G41 :Company organizational structure	5.04%
G42 :Qualifications of the managerial staff	3.60%
G43 :Availability of monitoring , tracking, and evaluation system	1.92%
G44 :The use of computerized systems in the Management	0.96%
G45 : Existence of an integrated strategy for the company	0.48%
	$\sum = 12\%$
Subcriteria	**Technical ability (T.A)**
G51 :The experience of the technical staff	7.38%
G52 :The number , type , and condition of equipment and machinery	5.58%
G53 :The number of the technical staff	3.06%
G54 :Capital of equipment and machinery	1.44%
G55 :Technological means used in the implementation of projects	0.54%
	$\sum = 18\%$
Subcriteria	**Reputation (R)**
G61 :Company classification	1.30%
G62 :The previous relationship between the company and the owner	4.10%
G63 :The diversity of areas of specialization	0.90%
G64 :The previous relationship between the company and other owners	2.40%
G65 :Size of the company	1.30%
	$\sum = 10\%$
Subcriteria	**Claims and contractual disputes (C.C.D)**
G71 :Company response in finding solutions to claims and disputes	2.94%
G72 :The tendency of company towards the claims	1.86%
G73 :Number of claims in the previous projects	1.20%
	$\sum = 6\%$

Subcriteria	Current work load (C.W.L)
G81 :Number of current projects	2.08%
G82 :Amount of current projects	1.36%
G83 :Type of current projects	0.56%
	$\sum$ = 4%
Subcriteria	**Health and safety (H.S)**
G91 :Health and safety policy	3.12%
G92 :Health and safety records in the previous projects	0.84%
G93 : Health and safety training programs	2.04%
	$\sum$ = 6%

4.5 Conclusions

From the results obtained, analyzed, and discussed, the researcher concludes that:

1) Regarding the part of organization profile:

- It is clear that the building constitutes 34% of the implemented projects, waters and wastewater are 30%, and roads are 30%. On the other hand, the other projects constitute 9%.
- Over the past five years, 49 % of executed projects are of large-scale projects.
- The results indicate the importance of the respondents to enrich the survey in order to achieve the objective of this research.
- Respondents of the questionnaire are long-experienced in construction business where 75% of them have been in this field for more than 10 years.
- Hence, this result indicates that PCU classification is essential for all the targeted organizations in Gaza Strip where 55% stated they always depend on it while 45% stated they often depend on it.
- The results shows 40% of the respondents' organizations sometimes exercise the prequalification process, 45% rarely exercise the prequalification process, and 15% never exercise the prequalification process. The results show high tendency toward exercising the prequalification process.

2) Regarding the part of the prequalification criteria, the criteria were ranked from the highest to lowest according to the relative importance index as follows:

- "The past performance of the company" has been ranked in the first position with relative importance index 88% and this agreed with the findings of previous studies conducted by Alfred (2006), Ng and Skitmore (1999), and Bubshait and Al-Gobali (1996).
- "The experience of the company" has been ranked in the second position with relative importance index 85% and this agreed with the previous studies conducted by Alfred (2006), Ng and Skitmore (1999), and Bubshait and Al-Gobali (1996).
- "The financial stability of the company" has been ranked in the third position with relative importance index 84%. This result agreed with several previous studies such that conducted by Alfred (2006) in 15 African countries, 4 Asian countries, and 2 South American countries; Tarawneh (2004) in Jordan; Ng and Skitmore (2000) in UK; Ng and Skitmore (1999) in UK; Khosrowshahi (1999) in UK; and Bubshait and Al-Gobali (1996) in Kingdom of Saudi Arabia.
- "The reputation of the company" has been ranked in the forth position with relative importance index 80%. This result agreed with the findings of previous studies conducted by Alfred (2006), and Ng and Skitmore (1999).
- "The claims and contractual disputes" has been ranked in the fifth position with relative importance index 79%. This result indicates the importance of the claims and contractual disputes in the prequalification process where RII equals 80% while Ng and Skitmore (2000) found RII 72%. The researcher refers this increase in RII to the latest situation in Gaza Strip due to the siege that forces most the owners to terminate the projects and enter in claims stage with contractors.
- "The management capabilities of the company" has been ranked in the sixth position with relative importance index 79%. This result agreed with previous studies conducted by Ng and Skitmore (2000), Ng and Skitmore (1999), Bubshait and Al-Gobali (1996).
- "The technical ability of the company" has been ranked in the seventh position with relative importance index 77%. The result indicates the importance of technical abilities of the company.
- "The current workload of the company" has been ranked in the eighth position with relative importance index 77% and this agreed with the study conducted by Tarawnah (2004).

- "The health and safety procedures in the company" has been ranked in ninth with relative index 0.76 and this agreed with several previous studies conducted by Alfred (2006), Ng and Skitmore (2000), and Ng and Skitmore (1999).

3) Regarding the part of the weight of the prequalification criteria, the criteria were ranked from the highest to lowest according to their weights as follows:

- "The financial stability" weight equals 20%.
- "The technical ability" weight equals 18%.
- "The past performance" weight equals 13%.
- "The management capabilities" weight equal 12%.
- "The experience" with weight equals 10%.
- "The reputation" with weight equals 10%.
- "The claims and contractual disputes" with weight equal 6%.
- "The health and safety" with weight equals 6%.
- "The current workload" with weight equals 4%.

The findings indicated that the major decision criteria include financial stability; technical ability; past performance; management capabilities; experience; and reputation of the company. Thus, it is concluded that these six criteria are important and should be adopted when performing contractor prequalification practice.

Moreover, the results indicated that 13 out 42 of the subcriteria have weight equals 60.16%, which indicates their importance. These top thirteen subcriteria of weight $\geq$ 3% were ranked from the highest to lowest according to their weights as follows:

- "The Liquidity of the company" weight equals 10%.
- "The experience of the technical staff " weight equals 7.38%
- "The number , type , and condition of equipment and machinery" weight equals 5.58%
- "The company organizational structure" weight equals 5.04%
- "The adherence to the contractual obligations" weight equals 4.42%
- "The adherence to the specifications" weight equals 4.16%
- " The previous relationship between the company and the owner" weight equals 4.10%
- " The qualifications of the managerial staff" weight equals 3.60%
- "The banking facilities" weight equals 3.40%

- " The capital of the company" weight equals 3.2%
- " The health and safety policy" weight equals 3.12%
- " The number of similar projects" weight equals 3.1%
- "The number of the technical staff" weight equals 3.06%

CHAPTER FIVE

CASE STUDY

This chapter presents the results of a case study regarding large construction project in Gaza Strip. The researcher used this case in order to present the application of AHP in the prequalification process in Gaza Strip construction industry.

5.1 Project Background

The implementing agency advertised in 2005 an invitation for prequalification in the local newspapers in order to prequalify contractors to implement this project. Twelve contractors submitted their documents to the prequalification process.

The implementing agency adopted three main criteria, namely, legal status of the company, managerial and technical team, and financial and technical situation of the company and equipment. Table 5.1 shows the main and subcriteria and their weights as proposed by the implementing agency.

Table 5.1: Main criteria and subcriteria weights from the implementing agency viewpoint

Criteria	Subcriteria	Weight	
Legal status of the company (LS)	1. Commercial registration of the company (COR) 2. Record of the company tax (RT) 3. Contractors union classification (CUC) 4. Tax clearance statement (TC) 5. Projects similar to the nature of the project (PS)	1% 2% 2% 3% 2%	10%
Managerial and technical team (MT)	1. Engineer (En) 2. Foreman (F) 3. Secretary (S) 4. Accountant (AC) 5. Skilled laborer (SL) 6. Unskilled laborer (USL)	5% 2% 2% 2% 2% 2%	15%
Financial and technical situation of the company (FTS)	1. Financial status of the company (FST) 2. Amount of implemented projects in the last three years (AIP) 3. Good performance certificate in previous project (GPC) 4. Number of available trucks (NAT) 5. Number of available loaders (NAL) 6. Contractors past performance in implementing agency projects and others (CPP)	35% 10% 5% 5% 5% 15%	75%

Moreover, the implementing agency adopted basis for the evaluation process as follows:

1. The project activities are mainly transport and technical requirements are limited to safety measures.
2. It was clear that the prequalification is meant to assure mainly the financial capacity of the participating firm and their legal.
3. The Technical and administrative team was graded 10 out of 15 for all firms if there is no CVs or Contracts.
4. It was considered that the letter from supervisory firm or consultants in connection with the projects' achievements to be the recommendation letters for the firm.
5. Bank letter with reservations (acceptable collateral and irrecoverable of assignment of payments) was graded 10 out of 35 for all such cases. Such guarantee was agreed to be worthless in comparison with other statements.
6. It was agreed that the evaluation for trucks and loaders will be based on:
   a. Availability of statements & supporting documents that meet the add requirements.
   b. Availability of contracts for the rented trucks & loaders and their maintenance
7. The contractor will be qualified if he obtains more or equal 70 scores.

Table 5.2 shows the necessary data regarding the case study where twelve contractors wish to be prequalified. It is clear that each contractor submitted the available requirements in order to be prequalified for the project.

5.2 Application of AHP to the Case Study

In this section, the researcher used AHP in order to prequalify the submitted contractors. This process conducted throu1gh three steps. The first step is determining the weights of main and subcriteria of the case study is calculated by using AHP in order to be used later in the prequalification of the contractors. The second step is pairwise comparison between all contractors with respect to the main and subcriteria. The third step is determining the overall weight of all the contractors in order to determine the best contractors to participate in the tender process.

Table 5.2: Contractors data

Contractor	Legal status of the company	Technical and managerial team	Financial and technical situation of the company
C1	- Submitted commercial registration of the company - Submitted Record of the company tax - Classification: Grade 1A in roads and 1A in construction - Submitted Tax clearance statement - Three similar projects	Technical & Managerial team: 1. Project manager (1) 2. Project engineer (1) 3. Office engineer (1) 4. Foreman (1) 5. Skilled & unskilled (30) 6. Secretary (1) 7. Accountant (1)	- US$ 2,558,000 without reservation bank facility - US$ 5000,000 implemented projects in the last three years - Submitted six good performance certificate - 20 rented trucks - 2 rented loaders - Excellent past performance in owner's projects and others
C2	- Submitted commercial registration of the company - Submitted Record of the company tax - Classification: Grade 3 in roads and 1A in construction - Submitted Tax clearance statement - Three similar projects	Technical & Managerial team: 1. Project manager (1) 2. Project engineer (1) 3. Office engineer (1) 4. Foreman (1) 5. Skilled & unskilled (30) 6. Secretary (1) 7. Accountant (1)	-US$ 1,000,000 with reservation bank facility -US$ 7,500,000 implemented projects in the last three years -Submitted three good performance certificates -38 rented trucks -3 rented loaders -Satisfactory past performance in owner's projects and others
C3	- Submitted commercial registration of the company - Submitted Record of the company tax - Classification: Grade 2 in roads and 1A in construction - Submitted Tax clearance statement - One similar projects	Technical & Managerial team: 1. Project manager (1) 2. Project engineer (1) 3. Office engineer (1) 4. Foreman (1) 5. Skilled & unskilled (30) 6. Secretary (1) 7. Accountant (1)	-US$ 552,000 with reservation bank facility -US$ 1,500,000 implemented projects in the last three years -Submitted one good performance certificate -10 rented trucks -2 rented loaders -Excellent past performance in owner's projects and others
C4	-Submitted commercial registration of the company - Submitted Record of the company tax - Classification: Grade 2 in roads and 1A in construction - Submitted Tax clearance statement - Six similar projects	Technical & Managerial team: 1. Project manager (1) 2. Project engineer (1) 3. Office engineer (1) 4. Foreman (1) 5. Skilled & unskilled (30) 6. Secretary (1) 7. Accountant (1)	-US$ 5,000,000 without reservation bank facility -US$ 43,000,000 implemented projects in the last three years -Submitted five good performance certificates -23 rented trucks -2 rented loaders -Excellent past performance in owner's projects and others

Contractor	Legal status of the company	Technical and managerial team	Financial and technical situation of the company
C5	-Submitted commercial registration of the company - Submitted Record of the company tax - Classification: Grade 3 in roads and 1A in construction - Submitted Tax clearance statement - One similar projects	Technical & Managerial team: 1. Project manager (1) 2. Project engineer (1) 3. Office engineer (1) 4. Foreman (1) 5. Skilled & unskilled (30) 6. Secretary (1) 7. Accountant (1)	-US$ 1,5000,000 with reservation bank facility -US$ 1,180,000 implemented projects in the last three years -Submitted two good performance certificates -25 rented trucks -4 rented loaders -Satisfactory past performance in owner's projects and others
C6	Submitted commercial registration of the company - Submitted Record of the company tax - Classification : Grade 1A in roads and 1A in construction - Submitted Tax clearance statement -Three similar projects	Technical & Managerial team: 1. Project manager (1) 2. Project engineer (1) 3. Office engineer (1) 4. Foreman (1) 5. Skilled & unskilled (30) 6. Secretary (1) 7. Accountant (1)	-US$ 1,000,000 with reservation bank facility -US$ 6,000,000 implemented projects in the last three years -Submitted five good performance certificates -50 rented trucks -6 rented loaders -Excellent past performance in owner's projects and others
C7	-Submitted commercial registration of the company - Submitted Record of the company tax - Classification: Grade C in roads and 1A in construction - Submitted Tax clearance statement - One similar projects	Technical & Managerial team: 1. Project manager (1) 2. Project engineer (1) 3. Office engineer (1) 4. Foreman (1) 5. Skilled & unskilled (30) 6. Secretary (1) 7. Accountant (1)	-US$ 1,000,000 with reservation bank facility -US$ 6,260,000 implemented projects in the last three years -Submitted five good performance certificates -180 rented trucks -10 rented loaders -Very good past performance in owner's projects and others
C8	-Submitted commercial registration of the company - Submitted Record of the company tax - Classification: Grade 2 in roads and 1A in construction - Submitted Tax clearance statement - Three similar projects	Technical & Managerial team: 1. Project manager (1) 2. Project engineer (1) 3. Office engineer (1) 4. Foreman (1) 5. Skilled & unskilled (30) 6. Secretary (1) 7. Accountant (1)	-US$ 1,000,000 with reservation bank facility -US$ 5,870,,000 implemented projects in the last three years -Submitted three good - performance certificates -170 rented trucks -20 rented loaders -Excellent past performance in owner's projects and others

Contractor	Legal status of the company	Technical and managerial team	Financial and technical situation of the company
C9	-Submitted commercial registration of the company - Submitted Record of the company tax - Classification 1A in roads and 1A in construction - Submitted Tax clearance statement - One similar project	Technical & Managerial team: 1. Project manager (1) 2. Project engineer (1) 3. Office engineer (1) 4. Foreman (1) 5. Skilled & unskilled (30) 6. Secretary (1) 7. Accountant (1)	-US$1,000,000 without reservation bank facility -US$ 12,000,000 implemented projects in the last three years -Submitted two good performance certificates -31 rented trucks -10 rented loaders -Excellent past performance in owner's projects and others
C10	-Submitted commercial registration of the company - Submitted Record of the company tax - Classification : Grade 3 in roads and 1A in construction - Submitted Tax clearance statement - One similar project	Technical & Managerial team: 1. Project manager (1) 2. Project engineer (1) 3. Office engineer (1) 4. Foreman (1) 5. Skilled & unskilled (30) 6. Secretary (1) 7. Accountant (1)	-US$ 1,000,000 without reservation bank facility -US$ 1,270,000 implemented projects in the last three years -Submitted two good performance certificates -49 rented trucks -4 rented loaders -Excellent past performance in owner's projects and others
C11	-Submitted commercial registration of the company - Submitted Record of the company tax - Classification: Grade 1A in roads and 1A in construction - Submitted Tax clearance statement - Three similar project	Technical & Managerial team: 1. Project manager (1) 2. Project engineer (1) 3. Office engineer (1) 4. Foreman (1) 5. Skilled & unskilled (30) 6. Secretary (1) 7. Accountant (1)	-US$ 1,000,000 with reservation bank facility -US$ 500,000 implemented projects in the last three years -Submitted four good performance certificates -51 rented trucks -8 rented loaders -Satisfactory past performance in owner's projects and others
C12	-Submitted commercial registration of the company - Submitted Record of the company tax - Classification : Grade B in roads and 1A in construction - Submitted Tax clearance statement - One similar project	Technical & Managerial team: 1. Project manager (1) 2. Project engineer (1) 3. Office engineer (1) 4. Foreman (1) 5. Skilled & unskilled (30) 6. Secretary (1) 7. Accountant (1)	-US$ 1,000,000 with reservation bank facility -US$ 2,370,000 implemented projects in the last three years -Submitted three good performance certificates -36 rented trucks -6 rented loaders -Good past performance in owner's projects and others

5.2.1 Determining the Weights by AHP

In this step, the researcher used the data set by the implementing agency in Table 5.1 to determine the weights by using AHP. Accordingly, the priorities were set according to Table 2.6 and the weights of the main criteria were calculated as shown in Table 5.3. In addition, Tables 5.4, 5.5, and 5.6 shows the weights of legal status, managerial and technical team, and financial and technical situation subcriteria.

Table 5.3: Pairwise comparison matrix regarding the main criteria[a]

	LS	MTT	FTS	Priority vector (weight)
LS	1	1/2	1/7	0.092
MTT	2	1	1/6	0.154
FTS	7	6	1	0.755
				$\sum$=1.001

[a] λ max = 3.03, CI= 0.02, RI= 0.58, CR= .03 < 0.1 OK.

Table 5.4: Pairwise comparison matrix regarding legal status of the company[a]

	COR	RT	CUC	TC	PS	Priority vector (weight)
COR	1	1/2	1/2	1/3	1/2	0.098
RT	2	1	1	1/2	1	0.184
CUC	2	1	1	1/2	1	0.184
TC	3	2	2	1	2	0.349
PS	2	1	1	1/2	1	0.184
						$\sum$=0.999

[a] λ max = 5.01, CI= 0.003, RI= 1.12, CR= 0.002 < 0.1 OK.

Table 5.5: Pairwise comparison matrix for managerial and technical team[a]

	En	F	S	AC	SL	USL	Priority vector (weight)
En	1	3	3	3	3	3	0.375
F	1/3	1	1	1	1	1	0.125
S	1/3	1	1	1	1	1	0.125
AC	1/3	1	1	1	1	1	0.125
SL	1/3	1	1	1	1	1	0.125
USL	1/3	1	1	1	1	1	0.125
							$\sum$=1.0

[a] λ max = 6.0, CI= 0.0, RI= 1.24, CR= 0.0 < 0.1 OK.

Table 5.6: Pairwise comparison matrix regarding the financial and technical situation[a]

	FST	AIP	GPC	NAT	NAL	CPP	Priority vector (weight)
FST	1	4	7	7	7	3	0.486
AIP	1/4	1	2	2	2	1/2	0.122
GPC	1/7	1/2	1	1	1	1/3	0.065
NAT	1/7	1/2	1	1	1	1/3	0.065
NAL	1/7	1/2	1	1	1	1/3	0.065
CPP	1/3	2	3	3	3	1	0.197
							$\sum$=1.0

[a] λ max = 6.02, CI= 0.004, RI= 1.24, CR= 0.003 < 0.1 OK.

Table 5.7 shows the weights of main criteria and subcriteria adopted by the implementing agency based on AHP and considering the weights that indicated in Table 5.1 in order to set the priorities. It is clear that the weight that was calculated by AHP is close to great extent with that adopted by the implementing agency as shown in Table 5.1. Hence, this result confirms the importance of using AHP in setting the main and subcriteria weight, which will be very important in the first stages in the prequalification process.

Table 5.7: Main criteria and subcriteria weights based on AHP

Criteria	Subcriteria	Weight	
Legal status of the company (LS)	1. Commercial registration of the company (COR) 2. Record of the company tax (RT) 3. Contractors union classification (CUC) 4. Tax clearance statement (TC) 5. Projects similar to the nature of the project (PS)	0.90% 1.70% 1.70% 3.2% 1.70%	9.20%
Managerial and technical team (MT)	1. Engineer (En) 2. Forman (F) 3. Secretary (S) 4. Accountant (AC) 5. Skilled laborer (SL) 6. Unskilled laborer (USL)	5.80% 1.90% 1.90% 1.90% 1.90% 1.90%	15.4%
Financial and technical situation of the company (FTS)	1. Financial status of the company (FST) 2. Amount of implemented projects in the last three years (AIP) 3. Good performance certificate in previous project (GPC) 4. Number of available trucks (NAT) 5. Number of available loaders (NAL) 6. Contractors past performance in owner projects and others (CPP)	36.7% 9.20% 4.9% 4.9% 4.9% 14.9%	75.5%

5.2.2 Pairwise Comparison of the Contractors

In this step, the researcher used the contractors data indicated in Table 5.2 to start up in pairwise comparison with the three main criteria and subcriteria based on AHP approach.

5.2.2.1 Pairwise Comparison with Respect to the Legal Status

Tables 5.8, 5.9, 5.10, and 5.11 showed the contractors pairwise comparison regarding the legal status of the company. The twelve contractors were pairwise compared to obtain their priority vector (weight) with respect to the legal status of the company. The results of the commercial registration of the company, the record of the company tax, and tax clearance statement have the same priority vector since the companies provided the requirements as shown in Table 5.8 below.

Table 5.8: Contractors pairwise comparison with respect to the commercial registration of the company[a]

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Priority Vector
C1	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C2	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C3	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C4	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C5	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C6	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C7	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C8	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C9	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C10	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C11	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C12	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
													$\sum = 1.00$

[a] λ max = 12, CI= 0.0, RI= 1.49, CR= 0.0 < 0.1 OK.

Table 5.9 shows that the contractors with classification A, B, and C in roads have weights 13.93%, 8.01%, and 3.07% respectively, which prove the soundness of the judgment.

Table 5.9: Contractors pairwise comparison with respect to the classification of contractors union*

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Priority Vector
C1	1	4	2	2	4	1	4	2	1	4	1	2	0.1393
C2	1/4	1	1/3	1/3	1	1/4	1	1/3	1/4	1	1/4	1/3	0.0307
C3	1/2	3	1	1	3	1/2	3	1	1/2	3	1/2	1	0.0801
C4	1/2	3	1	1	3	1/2	3	1	1/2	3	1/2	1	0.0801
C5	1/4	1	1/3	1/3	1	1/4	1	1/3	1/4	1	1/4	1/3	0.0307
C6	1	4	2	2	4	1	4	2	1	4	1	2	0.1393
C7	1/4	1	1/3	1/3	1	1/4	1	1/3	1/4	1	1/4	1/3	0.0307
C8	1/2	3	1	1	3	1/2	3	1	1/2	3	1/2	1	0.0801
C9	1	4	2	2	4	1	4	2	1	4	1	2	0.1393
C10	1/4	1	1/3	1/3	1	1/4	1	1/3	1/4	1	1/4	1/3	0.0307
C11	1	4	2	2	4	1	4	2	1	4	1	2	0.1393
C12	1/2	3	1	1	3	1/2	3	1	1/2	3	1/2	1	0.0801
													$\sum = 1.00$

[a] λ max = 12.07, CI= 0.1, RI= 1.49, CR= 0.00 < 0.1 OK.

Table 5.10 shows the priority vector of the twelve contractors with respect to projects that are similar in nature.

Table 5.10: Contractors pairwise comparison with projects similar in nature[a]

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Priority Vector
C1	1	1	3	1/2	3	1	3	1	3	3	1	3	0.1111
C2	1	1	3	1/2	3	1	3	1	3	3	1	3	0.1111
C3	1/3	1/3	1	1/6	1	1/3	1	1/3	1	1	1/3	1	0.0370
C4	2	2	6	1	6	2	6	2	6	6	2	6	0.2222
C5	1/3	1/3	1	1/6	1	1/3	1	1/3	1	1	1/3	1	0.0370
C6	1	1	3	1/2	3	1	3	1	3	3	1	3	0.1111
C7	1/3	1/3	1	1/6	1	1/3	1	1/3	1	1	1/3	1	0.0370
C8	1	1	3	1/2	3	1	3	1	3	3	1	3	0.1111
C9	1/3	1/3	1	1/6	1	1/3	1	1/3	1	1	1/3	1	0.0370
C10	1/3	1/3	1	1/6	1	1/3	1	1/3	1	1	1/3	1	0.0370
C11	1	1	3	1/2	3	1	3	1	3	3	1	3	0.1111
C12	1/3	1/3	1	1/6	1	1/3	1	1/3	1	1	1/3	1	0.0370
													$\sum = 1.00$

[a] λ max = 12.00, CI= 0.00, RI= 1.49, CR= 0.00 < 0.1 OK.

Table 5.11: Contractors pairwise comparison with respect to the legal status of the company

	COR (0.10)	RT (0.18)	CUC (0.18)	TC (0.35)	PS (0.18)	Priority Vector (Weight)
C1	0.0833	0.0833	0.1393	0.0833	0.1111	0.0988
C2	0.0833	0.0833	0.0307	0.0833	0.1111	0.0787
C3	0.0833	0.0833	0.0801	0.0833	0.037	0.0742
C4	0.0833	0.0833	0.0801	0.0833	0.2222	0.1083
C5	0.0833	0.0833	0.0307	0.0833	0.037	0.0651
C6	0.0833	0.0833	0.1393	0.0833	0.1111	0.0988
C7	0.0833	0.0833	0.0307	0.0833	0.037	0.0651
C8	0.0833	0.0833	0.0801	0.0833	0.1111	0.0878
C9	0.0833	0.0833	0.1393	0.0833	0.037	0.0851
C10	0.0833	0.0833	0.0307	0.0833	0.037	0.0651
C11	0.0833	0.0833	0.1393	0.0833	0.1111	0.0988
C12	0.0833	0.0833	0.0801	0.0833	0.037	0.0742
						$\sum = 1.00$

Table 5.11 summarizes the weights of each contractor with respect to the legal status of the company based on the individual priority vector in each subcriterion relevant to the legal status of the company. However, it is clear that the results are relatively close and that attributed to fact of easiness of providing such requirements. The differences are attributed to differences in classification and number of similar projects.

5.2.2.2 Pairwise Comparison with Respect to the Managerial and Technical Team of the Company

Table 5.12 shows the comparison of all contractors in pairwise comparison regarding the managerial and technical team of the company. The twelve contractors were pairwise compared to obtain their priority vector with respect to the managerial and technical team of the company. It is clear that all contractors have the same priority vector where they provided all the requirement of the owner in this regard.

Table 5.12: Contractors pairwise comparison with respect to managerial and technical team[a]

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Priority Vector
C1	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C2	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C3	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C4	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C5	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C6	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C7	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C8	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C9	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C10	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C11	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
C12	1	1	1	1	1	1	1	1	1	1	1	1	0.0833
													$\sum = 1.00$

[a] λ max = 12.00, CI= 0.00, RI= 1.49, CR= 0.00 $\leq$ 0.1 OK.

5.2.2.3 Pairwise Comparison with Respect to the Financial and Technical Situation of the Company

The twelve contractors were pairwise compared to obtain their priority vector with respect to the financial and technical situation of the company as shown in Tables 5.13 to 5.19.

Table 5.13: Contractors pairwise comparison with financial status of the company[a]

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Priority Vector
C1	1	7	7	1/2	7	7	7	7	2	2	7	7	0.210
C2	1/7	1	1	1/9	1	1	1	1	1/5	1/5	1	1	0.029
C3	1/7	1	1	1/9	1	1	1	1	1/5	1/5	1	1	0.029
C4	2	9	9	1	9	9	9	9	2	2	9	9	0.277
C5	1/7	1	1	1/9	1	1	1	1	1/5	1/5	1	1	0.029
C6	1/7	1	1	1/9	1	1	1	1	1/5	1/5	1	1	0.029
C7	1/7	1	1	1/9	1	1	1	1	1/5	1/5	1	1	0.029
C8	1/7	1	1	1/9	1	1	1	1	1/5	1/5	1	1	0.029
C9	1/2	5	5	1/2	5	5	5	5	1	1	5	5	0.140
C10	1/2	5	5	1/2	5	5	5	5	1	1	5	5	0.140
C11	1/7	1	1	1/9	1	1	1	1	1/5	1/5	1	1	0.029
C12	1/7	1	1	1/9	1	1	1	1	1/5	1/5	1	1	0.029
													$\sum = 0.999$

[a] λ max = 12.03, CI= 0.003, RI= 1.49, CR= 0.002 < 0.1 OK.

Table 5.14: Contractors pairwise comparison with amount of implemented projects in the last three years[a]

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Priority Vector
C1	1	1/2	3	1/7	4	1/2	1/2	1/2	1/4	4	9	3	0.059
C2	2	1	5	1/5	7	2	2	2	1/3	6	9	4	0.107
C3	1/3	1/5	1	1/9	2	1/4	1/4	1/4	1/8	2	3	1/2	0.025
C4	7	5	9	1	9	7	6	7	4	9	9	9	0.321
C5	1/4	1/7	1/2	1/9	1	1/5	1/5	1/5	1/9	1/2	3	1/2	0.018
C6	2	1/2	4	1/7	5	1	1/2	2	1/2	5	9	3	0.080
C7	2	1/2	4	1/6	5	2	1	2	1/3	5	9	3	0.087
C8	2	1/2	4	1/7	5	1/2	1/2	1	1/3	5	9	3	0.071
C9	4	3	8	1/4	9	2	3	3	1	9	9	6	0.167
C10	1/4	1/6	1/2	1/9	2	1/5	1/5	1/5	1/9	1	3	1/3	0.020
C11	1/9	1/9	1/3	1/9	1/3	1/9	1/9	1/9	1/9	1/3	1	1/5	0.011
C12	1/3	1/4	2	1/9	2	1/3	1/3	1/3	1/6	3	5	1	0.034
													$\sum = 1.00$

[a] λ max = 12.93, CI= 0.08, RI= 1.49, CR= 0.06 < 0.1 OK.

Table 5.15: Contractors pairwise comparison regarding good performance in previous projects[a]

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Priority Vector
C1	1	2	6	2	3	2	2	2	3	3	2	2	0.167
C2	1/2	1	3	1/2	2	1/2	1/2	1	2	2	1/2	1	0.070
C3	1/6	1/3	1	1/5	1/2	1/5	1/5	1/3	1/2	1/2	1/4	1/3	0.023
C4	1/2	2	5	1	3	1	1	2	3	3	2	2	0.127
C5	1/3	1/2	2	1/3	1	1/3	1/3	1/2	1	1	1/2	1/2	0.042
C6	1/2	2	5	1	3	1	1	2	3	3	2	2	0.127
C7	1/2	2	5	1	3	1	1	2	3	3	2	2	0.127
C8	1/2	1	3	1/2	2	1/2	1/2	1	2	2	1/2	1	0.070
C9	1/3	1/2	2	1/3	1	1/3	1/3	1/2	1	1	1/2	1/2	0.042
C10	1/3	1/2	2	1/3	1	1/3	1/3	1/2	1	1	1/2	1/2	0.042
C11	1/2	2	4	1/2	2	1/2	1/2	2	2	2	1	2	0.093
C12	1/2	1	3	1/2	2	1/2	1/2	1	2	2	1/2	1	0.070
													$\sum = 1.00$

[a] λ max = 12.19, CI= 0.02, RI= 1.49, CR= 0.01 < 0.1 OK.

Table 5.16: Contractors pairwise comparison number of available trucks[a]

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Priority Vector
C1	1	1/2	2	1	1/2	1/3	1/9	1/8	1/2	1/3	1/3	1/2	0.026
C2	2	1	4	2	2	1/2	1/5	1/5	2	1/2	1/2	1	0.055
C3	1/2	1/4	1	1/3	1/3	1/5	1/9	1/9	1/3	1/5	1/5	1/4	0.016
C4	1	1/2	3	1	1	1/2	1/8	1/8	1/2	1/2	1/2	1/2	0.033
C5	2	1/2	3	1	1	1/2	1/7	1/7	1/2	1/2	1/2	1/2	0.036
C6	3	2	5	2	2	1	1/4	1/4	2	1	1	2	0.078
C7	9	5	9	8	7	4	1	1	6	4	4	5	0.252
C8	8	5	9	8	7	4	1	1	6	4	4	5	0.249
C9	2	1/2	3	2	2	1/2	1/6	1/6	1	1/2	1/2	1	0.046
C10	3	2	5	2	2	1	1/4	1/4	2	1	1	1/2	0.071
C11	3	2	5	2	2	1	1/4	1/4	2	1	1	1/2	0.071
C12	2	1	4	2	2	1/2	1/5	1/5	1	2	2	1	0.067
													$\sum = 1.00$

[a] λ max = 12.4, CI= 0.04, RI= 1.49, CR= 0.02 < 0.1 OK.

Table 5.17: Contractors pairwise comparison number of available loaders[a]

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Priority Vector
C1	1	1/2	1	1	1/2	1/3	1/5	1/9	1/5	1/2	1/4	1/3	0.025
C2	2	1	2	2	1/2	1/2	1/4	1/7	1/4	1/2	1/3	1/2	0.038
C3	1	1/2	1	1	1/2	1/3	1/5	1/9	1/5	1/2	1/4	1/3	0.025
C4	1	1/2	1	1	1/2	1/3	1/5	1/9	1/5	1/2	1/4	1/3	0.025
C5	2	2	2	2	1	1/2	1/3	1/5	1/3	1	1/2	1/2	0.049
C6	3	2	3	3	2	1	1/2	1/4	1/2	2	1/2	1	0.074
C7	5	4	5	5	3	2	1	1/2	1	3	2	2	0.141
C8	9	7	9	9	5	4	2	1	2	5	3	4	0.258
C9	5	4	5	5	3	2	1	1/2	1	3	2	2	0.141
C10	2	2	2	2	1	1/2	1/3	1/5	1/3	1	1/2	1/2	0.049
C11	4	3	4	4	2	2	1/2	1/3	1/2	2	1	2	0.101
C12	3	2	3	3	2	1	1/2	1/4	1/2	2	1/2	1	0.074
													$\sum = 1.00$

[a] λ max = 12.15, CI= 0.01, RI= 1.49, CR= 0.01 < 0.1 OK.

Table 5.18: Contractors pairwise comparison regarding past performance in the implementing agency projects and others[a]

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Priority Vector
C1	1	9	1	1	9	1	2	1	1	1	9	3	0.122
C2	1/9	1	1/9	1/9	1	1/9	1/5	1/9	1/9	1/9	1	1/3	0.014
C3	1	9	1	1	9	1	2	1	1	1	9	3	0.122
C4	1	9	1	1	9	1	2	1	1	1	9	3	0.122
C5	1/9	1	1/9	1/9	1	1/9	1/5	1/9	1/9	1/9	1	1/3	0.014
C6	1	9	1	1	9	1	2	1	1	1	9	3	0.122
C7	1/2	5	1/2	1/2	5	1/2	1	1/2	1/2	1/2	5	2	0.064
C8	1	9	1	1	9	1	2	1	1	1	9	3	0.122
C9	1	9	1	1	9	1	2	1	1	1	9	3	0.122
C10	1	9	1	1	9	1	2	1	1	1	9	3	0.122
C11	1/9	1	1/9	1/9	1	1/9	1/5	1/9	1/9	1/9	1	1/3	0.014
C12	1/3	3	1/3	1/3	3	1/3	1/2	1/3	1/3	1/3	3	1	0.040
													$\sum = 1.00$

[a] λ max = 12.01, CI= 0.0006, RI= 1.49, CR= 0.0004 < 0.1 OK.

Table 5.19: Priority matrix of the financial and technical situation of the company

	FST (0.486)	**AIP** (0.122)	**GPC** (0.065)	**NAT** (0.065)	**NAL** (0.065)	**CPP** (0.197)	**Priority Vector (Weight)**
C1	0.210	0.059	0.167	0.026	0.025	0.122	0.148
C2	0.029	0.107	0.070	0.055	0.038	0.014	0.041
C3	0.029	0.025	0.023	0.016	0.025	0.122	0.045
C4	0.277	0.321	0.127	0.033	0.025	0.122	0.210
C5	0.029	0.018	0.042	0.036	0.049	0.014	0.027
C6	0.029	0.080	0.127	0.078	0.074	0.122	0.066
C7	0.029	0.087	0.127	0.252	0.141	0.064	0.071
C8	0.029	0.071	0.070	0.249	0.258	0.122	0.084
C9	0.140	0.167	0.042	0.046	0.141	0.122	0.127
C10	0.140	0.020	0.042	0.071	0.049	0.122	0.105
C11	0.029	0.011	0.093	0.071	0.101	0.014	0.035
C12	0.029	0.034	0.070	0.067	0.074	0.040	0.040
							$\sum = 0.999$

5.2.3 AHP Results Regarding the Prequalification of the Contractors

Table 5.20 shows the results of the contractors' pairwise comparison with respect to the three main criteria based on AHP.

Table 5.20: Priority matrix of contractors prequalification

	LS (9.2%)	MT (15.4%)	FTS (75.5%)	Overall priority vector	Rank
C1	0.099	0.083	0.147	13.3%	2
C2	0.079	0.083	0.04	5.0%	9
C3	0.074	0.083	0.045	5.4%	8
C4	0.108	0.083	0.21	18.1%	1
C5	0.065	0.083	0.027	3.9%	12
C6	0.099	0.083	0.066	7.2%	6
C7	0.065	0.083	0.071	7.2%	6
C8	0.088	0.083	0.084	8.4%	5
C9	0.085	0.083	0.127	11.7%	3
C10	0.065	0.083	0.105	9.8%	4
C11	0.099	0.083	0.035	4.8%	11
C12	0.074	0.083	0.04	5.0%	9
				$\sum = 100\%$	

5.3 Results Discussion

Table 5.20 summarizes all the different comparisons with respect to the main criteria that established by the implementing agency. For prequalification purpose, the contractors are now ranked according to their overall priority based on AHP approach, as follows: C4, C1, C9, C10, C8, C6, C7, C2, C3, C11, C12, and C5. The results indicate that C4 is the best-qualified contractor to perform the project. However, the over all priority of contractors gave sound judgment to solve such complex issues.

It is clear that all contractors have nearly close results with respect to legal status, and technical and managerial team of the company. On the other hand, the financial and technical situation of the company seems to be the decisive criterion where its weight equal 75.5%, which greatly influenced the results. For example, the priority vector of C4, C1, and C9 with respect to financial and technical situation was 0.21, 0.147, and 0.127 respectively, which reflect the soundness of AHP approach.

Accordingly, the implementing agency can invite C4, C1, C9, C10, and C8 to participate in the tendering process of the project. In addition, the implementing agency can extend the list to include C6, and C7 where they achieved reasonable results, which will permit seven contractors to participate in the tendering process. Moreover, comparing the results of the case study, which was summarized in Table 5.20 with the data of contractor in Table 5.2, it can be concluded that AHP approach is logic and applicable approach to be adopted in the construction industry in Gaza Strip.

Table 5.21 shows a comparison between the results obtained by AHP approach and the scores that calculated by the implementing agency. It is clear that the rank of contractors obtained by AHP approach to large extent consistent with that obtained by the scores method.

The only tangible difference was in C9 that was ranked 3 by AHP while it was ranked 1 by the implementing agency. Table 5.22 shows comparison between C4 was that ranked 1 by AHP and C9 that was ranked 1 by the implement agency by using scores method. It was obvious that C9 is better than C4 in most of the subcriteria of financial and technical situation of the company that represent the bulk weight (75%) of the main criteria as shown in Table 5.1. The financial status of the company; amount of implemented projects in the last three years; good performance certificate in previous project; contractors past performance in implementing agency projects and others that represents 65% out of 75% which doubtlessly confirm that C9 is better than C4 and AHP is sound approach.

Table 5.21: Comparison between AHP results and the implementing agency scores

	Overall priority vector by AHP	Rank by AHP	Scores by Implementing Agency	Rank by Implementing Agency
C4	18.1%	1	94	1
C1	13.3%	2	87	3
C9	11.7%	3	94	1
C10	9.8%	4	87	4
C8	8.4%	5	75	5
C6	7.2%	6	70	6
C7	7.2%	6	72	6
C3	5.4%	8	60	8
C2	5.0%	9	55	9
C12	5.0%	9	53	10
C11	4.8%	11	51	11
C5	3.9%	12	45	12

Table 5.22: Comparison between C4 and C9 with respect to financial and technical situation

Subcriteria	Weight	C4[a]	C9[b]
FST	35%	US$ 5,000,000 without reservation bank facility	US$1,000,000 without reservation bank facility
AIP	10%	US$ 43,000,000 implemented projects in the last three years	US$ 12,000,000 implemented projects in the last three years
GPC	5%	Submitted five good performance certificates	Submitted two good performance certificates
NAT	5%	23 rented trucks	31 rented trucks
NAL	5%	2 rented loaders	10 rented loaders
CPP	15%	Excellent past performance in owner's projects and others	Excellent past performance in owner's projects and others

[a] C9 ranked 1 by AHP, [b] C4 ranked 1 by the implementing agency

5.4 Conclusion

The results of the case study confirmed that AHP based on scientific basis and it is to large extent free from bias and intuition in the scores method. In addition, the results reflect the extent of reliability of AHP where all the contractors were pairwise compared with respect to all the adopted criteria upon the data in Table 5.2. Moreover, all the comparison matrices were subjected to the inconsistency check, which indicated the soundness of the judgments.

The case study presents a decision-analysis modeling technique for the prequalification process of contractors compared with the prevailing method used in Gaza Strip, which represented in the score method. AHP provides a tool for selecting the most qualified contractors in an easy, fast, and low-cost approach. It enables the decision-makers to use all the necessary information they have about contractors, as well as their knowledge and expertise and incorporate them to the tool to evaluate and rate the potential contractors. It incorporates all necessary information about the contractor in a very systematic, numerical, and verbal approach. Such approach leads to durable calculated results.

CHAPTER SIX
CSP SOFTWARE

6.1 Introduction

This chapter presents the computerized software based on AHP developed to help the implementing agencies in improving their prequalification practices in Gaza Strip. In addition, it describes the software components, and the method of use. The software implementation and evaluation are also discussed.

6.2 Concepts

It is found that the prequalification process needs improvements to be more scientific by using one ore more of the available quantitative approaches. AHP has been found as one of the suitable approaches for this purpose. Hence, the researcher developed software based on AHP approach to help the owners in the prequalification process and the selection of the contractors. The researcher named this software Contractors Selection Program (CSP).

The software was developed by using "Visual Basic" programming language. Visual Basic was originally created to make it easier to write programs for the Windows computer operating system. Moreover, Visual Basic is the most widely used computer programming system in the history of software. The software was designed to be flexible and easy to use. This chapter presents concepts, description, implementation, and evaluation of the software. Ahuja et al. (1994) summarize the criteria for selection a software system as follows:

1. The software must be relatively easy to install and operate. The input data must be easy to prepare, and the output reports must be understandable.
2. Data sorting is one of the basic uses of computers.
3. The program should be flexible and have the capacity for handling many types of application.
4. The database must contain all the necessary elements so it can be managed to generate the desired information reports.
5. The program should be compatible with other programs and systems in use in the company.

6.3 Program Description

CSP program must be run under Win2000/XP. The user runs the program by double click on its icon that is located typically in the CSP folder (Figure 6.1).

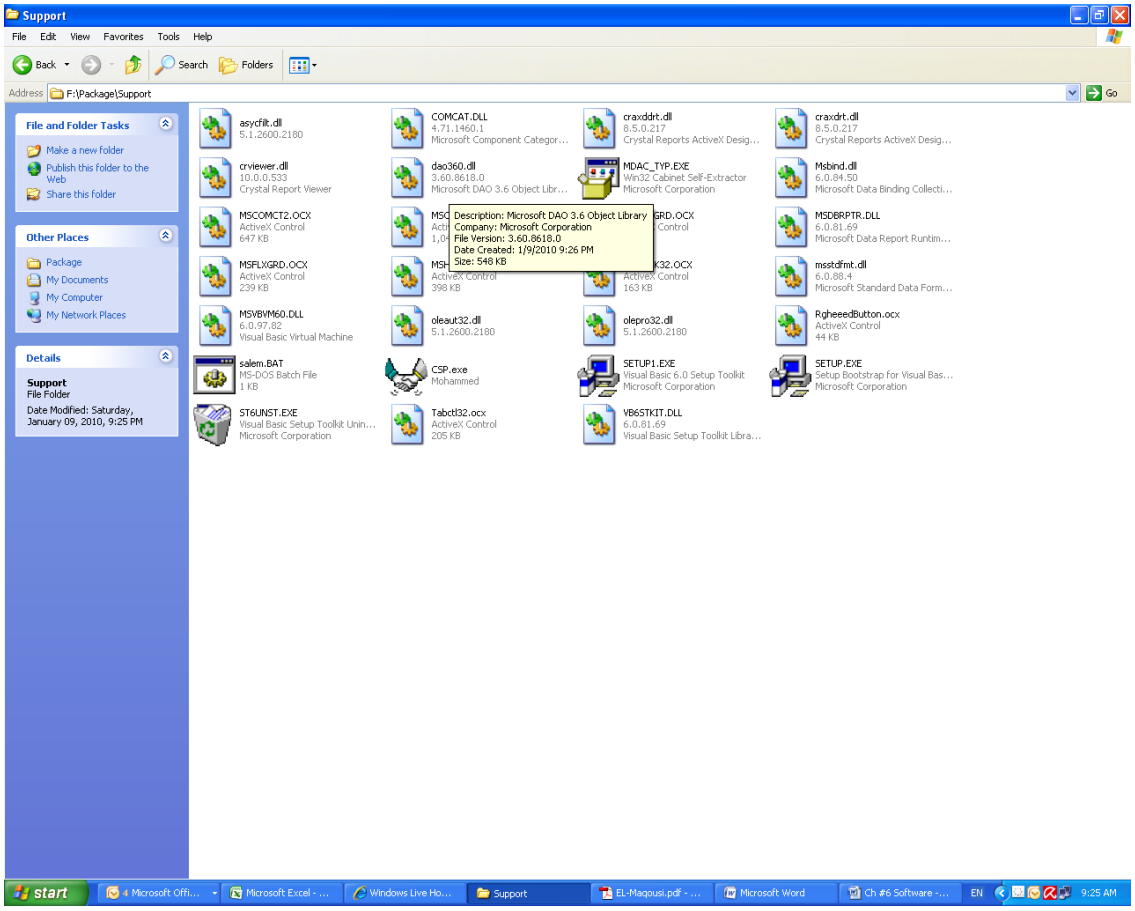

Figure 6.1: Entering to CSP

CSP begins with an introductory screen (Figure 6.2). By clicking on OK button, the main input screen will be displayed (see Figure 6.3). At the top of the main input screen, the menu bar is clear and consists of three choices, namely, file, record, and program. By clicking on record, the data entry sheet is displayed. By clicking on data entry, two tabs screen will appear as shown in Figure 6.4 and Figure 6.5.

Figure 6.2: CSP Interface

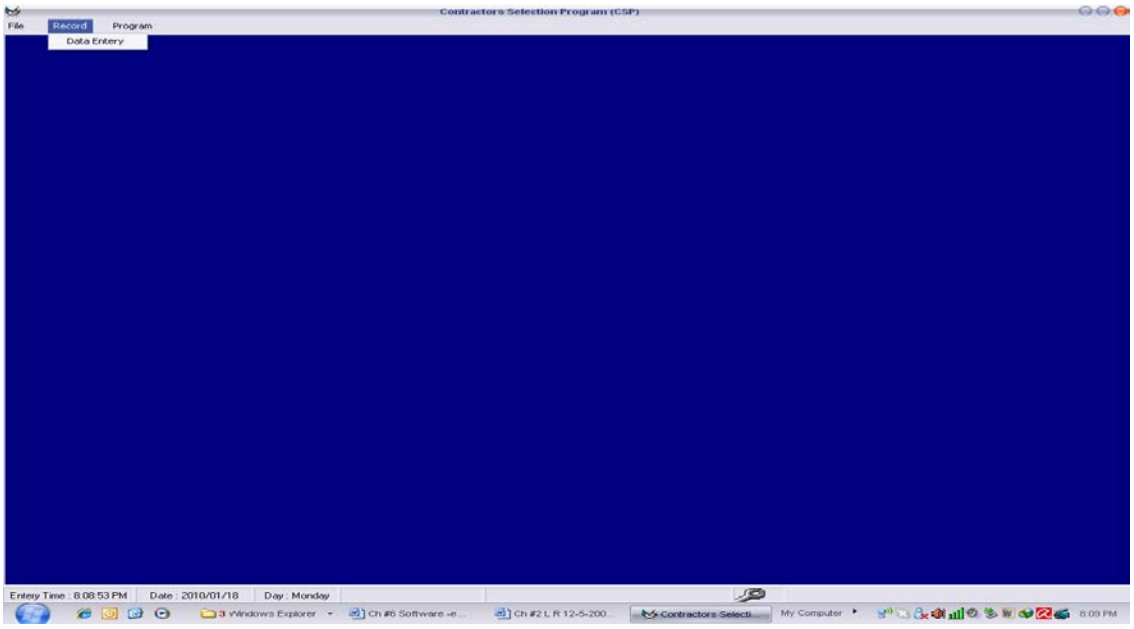

Figure 6.3: CSP main input screen

When the user finishes using CSP, and he/she wants to return to Windows, he/she must click on the close button in the top right corner of the screen or file in order to exit.

The application consists of two tabs and they are:

6.3.1 First Tab (Input main criteria)

Figure 6.4 shows the first screen, which has the main input screen regarding the main prequalification criteria. Entry is mainly done through three text boxes regarding the project name, goal name, and criteria number. In addition, there is a combo box regarding the comparison priorities. Add, modify, and delete facilities are also available at a convenient disposal of the user.

Moreover, default 2*2 matrix appears and its size depends on the number of criteria entered as will be discussed in the implementation later. The entry of cells will be also discussed through the implementation of the software. The "Print" button will manage the user to browse and print the results report regarding the weights of the criteria used in the process. In addition, the consistency ratio is calculated and its value appears at the top of the table just the user complete entering the priorities.

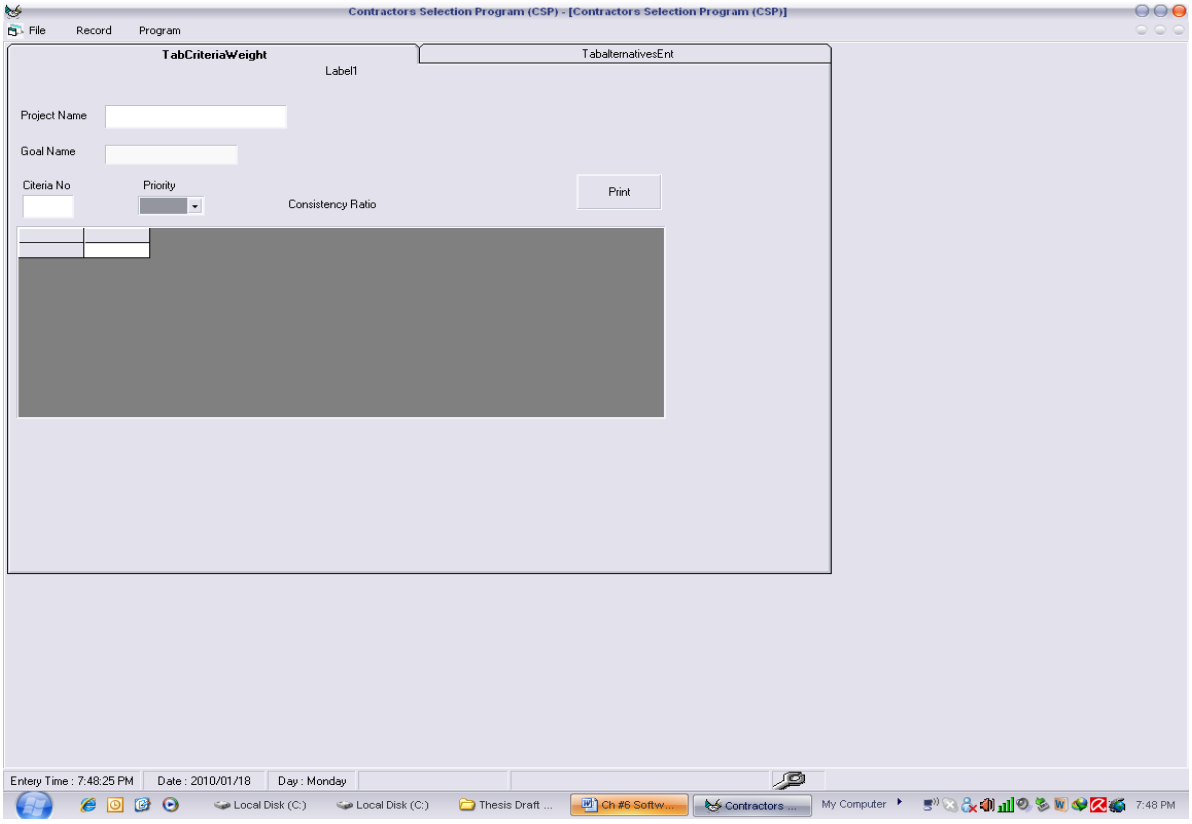

Figure 6.4: First tab of CSP software

6.3.2 Second Tab (Input comparison entry)

Figure 6.4 shows CSP second tab. Entry is done through text box regarding the name of companies to be prequalified. In addition, there is combo box regarding the priorities used in the pairwise comparison of the companies with respect to the main criteria in the first tab. Add, modify, and delete facilities are also available at a convenient disposal of the user. Moreover, an additional column will appear just the entry of cells including the weights (priority vector) of each criterion with respect to the goal

In addition, two default 2*2 matrices appear. The size of the top matrix depends on the number of companies to be pairwise compared as will be discussed in the implementation later. The button "New Comparison" manages the user to conduct all the required

pairwise comparisons with respect to main criteria entered in the first tab. By clicking on "New Comparison", the weights of the pairwise comparison will be transferred to the lower matrix. After conducting all the comparisons, the overall priority values appear and a message appears to highlight the completion of the process and the "Print" button is activated.

The "Print" button manages the user to browse and print the results report regarding the comparison process in order to select the best one or group based on the results listed under the overall priority.

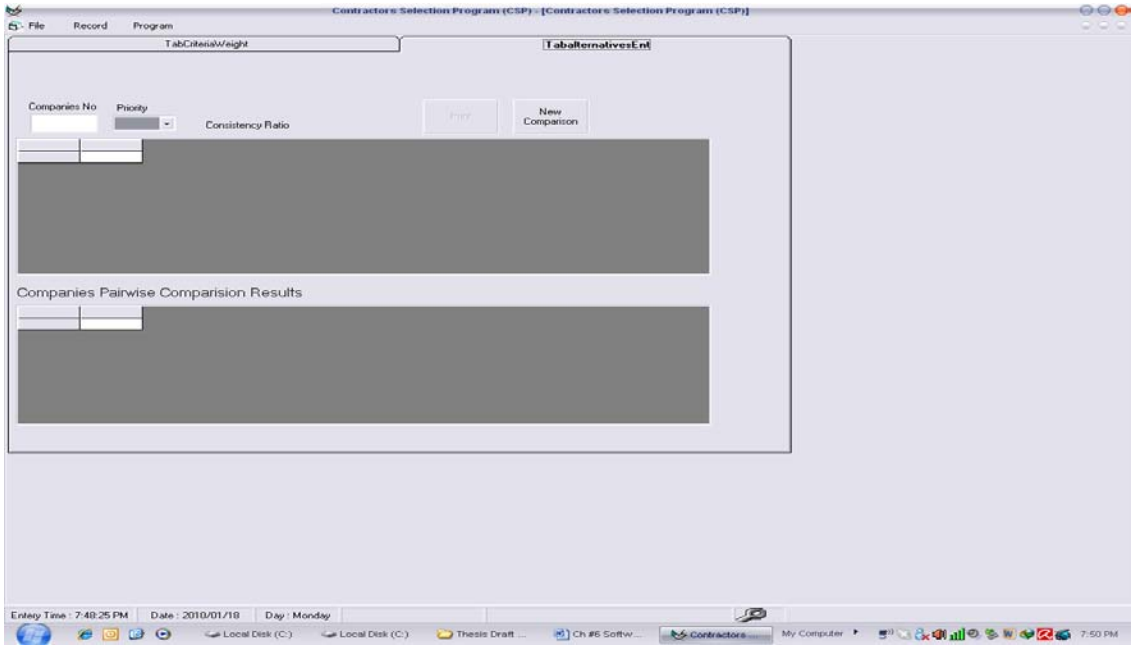

Figure 6.5: Second tab of CSP software

6.4 CSP Implementation

The researcher finds that the best way to explain the system functions is by applying it on an example. The selected example was that found in Al-Harbi (2001).This makes it easier for the researcher to explain and for the reader to understand (See Figure 6.6).

Figure 6.7 shows the first tab containing the entries. In this tab, the user enters the project name, the process goal, the number of the criteria, and the description of the criteria. Accordingly, CSP will create matrix its size equal the number of criteria. The user will commence entering the data regarding the priorities of criteria upon the numerical rating shown in Table 2.6.

The user can enter the cell values regarding the priorities by clicking on its cell then rotating the mouse wheel to choose the priority, which appear in the priority combo from 1 to 9 and (-2) to (-9). In case of negative values in the priority combo, the numerical rating will appear as positive fraction of the inverse value in the cells of the top matrix.

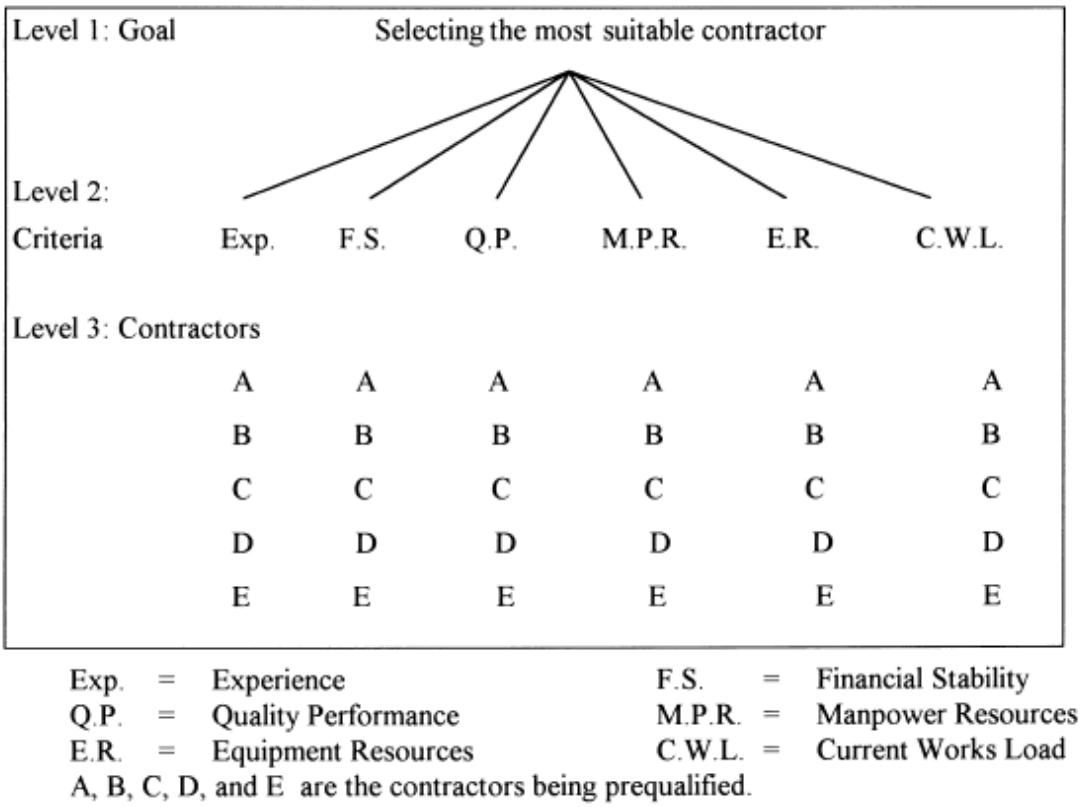

Figure 6.6: Hierarchy of the project example (Al-Harbi, 2001)

The first step as shown in Figure 6.7 shows the pairwise comparison of the six main criteria in the example. However, CSP calculated the weights of the main criteria, as it is clear in the eighth column. In addition, the CPS calculates the consistency index when the priorities entry is completed. By clicking "Print" button, a brief report appeared regarding the criteria weights and its consistency (see Figure 6.8).

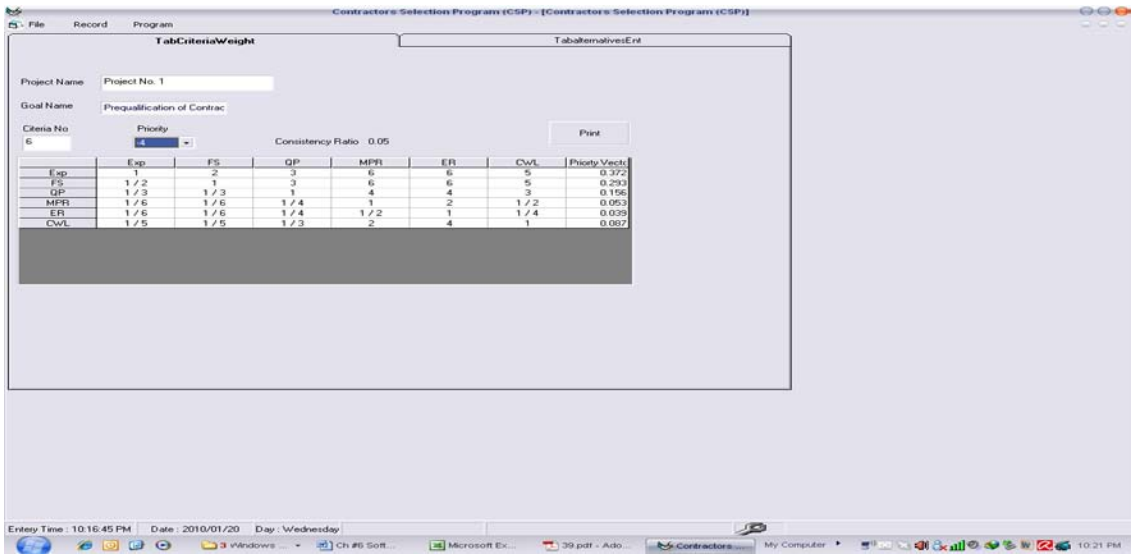

Figure 6.7: First tab with its entries

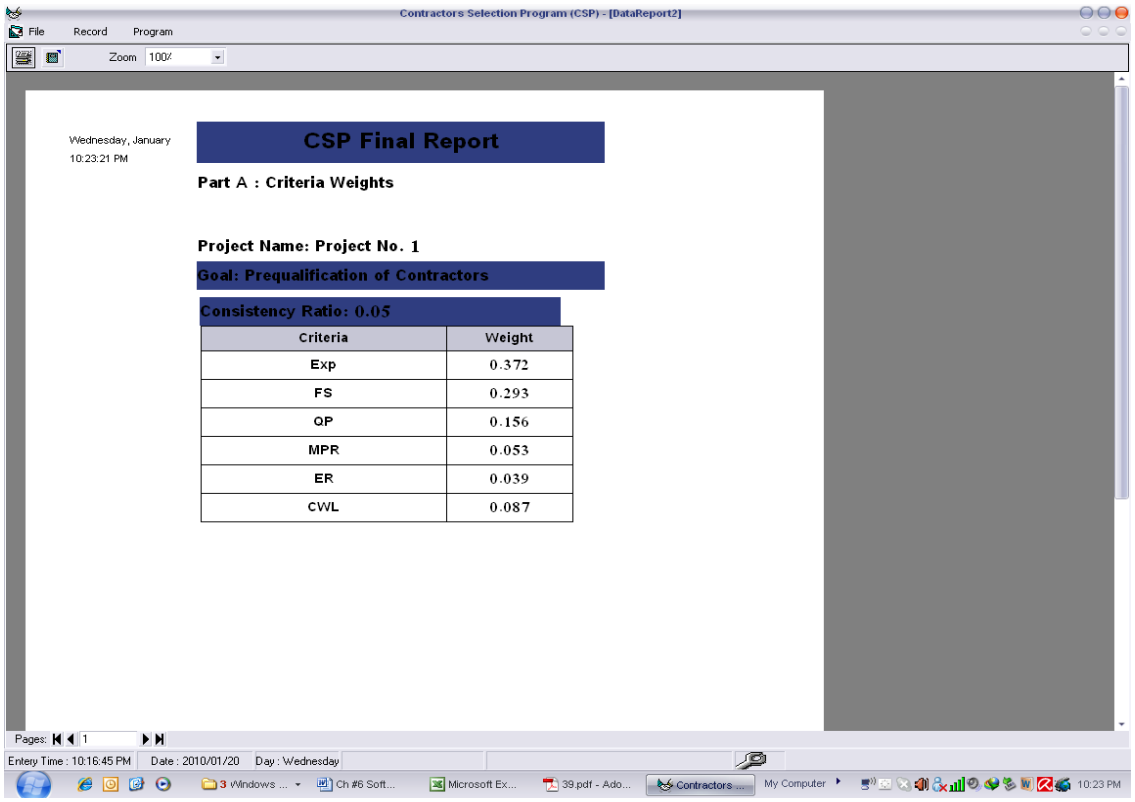

Figure 6.8: Criteria weights output

The second step is to click on the second tab in order to commence the pairwise comparison of the companies with respect to the main criteria. CPS will start the comparison with respect to the experience and calculates the weights and the consistency index in process. Figure 6.9 shows the first comparison with respect to the experience. After completing the comparison with respect to the experience and clicking "New

Comparison" button, a new comparison will start with respect to the following criterion according to the entry in the first tab. In addition, the priority vector (weight) with respect to the experience will be transferred to the bottom matrix and so forth as shown in Figures from 6.10 to 6.14. When the user complete the last comparison with respect to the current works load and click on "New Comparison" button, a message of "The comparisons completed" appear and the "Print" button is activated as in Figure 6.14. By clicking on "Print" button, a report contains the overall priority with respect to the prequalification criteria will appear as shown in Figure 6.15.

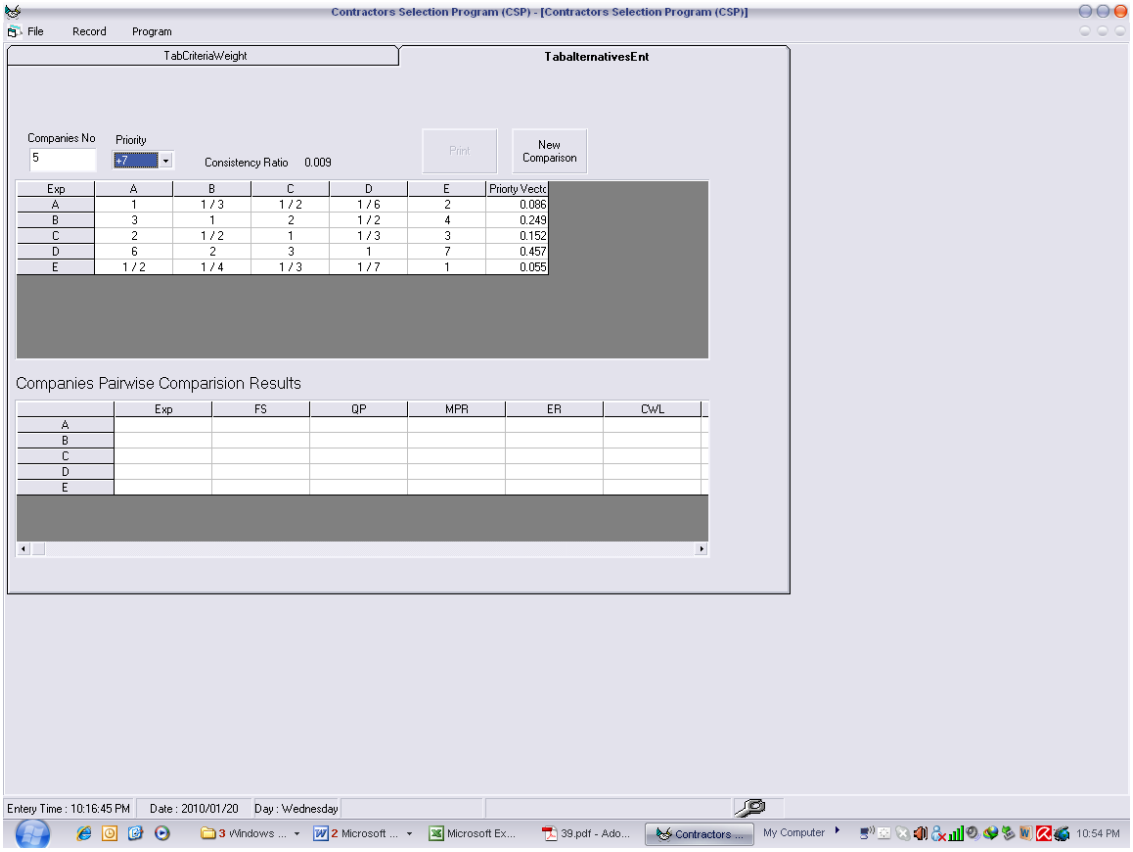

Figure 6.9: Pairwise comparison with respect to the experience

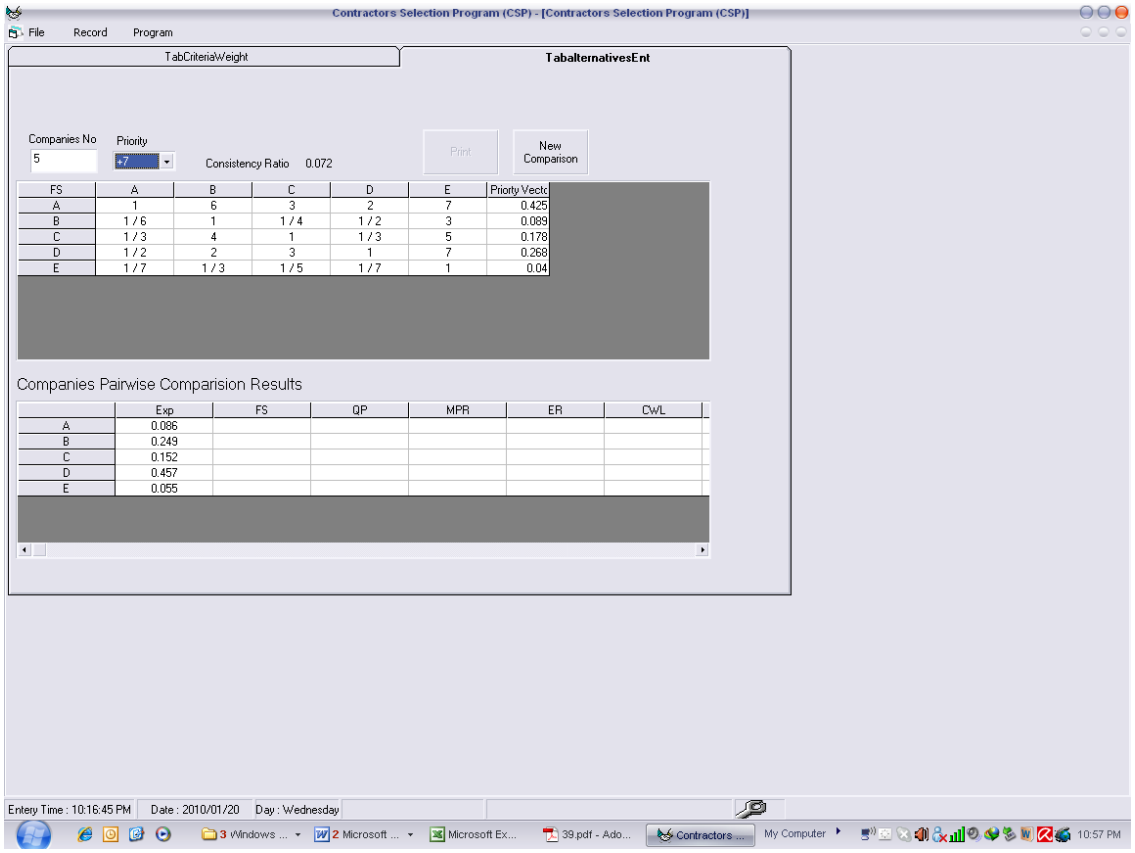

Figure 6.10: Pairwise comparison with respect to the financial stability

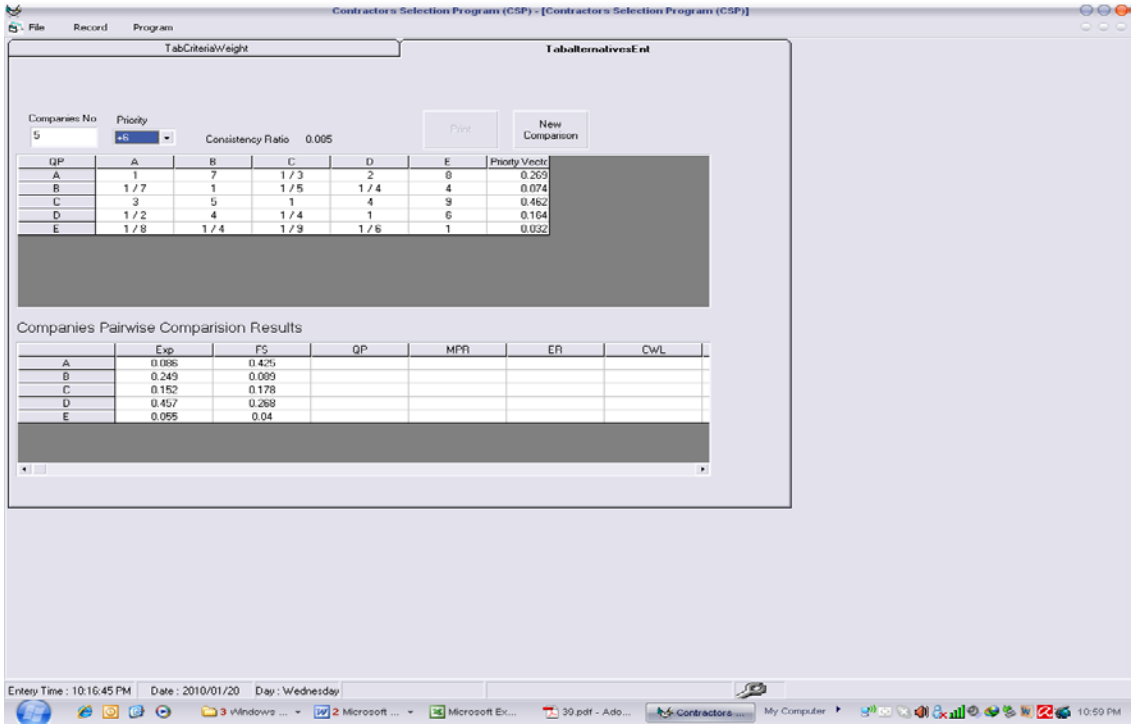

Figure 6.11: Pairwise comparison with respect to the quality performance

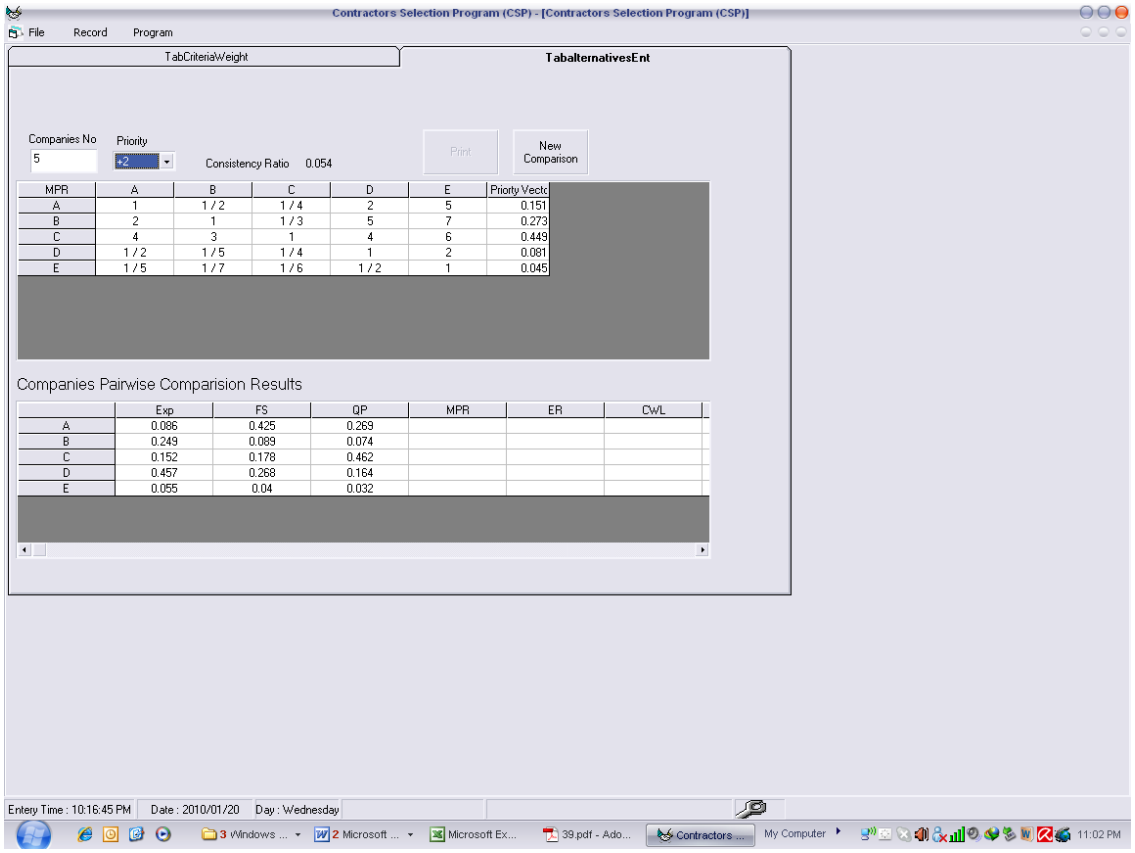

Figure 6.12: Pairwise comparison with respect to the manpower resources

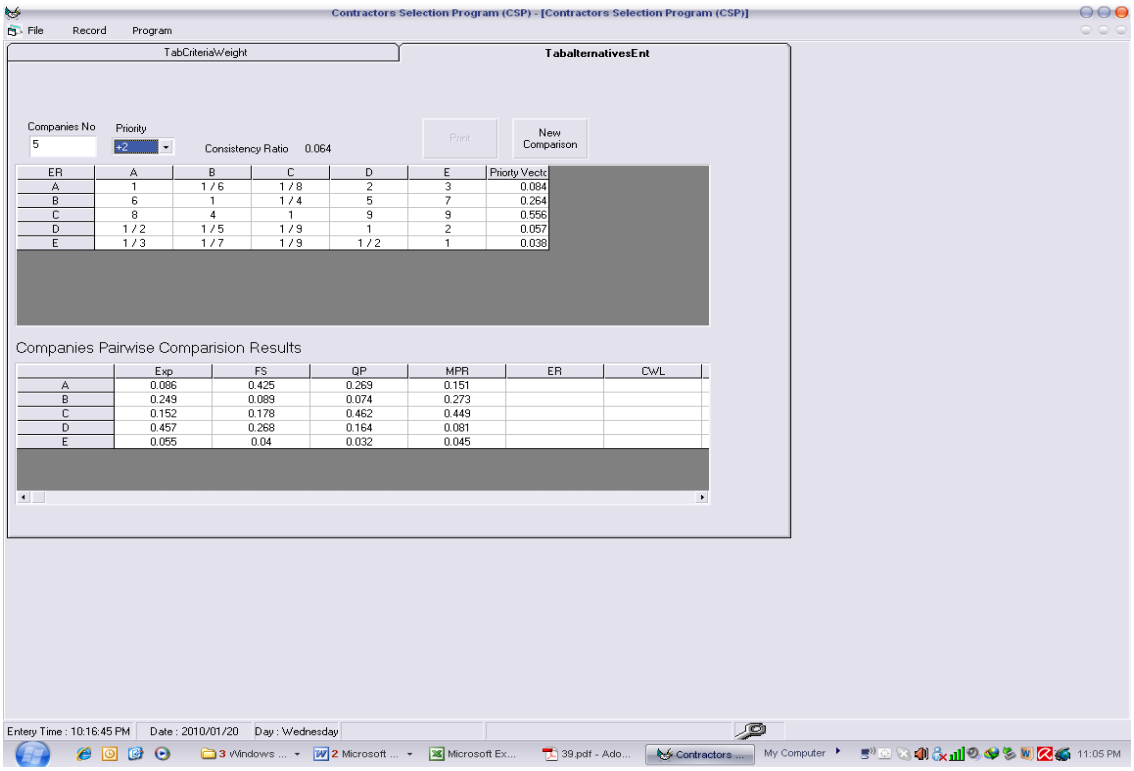

Figure 6.13: Pairwise comparison with respect to the Equipment Resources

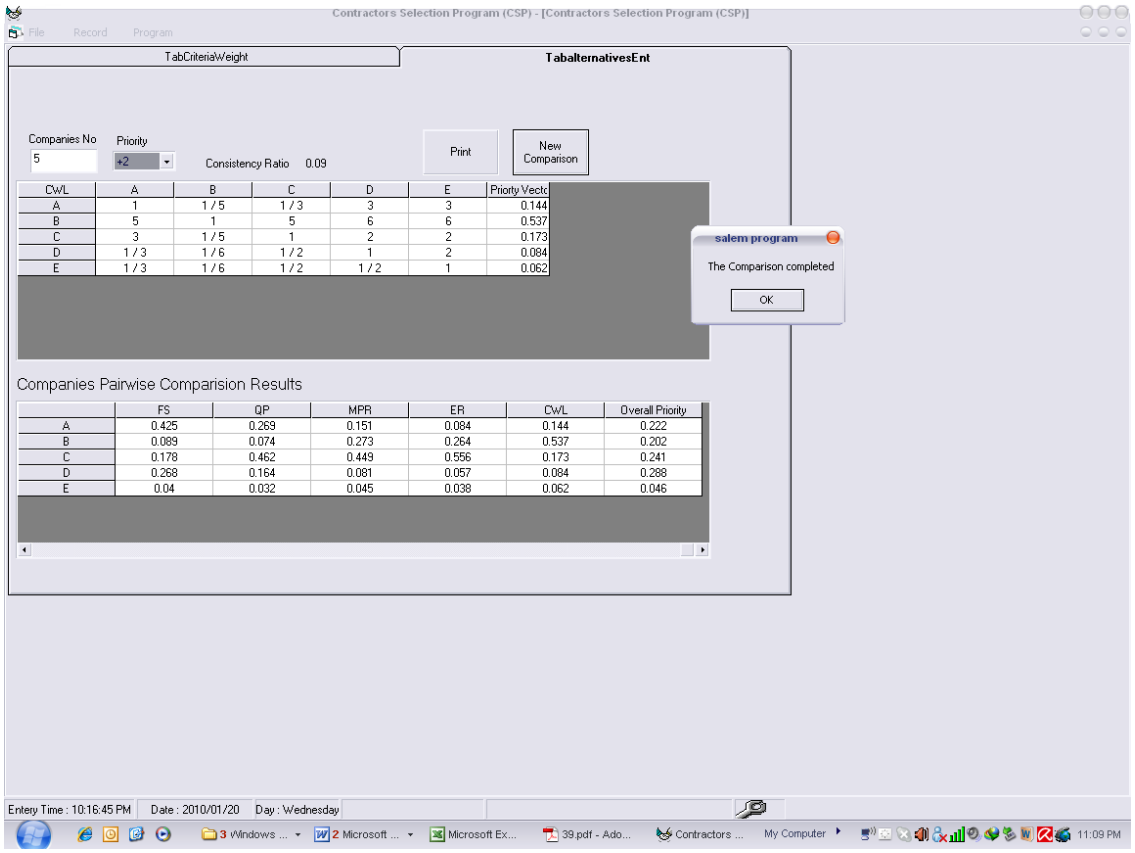

Figure 6.14: Pairwise comparison with respect to the current workload

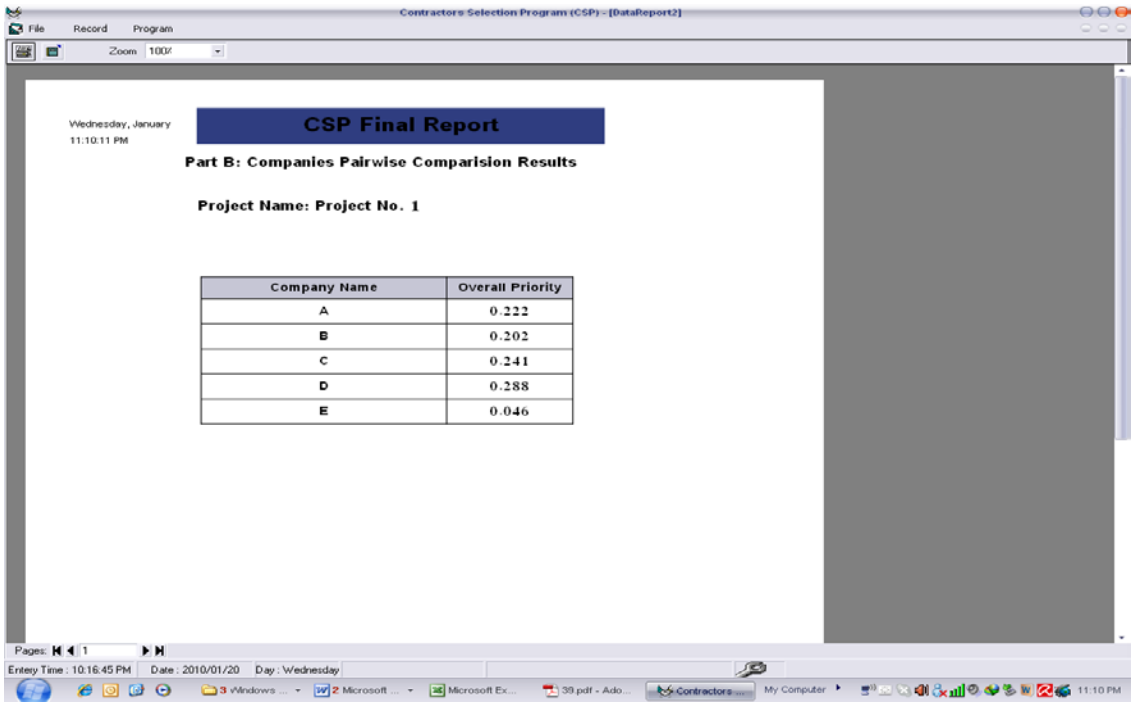

Figure 6.15: The overall priority with respect to the prequalification criteria

6.5 CSP Results Discussion

Tables 6.1 to 6.8 show comparison between the results in the previous section that was obtained by using CSP software and that calculated manually by Al-Harbi (2001). There were negligible deviations especially in the consistent ratio that refer to the round off through processing the data. The priority vector and overall priority vector are completely agreed in both CSP and Al-Harbi (2001) in selecting the best contractors.

It is clear that CSP software gave the same results that obtained by Al-Harbi (2001) which indicates that CSP is efficient software and can be used in prequalification process.

Table 6.1: CSP and Al-Harbi (2001) results with respect to the main criteria

Criteria	**Priority Vector**	
	CSP [a]	**Al-Harbi (2001)** [b]
Exp.	0.372	0.372
FS	0.293	0.293
QP	0.156	0.156
MPR	0.053	0.053
ER	0.039	0.039
CWL	0.087	0.087

[a] CR= 0.05 < 0.1 OK.; [b] CR= 0.05 < 0.1 OK

Table 6.2: CSP and Al-Harbi (2001) results with respect to the experience

Exp.	**Priority Vector**	
	CSP [a]	**Al-Harbi (2001)** [b]
A	0.086	0.086
B	0.249	0.249
C	0.152	0.152
D	0.457	0.457
E	0.055	0.055

[a] CR= 0.009 < 0.1 OK.; [b] CR= 0.0082 < 0.1 OK

Table 6.3: CSP and Al-Harbi (2001) results with respect to the financial stability

FS	Priority Vector	
	CSP [a]	Al-Harbi (2001) [b]
A	0.425	0.425
B	0.089	0.089
C	0.178	0.178
D	0.268	0.268
E	0.04	0.04

[a] CR= 0.072 < 0.1 OK.; [b] CR= 0.071 < 0.1 OK

Table 6.4: CSP and Al-Harbi (2001) results with respect to the quality performance

QP	Priority Vector	
	CSP [a]	Al-Harbi (2001) [b]
A	0.269	0.269
B	0.074	0.074
C	0.462	0.462
D	0.164	0.164
E	0.032	0.032

[a] CR= 0.085 < 0.1 OK.; [b] CR= 0.085 < 0.1 OK

Table 6.5: CSP and Al-Harbi (2001) results with respect to the manpower resources

MPR	Priority Vector	
	CSP [a]	Al-Harbi (2001) [b]
A	0.151	0.151
B	0.273	0.273
C	0.449	0.449
D	0.081	0.081
E	0.045	0.045

[a] CR= 0.054 < 0.1 OK.; [b] CR= 0.053 < 0.1 OK

Table 6.6: CSP and Al-Harbi (2001) results with respect to the equipment resources

ER	Priority Vector	
	CSP [a]	Al-Harbi (2001) [b]
A	0.084	0.084
B	0.264	0.264
C	0.556	0.556
D	0.057	0.057
E	0.380	0.380

[a] CR= 0.064 < 0.1 OK.; [b] CR= 0.063< 0.1 OK

Table 6.7: CSP and Al-Harbi (2001) results with respect to the current works load

CWL	Priority Vector	
	CSP [a]	Al-Harbi (2001) [b]
A	0.144	0.144
B	0.537	0.537
C	0.173	0.173
D	0.084	0.084
E	0.062	0.062

[a] CR= 0.09 < 0.1 OK.; [b] CR= 0.089 < 0.1 OK

Table 6.8: CSP and Al-Harbi (2001) results with respect to overall priority vector

Contractor	Overall Priority Vector	
	CSP	Al-Harbi (2001)
A	0.222	0.222
B	0.202	0.201
C	0.241	0.241
D	0.288	0.288
E	0.046	0.046

6.6 CSP Evaluation

Sargent (2000) stated that the face validity is used as a test for model evaluation. Face validity is represented in asking acknowledged and well-experienced people regarding the system whether the model and/or its behavior are reasonable.

6.6.1 Evaluation Objectives

The software evaluation objectives should consider the following:

- to evaluate the performance of prequalification of contractors;
- to verify the suitability of software design and structure;
- to allocate the software difficulties that meet the user and try to avoid them;
- to consider the evaluators' comments;
- and to explore the software advantages.

6.6.2 Evaluation Methodology

The researcher used this technique by asking five implementing agencies engineers who are experts in construction projects and involved in prequalification and evaluation process of contractors. The researcher asked them to give their points of view in CSP software and about its input-output relationships.

In addition, all steps have been explained to the evaluators regarding using, operating, and reading results. The researcher gave a copy of the evaluation questionnaire for each one of them to fill in. A questionnaire is mainly designed to get a feedback regarding CSP software performance and its benefits in addition to respondents' comments as shown in Annex 3.

6.6.3 Evaluators' Comments and Suggestions

Table 6.9 illustrates the evaluators' responses to the features of CSP design and structure. The results show that four evaluators agreed that CSP contributes in improving the prequalification process while the other strongly agreed. Regarding the contribution of CSP in developing the construction industry in Gaza Strip, just three evaluators out five are agreed. Moreover, one strongly agreed and four agreed that CSP provides the possibility of contractors prequalification in proper and scientific manner.

The results show that most evaluators agreed on CSP suitability for all types of projects. In addition, most of the evaluators are agreed that CSP is convincing to be applied by the owners and implementing agencies.

It is clear that all evaluators have positive attitudes towards CSP features regarding the easiness in use, flexibility, and results readability. Moreover, four evaluators out five agreed that CSP saves time and effort in the prequalification process. Finally, three evaluators are strongly agreed and two agreed that CSP is suitable for small and large projects.

In general, the results shown in Table 6.8 indicates that the respondents show high attitudes towards CSP where the average mean (86%), which reflects its importance in the prequalification of contractors in Gaza Strip.

Some of evaluators mentioned that CSP is considered an efficient tool to overcome the problems of traditional practices, which lacks objectivity especially in establishing the scores/weights of the used prequalification criteria. Others mentioned that by using CSP, the prequalification of contractors would be faster and easier than other local practices. In addition, they recommended giving training in this regard to be familiar with it.

Regarding the advantages of CSP, there was consensus among the evaluators that CSP can facilitate and speed the prequalification process. In addition, they mentioned CSP

provides the weights of the criteria based on scientific approach as well as the pairwise comparison among the companies.

Table 6.9: CSP performance as expressed by evaluators*

No.	Techniques	No. of respondents					Weighted Mean %
		S.A	A	N	D	S.D	
1	The software contributes in improving the process of prequalification	1	4				84%
2	Assist in the development of the construction industry in Gaza Strip		3	2			72%
3	Provide the possibility of contractors prequalification in proper and scientific manner	1	4				84%
4	Suitable for all types of projects		5				80%
5	Convincing to be applied by the owners and implementing agencies	2	2	1			84%
6	Contribute in increasing the dependence on computers in projects management		4	1			76%
7	The program is easy to use	4	1				96%
8	The program is flexible and the inputs can be easily modified	3	2				92%
9	The results can be read easily and clearly	4	1				96%
10	Displays the results clearly	3	2				92%
11	Saves time and effort in the prequalification process	1	4				84%
12	Suitable for small projects	3	2				92%
13	Suitable for large projects	3	2				92%
Average mean %							**86%**

*(**S.A**= Strongly Agree, **A**= Agree, **N**= Neutral, **D**= Disagree, **S.D**= Strongly Disagree)

Regarding the evaluators' suggestions, most of evaluators recommended that CSP could be developed further to include models/templates for specific industries to serve other sectors. Two evaluators advised for development another version in Arabic language. In addition, all the evaluators suggested using CSP in the awarding process in case of postqualification practices, which are widely used in construction industry in Gaza Strip.

CHAPTER SEVEN
CONCLUSION AND RECOMMENDATION

7.1 Introduction

This chapter introduces the research conclusions and recommendations for many parties involved in the construction process to improve the local practices in the prequalification process. Recommendations for further studies are also included.

7.2 Conclusion

1) Building, water and wastewater, and roads represented the bulk of implemented projects by the implementing agencies in Gaza Strip.
2) Over the past five years, most projects executed were large-scale projects. This may be a result of the Israeli withdrawal from Gaza Strip, which has encouraged the donor countries to pump contributions to the Palestinian people for the reconstruction in the various areas. However, it is important to highlight that this study actually represents just the first three years where the last two years can be classified as idle years due the Israeli siege on Gaza Strip that forced most of the implementing agencies to terminate all contracts for the ongoing projects at this period.
3) The Palestinian Contractors Union (PCU) classification is considered as the essence for the implementing agencies in Gaza Strip. This may refer to the nature of projects, which has become similar in the different field as well as the nature of some implementing agencies that have not the technical ability to exercise the prequalification process. In addition, the restrictions imposed by PCU have prevented some of the implementing agencies to conduct prequalification process.
4) It was found that 40% of the respondents' organizations sometimes exercise the prequalification process, 45% rarely exercise the prequalification process, and 15% has never exercised the prequalification process. Exercising prequalification may be referred to the size and nature of the projects upon which the implementing agencies decide to exercise it or depend on PCU classification. Accordingly, the findings show the high tendency toward exercising the prequalification process especially in projects that needs special experience, technical abilities, and financial stability.
5) There is a consensus amongst the implementing agencies on the importance of the proposed prequalification criteria. The findings showed high degree of agreement

between the different implementing agencies toward the proposed prequalification criteria.

6) Based on AHP, the prequalification criteria weights are as follows: financial stability (20%); technical ability (18%); past performance (13%); management capabilities (12%); experience (10%); and reputation (10%).On the other hand, claims and contractual disputes (6%); health and safety procedures (6%); and current workload (4%). Accordingly, the financial stability represents the overriding criterion that meets the researcher expectations. In addition, technical ability, past performance, management capabilities, experience, and reputation can represent practical prequalification criteria. From the results, researcher set prequalification criteria for the construction industry in Gaza Strip after neglecting all the marginal subcriteria and normalizing the remaining subcriteria weights as shown in Table 7.1.
7) It was found that 13 out 42 of the subcriteria have weight equals 60%, namely, the liquidation of the company; the experience of the technical staff; the number, type, and condition of equipment and machinery; the company organizational structure; the adherence to the contractual obligations; the adherence to the specifications; the previous relationship between the company and the owner; the qualifications of the managerial staff; the banking facilities; the capital of the company; the health and safety policy; the number of similar projects; and the number of the technical staff.
8) The findings have agreed with several local and global previous studies in this field, which enrich and represent a strength point for this research.
9) Hierarchical method of analysis used in this study, provided an effective tool to measure the weights of criteria through pairwise comparison of all the proposed criteria as it was clear in the case study. In addition, it is more efficiently than local techniques or methods, which depend on the weights given directly to the criteria without a real examination for their relevance compared to other criteria.
10) AHP provides a tool for selecting the most qualified contractors in an easy, fast, and low-cost approach. It enables the decision-makers to use all the necessary information they have about contractors, as well as their knowledge and expertise and incorporate them to the tool to evaluate and rate the potential contractors. It incorporates all necessary information about the contractor in a very systematic, numerical, and verbal approach. Such approach leads to durable calculated results.

Table 7.1: Recommended Prequalification criteria and its weights

Criteria	Subcriteria	Weight
Financial Stability	1. Liquidity of the Company	10.00%
	2. Banking Facilities	3.40%
	3. Annual Turnover	2.20%
	4. Debt volume	1.20%
	5. Capital of the company	3.20%
Technical Ability	1.The experience of the technical staff	7.61%
	2.The number , type , and condition of equipment and machinery	5.75%
	3.The number of the technical staff	3.15%
	4.Capital of equipment and machinery	1.48%
Management Capabilities	1.Company organizational structure	5.73%
	2.Qualifications of the managerial staff	4.09%
	3.Availability of monitoring , tracking, and evaluation system	2.18%
Past Performance	1. Adherence to the contractual obligations	4.75%
	2. Adherence to the specifications	4.47%
	3. Track Record of the company	2.37%
	4. Adherence to the contractual period	1.54%
Experience	1. Number of similar projects	4.13%
	2. Type of projects implemented	2.40%
	3. Amount of projects implemented	1.87%
	4. Number of projects implemented	1.60%
Reputation	1.The previous relationship with the current owner	4.51%
	2.Company size and classification	2.86%
	3.The previous relationship with other owners	2.64%
Health and Safety	1.Health and safety policy	3.12%
	2.Health and safety records in the previous projects	0.84%
	2.Health and safety training programs	2.04%
Claims and Disputes	1.Response in finding solutions to claims and disputes	2.94%
	2.The tendency of company towards the claims	1.86%
	3.Number of claims in the previous projects	1.20%
Current Work Load	1.Number of current projects	2.08%
	2.Amount of current projects	1.36%
	3.Type of current projects	0.56%

7.3 Recommendation to the Parties Involved in the Construction

1) Researcher recommends using the prequalification criteria of financial stability, technical ability, past performance, management capabilities, experience, reputation, and health and safety procedures in this study as a basis in the prequalification process of contractors in the construction industry in Gaza Strip. Moreover, it is recommended to consider the other criteria of claims and contractual disputes, and current workload in the awarding stage.
2) The implementing agencies is recommended to establish comprehensive and database regarding contractors who dealt with them with respect to their financial abilities, experience, performance etc. in order to be the basis of any prequalification process in future. This step will save a lot of time and manage the owners to select the best-qualified contractors. Moreover, it will enforce the contractors to improve their performance, which in turn will share in improving the construction industry in Gaza Strip.
3) The implementing agencies are recommended to establish prequalification committee consisting from all the parties that interested in the implementation of the specific projects. The committee is recommended to include implementing agency, stakeholder, municipality, and the Ministry of Public Works and Housing in order to guarantee the success of the project.
4) Encouraging the implementing agencies to use AHP in the prequalification process and helping them to understand and apply AHP approach by initiating training workshops.
5) AHP approach, in addition to its efficiency in prequalification process, can be developed further to use in the evaluation process in the awarding stage.

7.4 Recommendation for Further Studies

1) Researchers are invited to exercise more efforts in order to obtain unified prequalification criteria for each sector such as buildings, roads, and water and sewage water individually to ensure the main goals of owners in the construction industry in Gaza Strip.
2) Conducting studies on projects, which used of prequalification and others adopted the classification of union contractors and evaluate the performance, cost, time, and quality.
3) Study the possibility of using methods other than AHP in the prequalification process for contractors. In addition, study the possibility of merging AHP with other methods in order to obtain improved results.

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Annex 1

Questionnaire #1 (Arabic Version)

الجامعة الإسلامية–غزة
قسم الهندسة المدنية

استبيان

حول تحديد معايير التأهيل المسبق للمقاولين في قطاع التشييد في قطاع غزة

جزء من البحث التكميلي لنيل درجة الماجستير

في إدارة التشييد

الباحث /م سـالم يوسـف الـوحيدي

المشرف /د .نبيل الصوالحي

أغسطس /2009

استبيان

حول تحديد معايير التأهيل المسبق للمقاولين في قطاع التشييد في قطاع غزة

الأخ الكريم/الأخت الكريمة:

- يرجى التكرم بتعبئة هذا الاستبيان بتروي و بعناية قدر الإمكان وذلك للتعرف على كافة الآراء و وجهات النظر المتعلقة بهذا الموضوع الهام ، مع ملاحظة أن جميع المعلومات في هذا الاستبيان سوف تستخدم في أغراض البحث العلمي فقط.
- ونتقدم لكم بوافر الشكر على مشاركتكم في إثراء هذا البحث الذي يشكل جزءا من رسالة الماجستير.

مقدمة:

من المعروف لجميع العاملين و المشاركين في قطاع التشييد أن عملية اختيار المقاول الأنسب هي من أهم المحطات في حياة المشروع لما سيكون لها من أثر واضح في تحقيق أهداف المالك الرئيسة الثلاث و المتعلقة في الجودة و التكلفة و الوقت و كذلك لما لها من أثر إيجابي بخصوص اختيار المقاولين المشاركين حيث يتم استبعاد المقاولين غير المؤهلين مما يجنبهم و يجنب المالك الكثير من المخاطر المستقبلية . و مع تباين الطرق و الاليات المستخدمة لاختيار المقاولين في قطاع التشييد في قطاع غزة و التي تعتمد بالأساس على استراتيجية الجهات المنفذة و المستفيدة من المشاريع و المتأثرة في أغلب الأحيان بسياسات الجهات الممولة للمشاريع المختلفة في قطاع غزة برزت الحاجة لتحديد مجموعة من المعايير الرئيسة و المعايير الثانوية و التي تم تحديدها عبر مراجعة الأدبيات المتعلقة بالموضوع في العقدين الأخيرين و في دول مختلفة في جميع أنحاء العالم لعملية التأهيل المسبق لمقاولي التشييد و كذلك أخذ اراء الخبراء المحليين بخصوص ذلك.

ومن هنا تبرز أهمية هذا الاستبيان الذي سيحدد العوامل المؤثرة في عملية التأهيل المسبق للمقاولين و ذلك من خلال استدراج أراء أصحاب الاختصاص و الخبرة في الجهات المالكة (حكومية وغير حكومية) و مكاتب استشارية بغرض تحديد معايير للاختيار في قطاع التشييد وذلك بما يتناسب مع واقعنا المحلي والعمل على تطبيقها واستخدامها بشكل أشمل في عملية التأهيل المسبق للمقاولين في المشاريع المستقبلية.

أولا : معلومات عامة:

1-ما هو الوصف المناسب للمؤسسة التي تعمل بها ؟

☐ مؤسسة حكومية ☐ بلدية ☐ منظمة غير حكومية

☐ منظمة دولية ☐ استشاري ☐ جهة أخرى ، رجاء التوضيح _____

2-حدد طبيعة المشاريع التي تم تنفيذها عبر مؤسستكم؟

☐ مباني ☐ مياه و صرف صحي ☐ طرق

☐ مشاريع أخرى ، رجاء التوضيح _____

3-حدد حجم المشاريع التي نفذت عبر مؤسستكم خلال الخمس سنوات الماضية ؟

☐ 1 مليون $ فأقل ☐ 1.1 – 3 مليون $ ☐ 3.1 – 6 مليون $

☐ 6.1- 12مليون $ ☐ أكثر من 12 مليون $

4-ما هو الوصف الأنسب لطبيعة عملك في المؤسسة التي تعمل فيها ؟

☐ مدير مشروع ☐ مهندس مشرف ☐ مدير دائرة

☐ استشاري ☐ متخصص في العطاءات ☐ طبيعة عمل أخرى، رجاء التوضيح _____

5-حدد عدد سنوات خبرتك العملية؟

☐ 5 سنوات فأقل ☐ 6-10 سنوات ☐ 11-15 سنة

☐ 16-20 سنة ☐ أكثر من 20 سنة

6- هل تعتمد مؤسستك على تصنيف اتحاد المقاولين كبديل عن عملية التأهيل المسبق؟

☐ دائما ☐ غالبا ☐ أحيانا ☐ نادرا ☐ مطلقا

7-هل سبق أن قامت مؤسستك بعملية تأهيل مسبق للمقاولين ؟

☐ دائما ☐ غالبا ☐ أحيانا ☐ نادرا ☐ مطلقا

ثانيا: تحديد العوامل التي تؤثر في عملية التأهيل المسبق للمقاولين :

الرجاء تحديد أهمية العوامل التي تؤثر في عملية اختيار المقاولين بوضع إشارة " x " في الخانة لتعبر عن مدى الأهمية، كذلك وضع أي عوامل أخرى ترى إضافتها.

مجموعة (1) : العوامل المتعلقة بالاستقرار المالي للشركة

العامـــــــل المؤثر	مهم جدا	مهم	متوسط الأهمية	قليل الأهمية	عديم الأهمية
– رأس مال الشركة					
– الحجم المالي السنوي الدوار للشركة (Annual Turnover)					
– التسهيلات البنكية التي تحصل عليها الشركة					
– السيولة المالية للشركة					
– حجم ديون الشركة					

مجموعة (2) : العوامل المتعلقة بالقدرات الإدارية للشركة

العامـــــــل المؤثر	مهم جدا	مهم	متوسط الأهمية	قليل الأهمية	عديم الأهمية
– وجود هيكل تنظيمي مناسب للشركة					
–وجود إستراتيجية متكاملة للشركة					
– مؤهلات الطاقم الإداري للشركة					
– وجود نظام تدريبي للطاقم الإداري في الشركة					
– استخدام أنظمة محوسبة في الإدارة					
– توفر نظام مراقبة و متابعة و تقييم في الشركة					

مجموعة (3) : العوامل المتعلقة بخبرة الشركة

العامـــــــل المؤثر	مهم جدا	مهم	متوسط الأهمية	قليل الأهمية	عديم الأهمية
– عدد المشروعات التى نفذتها الشركة					
– قيمة المشروعات التي نفذتها الشركة					
– نوعية المشاريع التي نفذتها الشركة					
– خبرة الشركة في تنفيذ مشاريع مشابهة					
– قدرة الشركة على مواجهة مشاكل التنفيذ					
–قدرة الشركة على تحديد و إدارة المخاطر					
– عدد سنوات خبرة الشركة					
– الخبرة المحلية للشركة					

مجموعة (4) : العوامل المتعلقة بالأداء السابق الشركة

العامـــــــل المؤثر	مهم جدا	مهم	متوسط الأهمية	قليل الأهمية	عديم الأهمية
– التزام الشركة بتنفيذ المشاريع ضمن المدة التعاقدية					
– التزام الشركة بتنفيذ المشاريع ضمن الميزانية المخصصة					
– سجلات نجاح الشركة في تنفيذ المشاريع					
– الالتزام بالمواصفات في تنفيذ المشاريع					
– التقيد بالالتزامات التعاقدية					

مجموعة (5) : العوامل المتعلقة بالقدرة الفنية للشركة

العامـــــــل المؤثر	مهم جدا	مهم	متوسط الأهمية	قليل الأهمية	عديم الأهمية
– عدد و نوعية و حالة المعدات و الاليات					
–رأس مال المعدات و الاليات					
– عدد الطاقم الفنية					
–خبرة الطواقم الفنية					
– توفر نظام تدريبي للعمالة					
– الوسائل التكنولوجية المستخدمة من قبل الشركة في تنفيذ المشاريع					

مجموعة (6) : العوامل المتعلقة بسمعة الشركة

العامـــــــل المؤثر	مهم جدا	مهم	متوسط الأهمية	قليل الأهمية	عديم الأهمية
– تصنيف الشركة (درجة أولى ، ثانية ، الخ)					
– تنوع مجالات تخصص الشـــركة (مبـــاني ، ميـــاه و صـــرف صحي،...الخ)					
– حجم الشركة (كبيرة، متوسطة ، صغيرة)					
– العلاقة السابقة بين الشركة و الجهة المالكة					
– العلاقة السابقة بين الشركة و الجهات المالكة الأخرى					

مجموعة (7) : العوامل المتعلقة بإجراءات الصحة و السلامة في الشركة

العامـــــــل المؤثر	مهم جدا	مهم	متوسط الأهمية	قليل الأهمية	عديم الأهمية
– وجود سياسة للشركة في مجال الصحة و السلامة مع معايير لضبط العمل					
– وجود برامج تدريبية في مجال الصحة و السلامة					
– سجلات الصحة و السلامة للشركة في تنفيذ المشاريع السابقة					

مجموعة (8) : العوامل المتعلقة بالمطالبات و النزاعات التعاقدية

العامـــــــل المؤثر	مهم جدا	مهم	متوسط الأهمية	قليل الأهمية	عديم الأهمية
– ميل الشركة تجاه المطالبات و التشديد في الأمور التعاقدية					
– تجاوب الشركة في إيجاد الحلول للمطالبات و النزاعات					
– كثرة المطالبات في المشاريع السابقة					

مجموعة (9) : العوامل المتعلقة بمدى إنشغال الشركة حاليا

العامـــــــل المؤثر	مهم جدا	مهم	متوسط الأهمية	قليل الأهمية	عديم الأهمية
– عدد المشاريع التي تنفذها الشركة حاليا					
– نوعية المشاريع الحالية التي تنفذها الشركة					
– قيمة المشاريع الحالية التي تنفذها الشركة					
– نسبة الأعمال الحالية التي يتم تنفيذها بالباطن					

Annex 2

Questionnaire #1 (English Version)

Part 1: General Information

1- What is the proper description of your organization?

☐ Governmental Organization ☐ Municipality ☐ NGO

☐ International Organization ☐ Consultant Firm ☐ Others, Please Specify_____

2- Specify the types of projects implemented by your organization?

☐ Buildings ☐ Water and Wastewater ☐ Roads

☐ Others, Please Specify_____

3-Specify the average annual value for the projects implemented through your organization over the past five years?

☐ Less than 1 Million Dollars ☐ 1.1 - 3 Million Dollars ☐ 3.1 - 6 Million Dollars

☐ 6.1 - 12 Million Dollars ☐ More than 12 Million Dollars

4- Which is the best description of your occupation in your organization?

☐ Project Manager ☐ Supervisor Engineer ☐ Head of Department

☐ Consultant ☐ Procurement Specialist ☐ Others, Please Specify_____

5- Specify the number of years of your practical experience

☐ Less than 5 years ☐ 6-10 years ☐ 11-15 years

☐ 16-20 years ☐ More than 20 years

6- Does your organization depend on the classification of the Contractors Union as an alternative to the prequalification process?

☐ Always ☐ Frequently ☐ Sometimes ☐ Rarely ☐ Never

7- Have your organization ever practiced the prequalification process for the contractors?

☐ Always ☐ Frequently ☐ Sometimes ☐ Rarely ☐ Never

Part 2: Identification of the factors that affect the prequalification process of the contractors:

Please specify the importance of the factors that affect the process of selection of contractors by marking "x" in the box to reflect its importance.

Group (1): The factors related to the financial stability of the company

Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance
The capital of the company					
The annual turnover of the company					
The banking facilities provided by the company					
The liquidation of the company					
The debt volume of the company					

Group (2): factors related to the management capabilities of the company

Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance
The existence of an appropriate organizational structure for the company					
The existence of an integrated strategy for the company					
The qualifications of the managerial staff of the company					
The availability of training system for managerial staff in the company					
The use of computerized systems in the management					
The availability of monitoring , tracking, and evaluation system in the company					

Group (3): The factors related to the experience of the company

Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance
The number of projects implemented by the					
The amount of projects implemented by the					
The type of projects implemented by the					
The experience of the company in implementing					
The ability of the company to cope with the problems					
The ability of the company to identify and manage risks					
The number of years in construction					
The local experience of the company					

Group (4): The factors related to the past performance of the company

Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance
The adherence to the contractual period in the implementation of projects					
The adherence to the allocated budget in the implementation of projects					
The track Records of the company in the implementation of projects					
The adherence to the specifications in the implementation of projects					
The adherence to the contractual obligations					

Group (5): The factors related to the technical ability the company

Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance
The number , type , and condition of equipment and machinery					
The capital of equipment and machinery					
The number of the technical staff					
The experience of the technical staff					
The availability of training system for labor					
The technological means used by the company in the implementation of projects					

Group (6): The factors related to the reputation of the company

Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance
The company classification					
The diversity of specialization fields of the company					
The size of the company					
The previous relationship between the company and the owner					
The previous relationship between the company and other owners					

Group (7): The factors related to health and safety procedures in the company

Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance
The existence of policy for the company in the field of health and safety standards to control the work					
The existence of training programs in the field of health and safety					
Health and safety records of the company in the implementation of previous projects					

Group (8): The factors related to claims and contractual disputes

Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance
The tendency of company towards the claims and intransigence in contractual issues					
The company response in finding solutions to claims and disputes					
The number of claims in the previous projects					

Group (9): The factors related to the current workload of the company

Affecting Factor	Very Important	Important	Medium Importance	Low Importance	No Importance
The number of current projects implemented by the company					
The type of current projects implemented by the company					
The amount of current projects implemented by the company					
The percentage of current projects subcontracted					

Annex 3

Questionnaire # 2 (Arabic Version)

الجامعة الإسلامية–غزة
قسم الهندسة المدنية

استبيان رقم (2)

حول تحديد أوزان المعايير الرئيسية و الفرعية لمعايير التأهيل المسبق للمقاولين في قطاع التشييد في قطاع غزة باستخدام عملية التحليل الهرمي

جزء من البحث التكميلي لنيل درجة الماجستير
في إدارة التشييد

الباحث /م سـالم يوسـف الـوحيدي

المشرف /د .نبيـل الصوالحـي

نوفمبر /2009

استبيان رقم (2)

حول تحديد أوزان المعايير الرئيسية و الفرعية لمعايير التأهيل المسبق للمقاولين في قطاع التشييد باستخدام عملية التحليل الهرمي

- الأخ الكريم/الأخت الكريمة يرجى التكرم بتعبئة هذا الاستبيان بتروي و بعناية قدر الإمكان وذلك للتعرف على كافة الآراء و وجهات النظر المتعلقة بهذا الموضوع الهام ، مع ملاحظة أن جميع المعلومات في هذا الاستبيان سوف تستخدم في أغراض البحث العلمي فقط.
- ونتقدم لكم بوافر الشكر على مشاركتكم في إثراء هذا البحث الذي يعتبر من متطلبات إعداد مشروع التخرج الخاص برسالة الماجستير في إدارة التشييد.

مقدمة:

من المعروف لجميع العاملين و المشاركين في قطاع التشييد أن عملية اختيار المقاول الأنسب هي من أهم مراحل حياة المشروع لما سيكون له من أثر واضح في تحقيق أهداف المالك و كذلك لما لها من أثر إيجابي بخصوص المقاولين المشاركين حيث يتم استبعاد المقاولين غير المؤهلين مما يجنبهم و يجنب المالك أي أخطار محتملة . و مع تباين الطرق و الآليات المستخدمة في قطاع التشييد في قطاع غزة و التي تعتمد بالأساس على إستراتيجية الجهات المنفذة و المستفيدة من المشاريع و المتأثرة في أغلب الأحيان بسياسات الجهات الممولة للمشاريع المختلفة في قطاع غزة فأنه من المفيد لهذه الصناعة تقديم هذا النموذج و التي يعتمد على عملية التحليل الهرمي كطريقة بديلة للطرق المستخدمة في عملية تأهيل المقاولين المسبقة لما لها من استخدامات واسعة و ناجحة في مجالات الاقتصاد و السياسة و اتخاذ القرارات.

و من هنا برزت الحاجة لتحديد مجموعة من المعايير الرئيسية و المعايير الفرعية و التي تم تحديدها عبر المراجعة الأدبية لدراسات عديدة في العقدين الأخيرين و في دول مختلفة في جميع أنحاء العالم لعملية التأهيل المسبق لمقاولي التشييد و كذلك أخذ اراء الخبراء المحليين بخصوص ذلك مع العلم بأن هذه المعايير تم اعتمادها من خلال استبيان سابق و خضعت لتحليل إحصائي .

و كما تم ذكره سابقا فإن هناك تباينا في الطرق المستخدم للتأهيل المسبق من الجهات المختلفة حيث أن من هذه الجهات من يعتمد على تصنيف إتحاد المقاولين الفلسطينيين و منهم من يعتمد على تصنيف خاص بمؤسسته و منهم من شرع بإجراء عمليات تأهيل مسبق للمقاولين ووضع تصنيف بناء على نظام خاص به. لذا كانت هناك ضرورة لاعتماد طريقة علمية هي عملية التحليل الهرمي كأساس في عملية التأهيل المسبق بناء على معايير مدروسة و ذات أثر واضح على تحقيق أهداف المالك بالدرجة الأولى حيث أن جميع الطرق المستخدمة لا تستند على أسس علمية بل تعتمد على الخبرة التي اكتسبتها الجهات المختصة خلال السنوات الماضية في التعامل مع المقاولين و هي لا تخلو من التحيز و الحدس.

ومن هنا تبرز أهمية الاستبيان الذي سيحدد أوزان المعايير الرئيسية و الضرورية لعملية التأهيل المسبق و ذلك من خلال استدراج أراء أصحاب الاختصاص و الخبرة في الجهات المالكة (حكومية و غير حكومية و مكاتب

استشارية) بغرض تحديد الأوزان للمعايير في قطاع المباني و قطاع المياه الصرف الصحي و قطاع الطرق باستخدام طريقة التحليل الهرمي وذلك بما يتناسب مع واقعنا المحلي والعمل على تطبيقها و استخدامها بشكل أشمل في عمليات التأهيل المسبق للمقاولين في المشاريع المستقبلية لتجنب المشاكل الناتجة عن الاعتماد على تصنيف إتحاد المقاولين أو الطرق الأخرى و التي لا تعتمد على أساس علمي راسخ.

تحديد أوزان المعايير الرئيسية و الفرعية في التأهيل المسبق للمقاولين باستخدام عملية التحليل الهرمي:

الرجاء تحديد الأهمية النسبية لكل معيار رئيسي أو فرعي بالنسبة لباقي المعايير في عملية مقارنة زوجية لمقارنة كافة المعايير مع بعضها البعض , مع العلم بأن هذه الأهمية ستقاس بناء على عملية التحليل الهرمي حسب التصنيف الرقمي للمقارنة الزوجية حسب الجدول التالي:

- التصنيف الرقمي للمقارنة الزوجية للمعايير هي كما في الجدول التالي:

التصنيف الرقمي	أحكام لفظية للأهمية
9	أهم بدرجة قصوى (Extremely preferred)
8	بين الدرجة العالية جدا و القصوى
7	أهم بدرجة عالية جدا (Very strongly preferred)
6	بين الدرجة العالية و العالية جدا
5	أهم بدرجة عالية (Strongly preferred)
4	بين الدرجة المتوسطة و العالية
3	أهم بدرجة متوسطة (Moderately preferred)
2	بين المتساوية و المتوسطة
1	متساوي في الأهمية (Equally preferred)

1 -تحديد أوزان المعايير الرئيسية في التأهيل المسبق للمقاولين باستخدام عملية التحليل الهرمي:

	الأداء السابق للشركة	خبرة الشركة	الاستقرار المالي للشركة	القدرات الإدارية للشركة	القدرة الفنية للشركة	سمعة الشركة	المطالبات و النزاعات التعاقدية	مدى انشغال الشركة حاليا	إجراءات الصحة و السلامة في الشركة
الأداء السابق للشركة									
خبرة الشركة									
الاستقرار المالي للشركة									
القدرات الإدارية للشركة									
القدرة الفنية للشركة									
سمعة الشركة									
المطالبات و النزاعات التعاقدية									
مدى إنشغال الشركة حاليا									
إجراءات الصحة و السلامة في الشركة									

مثال على تعبئة الجدول أعلاه:

إجراءات الصحة و السلامة في الشركة	مدى انشغال الشركة حاليا	المطالبات و النزاعات التعاقدية	سمعة الشركة	القدرة الفنية للشركة	القدرات الإدارية للشركة	الاستقرار المالي للشركة	خبرة الشركة	الأداء السابق للشركة	
9	7	9	6	$\frac{1}{3}$	1	5	3	1	**الأداء السابق للشركة**

ففي هذا المثال يتم مقارنة المعيار الرئيسي في العمود الرأسي على يسار الجدول مع كافة المعايير في السطر الأفقي و فق التصنيف الرقمي للمقارنة الزوجية على النحو التالي:

- فلو كان الأداء السابق يفوق في الأهمية خبرة الشركة بدرجة متوسطة يتم وضع رقم 3 في الخلية البيضاء .
- و لو كان الأداء السابق للشركة يفوق في الأهمية الاستقرار المالي بدرجة عالية يتم و ضع الرقم 5 في الخلية البيضاء .
- و لو كان الأداء السابق للشركة متساوي في الأهمية مع القدرات الإدارية يتم و ضع الرقم 1 في الخلية البيضاء.
- و لو كانت أهمية الأداء السابق أقل من القدرة الفنية ، بمعنى أن القدرة الفنية تفوق الأداء السابق للشركة في الأهمية بدرجة متوسطة يتم وضع الرقم بصور كسر $\frac{1}{3}$
- و لو كان الأداء السابق أكثر أهمية من سمعة اللشركة بين الدرجة العالية و العالية جدا يتم وضع رقم 6 في الخلية و هكذا دواليك.

2 - تحديد أوزان المعايير الفرعية في التأهيل المسبق للمقاولين باستخدام عملية التحليل الهرمي:

2.1 -العوامل المتعلقة بالأداء السابق للشركة

	التزام الشركة بتنفيذ المشاريع ضمن المدة التعاقدية	الالتزام بالمواصفات في تنفيذ المشاريع	التقيد بالالتزامات التعاقدية	سجلات نجاح الشركة في تنفيذ المشاريع	إلتزام الشركة بتنفيذ المشاريع ضمن الميزانية المخصصة
التزام الشركة بتنفيذ المشاريع ضمن المدة التعاقدية					
الالتزام بالمواصفات في تنفيذ المشاريع					
التقيد بالالتزامات التعاقدية					
سجلات نجاح الشركة في تنفيذ المشاريع					
إلتزام الشركة بتنفيذ المشاريع ضمن الميزانية المخصصة					

2.2 - العوامل المتعلقة بخبرة الشركة

	خبرة الشركة في تنفيذ مشاريع مشابهة	نوعية المشاريع التي نفذتها الشركة	قيمة المشروعات التي نفذتها الشركة	قدرة الشركة على مواجهة مشاكل التنفيذ	عدد المشروعات التى نفذتها الشركة	قدرة الشركة على تحديد و إدارة المخاطر	عدد سنوات خبرة الشركة	الخبرة المحلية للشركة
خبرة الشركة في تنفيذ مشاريع مشابهة								
نوعية المشاريع التي نفذتها الشركة								
قيمة المشروعات التي نفذتها الشركة								
قدرة الشركة على مواجهة مشاكل التنفيذ								
عدد المشروعات التى نفذتها الشركة								
قدرة الشركة على تحديد و إدارة المخاطر								
عدد سنوات خبرة الشركة								
الخبرة المحلية للشركة								

2.3 -العوامل المتعلقة بالاستقرار المالي للشركة

	رأس مال الشركة	السيولة المالية للشركة	حجم ديون الشركة	الحجم المالي السنوي الدوار للشركة	التسهيلات البنكية التي تحصل عليها الشركة
رأس مال الشركة					
السيولة المالية للشركة					
حجم ديون الشركة					
الحجم المالي السنوي الدوار للشركة					
التسهيلات البنكية التي تحصل عليها الشركة					

2.4 -العوامل المتعلقة بالقدرات الإدارية للشركة

	وجود هيكل تنظيمي مناسب للشركة	مؤهلات الطاقم الإداري للشركة	توفر نظام مراقبة و متابعة و تقييم في الشركة	استخدام أنظمة محوسبة في الإدارة	وجود إستراتيجية متكاملة للشركة
وجود هيكل تنظيمي مناسب للشركة					
مؤهلات الطاقم الإداري للشركة					
توفر نظام مراقبة و متابعة و تقييم في الشركة					
استخدام أنظمة محوسبة في الإدارة					
وجود إستراتيجية متكاملة للشركة					

2.5 -العوامل المتعلقة بالقدرة الفنية للشركة

	خبرة الطواقم الفنية	عدد و نوعية و حالة المعدات و الاليات	عدد الطواقم الفنية	رأس مال المعدات و الاليات	الوسائل التكنولوجية المستخدمة من قبل الشركة في تنفيذ المشاريع
خبرة الطواقم الفنية					
عدد و نوعية و حالة المعدات و الاليات					
عدد الطواقم الفنية					
رأس مال المعدات و الاليات					
الوسائل التكنولوجية المستخدمة من قبل الشركة في تنفيذ المشاريع					

2.6 -العوامل المتعلقة بسمعة الشركة

	تصنيف الشركة	العلاقة السابقة بين الشركة و الجهة المالكة	تنوع مجالات تخصص الشركة	العلاقة السابقة بين الشركة و الجهات المالكة الأخرى	حجم الشركة
تصنيف الشركة					
العلاقة السابقة بين الشركة و الجهة المالكة					
تنوع مجالات تخصص الشركة					
العلاقة السابقة بين الشركة و الجهات المالكة الأخرى					
حجم الشركة					

2.7 – العوامل المتعلقة بالمطالبات و النزاعات التعاقدية

كثرة المطالبات في المشاريع السابقة	ميل الشركة تجاه المطالبات و التشديد في الأمور التعاقدية	تجاوب الشركة في إيجاد الحلول للمطالبات و النزاعات	
			تجاوب الشركة في إيجاد الحلول للمطالبات و النزاعات
			ميل الشركة تجاه المطالبات و التشديد في الأمور التعاقدية
			كثرة المطالبات في المشاريع السابقة

2.8 -العوامل المتعلقة بمدى انشغال الشركة حاليا

نوعية المشاريع الحالية التي تنفذها الشركة	قيمة المشاريع الحالية التي تنفذها الشركة	عدد المشاريع التي تنفذها الشركة حاليا	
			عدد المشاريع التي تنفذها الشركة حاليا
			قيمة المشاريع الحالية التي تنفذها الشركة
			نوعية المشاريع الحالية التي تنفذها الشركة

2.9 -العوامل المتعلقة بإجراءات الصحة و السلامة في الشركة

سجلات الصحة و السلامة للشركة في تنفيذ المشاريع السابقة	وجود برامج تدريبية في مجال الصحة و السلامة	وجود سياسة للشركة في مجال الصحة و السلامة مع معايير لضبط العمل	
			وجود سياسة للشركة في مجال الصحة و السلامة مع معايير لضبط العمل
			سجلات الصحة و السلامة للشركة في تنفيذ المشاريع السابقة
			وجود برامج تدريبية في مجال الصحة و السلامة

Annex 4

Questionnaire # 2 (English Version)

Identification of weights of the main criteria and subcriteria in the prequalification process by using the Analytical Hierarchy Process (AHP)

Please specify the relative importance of each criterion or sub criterion with respect to the other criterion or sub criterion in pairwise comparison to compare all of the criteria to each other, knowing that the relative importance should be based on AHP according to the numerical rating as shown in the table below:

Pairwise comparison scale for AHP preferences

Numerical rating	Verbal judgment of preference
9	Extremely preferred
8	Very strongly to extremely
7	Very strongly preferred
6	Strongly to very strongly
5	Strongly preferred
4	Moderately to strongly
3	Moderately preferred
2	Equally to moderately
1	Equally preferred

1. Determination of weights of the main criteria in the prequalification of contractors by AHP

	The Past Performance	The Experience	The Financial Stability	The Management Capabilities	The Technical Ability	The Reputation	The Claims and Contractual	The Current Workload	The Health and Safety Procedures
The Past Performance									
The Experience									
The Financial Stability									
The Management Capabilities									
The Technical Ability									
The Reputation									
The Claims and Contractual Disputes									
The Current Workload									
The Health and Safety Procedures									

Example regarding filling in the table above:

	The Past Performance	The Experience	The Financial Stability	The Management Capabilities	The Technical Ability	The Reputation	The Claims and Contractual Disputes	The Current Workload	The Health and Safety Procedures
The Past Performance		3	5	1	$\frac{1}{3}$	6			

In this example, the criterion in the vertical column at the left of the table is compared with all the criteria at the top row according the numerical rating in pairwise comparison as follows:

- If the past performance is more important than the experience of the company with moderate grade, number 3 is placed in the white cell.
- If the past performance is strongly important than the financial stability of the company, number 5 is placed in the white cell.
- If the past performance is equal in importance with the management capabilities of the company, number 1 is placed in the white cell.
- If the past performance is less important than the technical ability of the company with moderate grade, fraction $\frac{1}{3}$ is placed in the white cell.
- If the past performance is more important than the reputation of the company with strong to very strong grade, number 6 is placed in the white cell, and so forth.

2. Determination of weights of the sub criteria in the prequalification of contractors by AHP

2.1 The factors related to the past performance of the company

	The adherence to the contractual period	The adherence to the specifications	The adherence to the contractual obligations	The track record of the company	The adherence to the allocated budget
The adherence to the contractual period					
The adherence to the specifications					
The adherence to the contractual obligations					
The track record of the company					
The adherence to the allocated budget					

2.2 The factors related to the experience of the company

	The number of similar projects	The type of projects implemented	The amount of projects implemented	The ability to cope with the problems of implementation	The number of projects implemented	The ability to identify and manage risks	The number of years in construction	The local experience of the company
The number of similar projects								
The type of projects implemented								
The amount of projects implemented								
The ability to cope with the problems of implementation								
The number of projects implemented								
The ability to identify and manage risks								
The number of years in construction								
The local experience of the company								

2.3 The factors related to the financial stability of the company

	The capital of the company	The liquidation of the company	The debt volume of the company	The annual turnover of the company	The banking facilities provided by the company
The capital of the company					
The liquidation of the company					
The debt volume of the company					
The annual turnover of the company					
The banking facilities provided by the company					

2. 4The factors related to the management capabilities of the company

	The company organizational structure	The qualifications of the managerial staff	The availability of monitoring , tracking, and evaluation system	The use of computerized systems in the management	The existence of an integrated strategy for the company
The company organizational structure					
The qualifications of the managerial staff					
The availability of monitoring , tracking, and evaluation system					
The use of computerized systems in the management					
The existence of an integrated strategy for the company					

2. 5The factors related to the technical ability of the company

	The experience of the technical staff	The number , type , and condition of equipment and machinery	The number of the technical staff	The capital of equipment and machinery	The technological means used in the implementation of projects
The experience of the technical staff					
The number , type , and condition of equipment and machinery					
The number of the technical staff					
The capital of equipment and machinery					
The technological means used in the implementation of projects					

2.6 The factors related to the reputation of the company

	The company classification	The previous relationship between the company and the owner	The diversity of areas of specialization	The previous relationship between the company and other owners	The size of the company
The company classification					
The previous relationship between the company and the owner					
The diversity of areas of specialization					
The previous relationship between the company and other owners					
The size of the company					

2.7 The factors related to the claims and contractual disputes

	The company response in finding solutions to claims and disputes	The tendency of the company towards the claims	The number of claims in the previous projects
The company response in finding solutions to claims and disputes			
The tendency of the company towards the claims			
The number of claims in the previous projects			

2.8 The factors related to the current workload of the company

	The number of the current projects	The amount of the current projects	The type of the current projects
The number of the current projects			
The amount of the current projects			
The type of the current projects			

2.9 The factors related to the health and safety procedures in the company

	The health and safety policy	The health and safety records in the previous projects	The health and safety training programs
The health and safety policy			
The health and safety records in the previous projects			
The health and safety training programs			

Annex 5

CSP Evaluation Questionnaire

(Arabic Version)

استبيان لتقييم برنامج الحاسوب(CSP)

السادة مؤسسة / المحترمين،

نشكر سيادتكم للمساهمة في أوقاتكم و مجهوداتكم في تطبيق برنامج الحاسوب PCS و الخاص بعملية التأهيل المسبق للمقاولين والمقدم لسيادتكم لتجربته في مشروع حقيقي.

يرجى من سيادتكم تعبئة هذا الاستبيان، و ذلك من أجل التحقق من البرنامج المذكور . إن رأيكم و ملاحظاتكم على البرنامج مهمة جدا لتقييمه.

و لكم جزيل الشكر

يناير /2010

الباحث
م. ســـالم الوحيدي

استبيان لتقييم " CSP"

1 - يرجى التكرم بالإفادة برأيكم فيما يتعلق بالنقاط الواردة في الجدول التالي و ذللك لتقييم الفائدة من برنامج الحاسوب " Contractors Selection Program "

الرقم	البيان	موافق جدا	موافق	موافق بدرجة متوسطة	موافق بدرجة ضعيفة	موافق بدرجة ضعيفة جدا
1	يساهم البرنامج في تحسين عملية التأهيل المسبق					
2	يساعد في تطوير قطاع الإنشاءات في قطاع غزة					
3	يوفر الإمكانية في تأهيل المقاولين بشكل علمي و صحيح					
4	ملائم لجميع أنواع المشـــــاريع					
5	مقنع للاستعانة به من قبل الجهات المالكة و المنفذة					
6	يساهم في زيادة الاعتماد على الحاسوب في إدارة المشاريع					
7	البرنامج سهل الاستعمال					
8	البرنامج يتمتع بالمرونة ويمكن تعديل المدخلات بسهولـــة					
9	يمكن قراءة النتائج منه بسهولة ووضـــــوح					
10	يعرض النتائج بشكل واضـــــح					
11	يوفر الوقت و الجهد المبذول في عملية التأهيل المســـــبق					
12	مناسب للمشاريع الصغيرة					
13	مناسب للمشاريع الكبيرة					

2 - يرجى إبداء أي ملاحظات أو انتقادات تجدونها من خلال استخدام البرنامج

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3 - يرجى تحديد أي مميزات لهذا البرنامج من وجهة نظركم

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4 - يرجى إبداء أي مقترحات يمكن إدخالها على البرنامج

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Annex 6

CSP Evaluation Questionnaire

(English Version)

Questionnaire for CSP evaluation

1- In order to evaluate RCEM, please give your opinions regarding the following points:

No.	Techniques	No. of respondents					Weighted Mean %
		S.A	A	N	D	S. D	
1	The software contributes in improving the process of prequalification						
2	Assist in the development of the construction industry in Gaza Strip						
3	Provide the possibility of contractors prequalification in proper and scientific manner						
4	Suitable for all types of projects						
5	Convincing to be applied by the owners and implementing agencies						
6	Contribute in increasing the dependence on computers in projects management						
7	The program is easy to use						
8	The program is flexible and the inputs can be easily modified						
9	The results can be read easily and clearly						
10	Displays the results clearly						
11	Saves time and effort in the prequalification process						
12	Suitable for small projects						
13	Suitable for large projects						

(S.A= Strongly Agree, A= Agree, N= Neutral, D= Disagree, S.D= Strongly Disagree)

2- Please provide any comments or criticism you face when use the program

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3-Please identify any features of this program from your viewpoint

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4- Please provide any suggestions can be made to the program

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