CRITICAL SUCCESS FACTOR FOR DIFFERENT PROJECT OBJECTIVES

BY

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Dedication

Dedicated to my Parents

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I'm grateful to Almighty **ALLAH** for helping and enabling me to complete the thesis. I would like to appreciate and thank my thesis advisor **Dr. Abdulaziz A. Bubshait** for his incessant guidance through out thesis completion process, he has been available whenever I needed his guidance, assistance. I really appreciate his positive comments for improving and bring out the utmost optimum consequences out of my endeavors. Without his guidance and support I would have never been able to organize and complete the thesis tasks as optimal and with in time constraints.

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THESIS ABSTRACT

FULL NAME OF STUDENT	:	MUNIB AHMAD ASIF
TITLE OF THE STUDY	:	CRITICAL SUCCESS FACTORS FOR DIFFERENT PROJECT OBJECTIVES
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A model based on the Analytical Hierarchy Process was developed to investigate the most Critical Success Factor for different project objectives i.e. Time, Cost and Quality. Interview surveys were conducted with sixty (60) experts with a minimum ten (10) years experience in the construction industry, twenty (20) owners or owner representatives, twenty (20) consultant engineers and twenty (20) contractors or contractor representatives. Results are reported for all the project objectives, for overall project success, for all the project participants and also for overall construction industry. After that pairwise comparison and analysis of sixty (60) factors was done. Owners, consultants and contractors ranked *Adequate planning and controlling technique, Owner satisfaction with the delivered project and Clearly defined project mission, objectives and scope* as the top most important or critical success factors, respectively. Overall project participants agreed on Time as the most important project objective. A Successful project maybe defined as a project which starts with clearly defined objectives and scope, advances with meticulous planning, monitoring and control and in the end results in owner satisfaction, that will finish within time, without cost overruns and having acceptable quality.

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ملخص الرسالة

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تم تطوير نموذج مبني على إجراء التحليل التراكمي لدراسة عوامل النجاح الحرجة لأهداف المشروع المختلفة مثل وقت التنفيذ ، والتكاليف ، وجودة المشروع . تمت مقابلة ستون خبير ذو خبرة على الأقل عشر سنوات في صناعة التشييد ، عشرون منهم من الملاك أو ممثّليهم و عشرون استشاري و عشرون مقاول أو ممثل المقاول . وبعد تحليل النتائج تم مناقشة العديد منها وتشمل : أهداف المشروع ، عوامل نجاح المشروع لجميع المشاركين في المشروع ، وعوامل نجاح صناعة التشييد بصورة عامة .

بعد تمام المقارنة الثنائية وتحليل الستون عامل من عوامل النجاح وبعد عملية الترتيب من قبل ممثلي المالك ، الاستشاري ، والمقاول ، فقد تم الإجماع على أن أهم العوامل هي " التخطيط وتقنيات التحكم في المشروع " و " رضاء المالك عن المشروع " و "التعريف الواضح لمهام المشروع وأهدافه ونطاقه " . من ذلك يمكن تعريف المشروع الناجح بأنه المشروع الذي يبدأ بأهداف ومجال واضح ويتقدم في التنفيذ بتخطيط دقيق بالإضافة إلى مراقبة والتحكم في الجدول الزمني ويحوز على رضاء المالك وينتهي في الوقت المحدد من غير زيادة في التكلفة وبالجودة المطلوبة .

درجة الماجســـتير في العلوم

جامعة الملك فهد للبترول المعادن

الظهران ، المملكة العربية السعودية

يونيه ٢٠٠٣

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

The construction sector is one of the major parts of the contracting business in Saudi Arabia and it constitutes a major portion of the Kingdom's domestic economy, even though the share of construction sector GDP in the total national output has fallen since the early 1990s. The construction sector alone provided employment to more than one million workers in 2001 and accounted for nearly 14.4% of the Kingdom's total 7.3 million labor force. The construction sector GDP grew by 5.8% in 2000 and again increased by 3.1% to SR43 billion in 2001, and is expected to have grown by around 5% in 2002 on the back of accelerated construction activities being carried out. However, the share of the construction sector GDP in the total national output has declined from an average of 12% for the most of the 1980s to a more sustainable average of around 8% in the 1990s, mostly due to the completion of various infrastructure projects. However, the share of construction sector GDP within the non-oil output averaged around 10.5% in the 1990s and amounted to around 10.2% in 2001, suggesting continued investment activities in the construction sector (www.alahli.com).

The term "Critical Success Factors", in the context of projects and management of projects was first used by Rockart (1982). The widespread use of projects in organizations today is the driving force in the search for factors that influence project success. In spite of extensive research in recent years, there has been little agreement on the causal factors of project success (Pinto and Slevin, 1987).

A project is completed as a result of combination of many events and interactions, planned or unplanned, over the lifetime for a facility, with changing participants and processes in a constantly changing environment. Certain factors are more critical to project success than others. These factors are called Critical Project Success Factors (CSFs) (Sanvido et al., 1992).

It is generally accepted that the major goals in a construction project are budget, schedule and quality, although there are other more specific objectives, such as safety consideration and market entry, depending on the nature of the project and company. A variety of factors determine the success or failure of projects in terms of these objectives. The identification of the Critical Success Factors (CSFs) for these objectives will enable limited resources of time, manpower, and money to be allocated appropriately. Some researches have been conducted to identify CSFs for project success using quantitative measures of various factors (Jaselskis and Ashley 1991; Chua et al. 1997; Kog et al., 1999). However, these factors are only confined to the project management efforts. The same approach also cannot be adopted to cover intangible factors or be used when hard performance data are not available.

Alternatively, CSFs can also be identified based on expert opinions. The impact of experience possessed by project key personnel toward project outcomes has been widely recognized (Jaselskis and Ashley 1991; Sanvido et al. 1992). It would be legitimate then

to assume that experienced practitioners would have composed a set of CSFs after testing against their experience. Invariably, two approaches have been employed to capture expert opinions in a few previous surveys on project success. In the first approach, the respondents were asked to identify a list of factors that they thought were critical and then to indicate their subjective importance of these factors (Pinto and Slevin 1987). In this approach it is difficult to ensure that the factors identified by the respondents are consistent in nomenclature and scope. Alternatively, the respondents were given a list of factors and asked to assess the influence of these factors based on a scale determined by Chan and Kumaraswamy (1997). Using this approach, it also is not possible to ensure consistency in the assessment when there are more than a few factors.

Since the late 1960s project management researchers have been trying to discover which factors lead to project success (Baker et al 1988; Pinto and Slevin 1988) and have reached conclusions that have been widely reflected in literature written for project management practitioners. In spite of these well-known research results and despite column-miles of words that have been written about project management, despite decades of individual and collective experience of managing projects, despite the rapid growth in membership of project management professional bodies and despite a dramatic increase in the amount of project working in industry, project results continue to disappoint stakeholders (Davies, 2002).

Holding the belief that ''Construction Project Success is repeatable'' (Ashley et al. 1987), practitioners and researchers have paid attention to establishing a set of factors contributing to project success. Many empirical studies have been conducted to examine the impact of various project success factors. Ashley et al. (1987) and Pinto and Slevin (1988) are some of the major contributors in the identification and examination of critical

success factors empirically in the 1980s. Jaselskis and Ashley (1991) explored how project managers could allocate scarce resources in an effective manner to achieve higher project performance. Sanvido et al. (1992) examined the contribution of factors such as project team experience, contracts, resources, and information available to project success. Mohsini and Davidson (1992) tested the influence of a number of conflict-inducing organizational variables on performance of project using a traditional procurement method.

Now the topic of concern is the question of project success factors. What are the major managerial variables that contribute to project success? Are all projects subject to the same set of success factors? In spite of extensive research in recent years and a general agreement that some success factors are common to all projects, there has been limited convergence, let alone agreement, on the full spectrum of ingredients and causes of project success (Pinto and Slevin, 1987).

1.2 OBJECTIVES

Major objectives for this research were as follows:

(1) Define and identify the critical factors for the objectives of budget (cost), schedule (time) and quality that lead to project success.

(2) Investigation of the most important critical success factors for construction projects, based on accumulative knowledge and judgment of experts (owner/owner representative, consultant, and contractor) in the Saudi Arabian construction industry.

Apart from the above mentioned major objectives, this research was conducted to investigate the following sub-objectives as well:

- Defining success from the projects participants' point of view.
- Investigation of the most important overall critical success factors (CSFs) as well as for different objectives.
- Investigation of the most important critical success factors according to different project participants and also for all project participants.
- Comparing the results of the present study with those conducted in the past in different parts of the globe.
- Calculating the percentage agreement present between different project participants on the ranking of factors.

1.3 SCOPE AND LIMITATIONS

The following limitations were applicable to this study:

1. Due to the nature of questionnaire, (pair-wise comparison) direct interviews were conducted from the Experts. (owner/owner representative, consultant, contractor)
2. Minimum of 20 Experts from each group (owner/owner representative, consultant, contractor), with a minimum of 10-15 years experience in construction projects greater than 5 Million Saudi Riyal, were interviewed only.
3. Because of time and financial constraints, the study was limited to the Eastern Province.

1.4 SIGNIFICANCE OF STUDY

1. By identifying the CSFs from top successful local experts in the construction industry, one will gain insight and understand better how their business firms remain competitive and excel in the operating environment in Saudi Arabia.
2. The findings of the research are likely more relevant and applicable to local companies, though there are other generalizable aspects.
3. If project participants can predict probability of success better, they can take steps to:
    - Avoid unsuccessful projects,
    - Identify good projects worth pursuing, and
    - Identify problems on current projects and take corrective tasks.
4. The concept of CSF may be applied to:
    - The project itself;
    - The consortium that sponsors the project; and
    - The political, social, and economic environments where the project is located.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Essential objective of the literature review was to acquire the comprehensive knowledge about the critical success factors, retrieved by various research studies in the past. Analytical revision of the literature provides the optimum opportunity to explore the existing critical success factors, for this particular purpose, various contemporary and previous research papers have also been reviewed. A comprehensive catalogue was developed from the literature, which would serve as the rudimentary guidelines for further research as the integral objective of this research study.

This chapter consists of answers for the following questions:

1. What is meant by success?
2. What are the different project objectives?
3. Who are the different project participants?
4. What is meant by critical success factors?
5. What are the critical success factors as identified in previous researches?

2.2 DEFINITION OF SUCCESS

Success criteria or a persons' definition of success, often changes from project to project depending on participants, scope of services, project size, sophistication of the owner related to the design of facilities, technological implications and a variety of other factors. Common threads relating to success criteria often develop not only with an individual project but also across the industry as we relate success to the perceptions and expectations of the owner, designer or contractor. Differences in a persons' definition of success are often very evident.

According to Pinto and Slevin (1988) "there are few topics in the field of project management that are so frequently discussed and yet so rarely agreed upon as the notion of project success.''

The literature on critical success factors reveals the following definitions of success presented in Table 2.1.

Table 2.1: Definition of Success

SOURCE	DEFINITION
Tuman, 1986	Having everything turned out as hoped.....anticipating all projects requirements and have sufficient resources to meet needs in a timely manner.
de Wit, 1986	The project is considered an overall success if the project meets the technical performance specifications and/or mission to be performed, and if there is a high level of satisfaction concerning the project outcome among: key people in the parent organization, key people in the project team and key users or clientele of the project effort.
Ashley, 1987	Having results much better than expected. Results much better than expected or normally observed in terms of cost, schedule, quality, safety and participant satisfaction.

Baker et al. 1988	If the project meets the technical performance specifications and/or mission to be performed, and if there is a high level of satisfaction concerning the project outcome among key people in the parent organization, key people in the client organization, key people on the project team, and key users or clientele of the project effort, the project is considered an overall success.
Pinto and Slevin, 1988	A project is generally considered to be successfully implemented if it: • Comes in on-schedule (time criterion), • Comes in on-budget (monetary criterion), • Achieves basically all the goals originally set for it (effectiveness criterion), • Is accepted and used by the clients for whom the project is intended (client satisfaction criterion).
Wuellner, 1990	Successful project is one that: • Is completed on time and within budget at a profit acceptable to the firm. • Produces high-quality design or consulting services. • Limits the firm's professional liability to acceptable levels. • Satisfies the client's expectations.
Kerzner, 1998	Project success is stated in terms of five factors: • Completed on time • Completed within budget • Completed at the desired level of quality • Accepted by the customer • Resulted in customer allowing contractor to use customer as a reference.

Project success should be viewed from the different perspectives of the individual owner, developer, contractor, user, the general public, and so on. These perspective differences will explain the reason why the same project could be considered a success by one and unsuccessful by another. For those involved with a project, project success is normally thought of as the achievement of some predetermined project goals, which commonly include multiple parameters such as time, cost, performance quality and safety. However, it must not be forgotten that the users and the general public do not necessary have similar pre-determined goals regarding the project at all, as depicted in Figure 2.1. Hence, the expectation on the outcome of the project and the perception of project success or failure will be different for everyone (Lim and Mohamed, 1999).

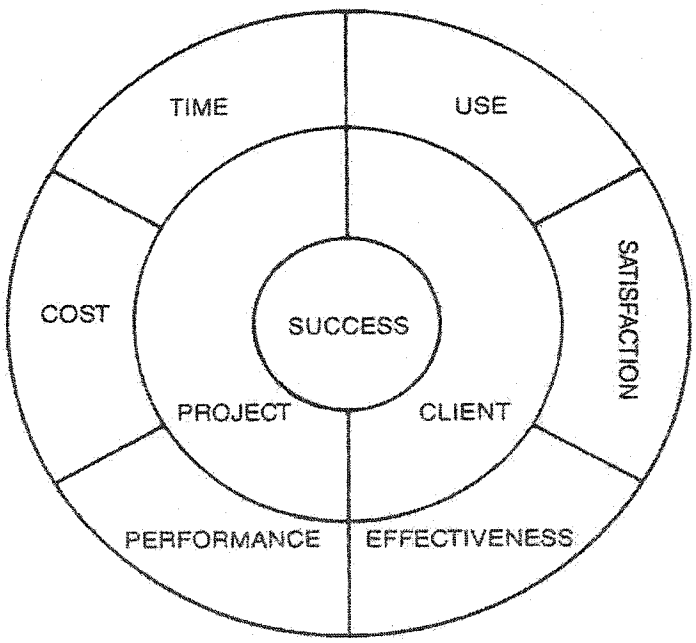

Figure 2.1: Model for Project Success (Lim and Mohamed, 1999)

The notion of what properties constitute a "successful" project has been much discussed in the project management field. In fact, evidence seems to indicate that this set of characteristics has changed, or developed, over the years. Project success involves concern for three factors: time, budget, and project performance. If the project came in on time, on or near budget, and performed as it was expected to perform (within tolerance limits), it was considered a success. More recently, an additional element has been added to the formula for a successful project. This element involves concern for the satisfaction and welfare of the client. By "client" we refer to any party for whom the project is intended, either internal or external to the organization. Typically, discussions with project managers as recently as ten years ago indicated that their primary focus as project leader was to get the project completed, make sure it "worked:' and get it out the door. Customer (client) contact after the project was delivered was minimal and any form of long-term follow-up or troubleshooting was often non-existent. (Pinto and Slevin, 1988)

Liu and Walker, (1998) articulated that satisfaction is an aptitude (an effect or emotion), the extent of which is related to the rewards one receives. Since success leads to satisfaction, the most straightforward relationship of goals to satisfaction is that the greater the success experienced relative to the goal set, the greater is the degree of satisfaction experienced. Similarly, dissatisfaction will be experienced when there is goal blockage or failure. These conclusions follow from the principle that goals are used as value standards for appraising performance.

Project success is a topic that is frequently discussed and yet rarely agreed upon. The concept of project success has remained ambiguously defined. It is a concept which can mean so much to so many different people because of varying perceptions, and leads

to disagreements about whether a project is successful or not. They divided the literature defining success into three categories which emphasize the following aspects:

Project goals: Commonly cited goals are those concerning time, budget and functionality/quality/ technical specification. Recent research has included other aspects such as safety and environmental sustainability issues. However, these can be interpreted as subsumed under the project goal of quality, which, in turn, is interdependent on the other two goals of time and cost.

Satisfaction of the claimant(s): An additional element for a successful project concerns the satisfaction of the claimants, for instance, the client.

Perception and awareness of different claimant(s): Project claimants with different orientation (e.g. management versus scientific) may have different views of what constitutes a successful project outcome.

According to a significant and comprehensive study by Murphy et al. (1974), the definition of project success centres upon "perceptions" and they argue that the definition be termed more appropriately "perceived success of a project".

The experiences of success and failure do not depend: on the absolute level of performance attained but on performance in relation to one's personal standard. If the standard is exceeded, the individual experiences success and feels pleasure and satisfaction, if the individual does not meet the standard, failure, displeasure and dissatisfaction are experienced; therefore, one project manager's assessment may be different from another project manager's, as may the assessment of the client and any other member of the project team (Lewin, 1958).

Baccarini (1999) suggested that the criteria for measuring project success must be set out at the beginning of the project, otherwise different team members will find themselves travelling in differing directions and one or more of them might perceive the project to be a failure.

In his research Baccarini (1999) presented two concepts or two distinct components of project success that can be identified as follows:

Project management success: This focuses upon the project process and, in particular, the successful accomplishment of cost, time, and quality objectives. It also considers the manner in which the project management process was conducted.

Project management success has three key components:

(1) Meeting time, cost, and quality objectives (project outputs and inputs),

- Time-Success can be measured in terms of meeting the schedule. The time success criterion could be measured in terms of schedule over/under run as a percentage of the initial plan.
- Cost-Success can be measured in terms of meeting the budget. The cost success criterion could be measured in terms of cost over/under run as a percentage of the initial budget.
- Quality-Success can be measured in terms of conformance to functional and technical specifications. In other words, "the project must produce what it said it would produce."

(2) Quality of the project management process, and

- Anticipating all project requirements, having sufficient resources to meet project needs in a timely manner, and using these resources efficiently to accomplish the right task at the right time and in the right manner.
- Dealing with the issues early or as soon as they surface and keeping management informed.
- Effective coordination and relation patterns between project stakeholders, e.g., team spirit, participative decision-making.
- Minimum scope changes, no disturbance to the organization's main flow of work, and no disturbance to corporate culture.
- Completeness of the termination, absence of post-project problems, quality of post-audit analysis, identifying technical problems during the project and solving them.

(3) Satisfying project stakeholders' needs where they relate to the project management process.

- Project management success entails satisfying project Stakeholders' needs where they relate to the project management process. The key stakeholders during the project management process are the client and the project team.

Product success: This deals with the effects of the project's final product. Product success has following three components:

(1) Meeting the project owner's strategic organizational objectives (project goal),

- Product success means achieving the project goal. i.e., "the project reaches a favorable termination in support of the enterprise mission ...(and) succeeds as a building block in the design and execution of enterprise strategy."

(2) Satisfaction of users' needs (project purpose), and

- The project's product must have fitness for use, i.e., "the product or service produced must satisfy real needs."

(3) Satisfaction of stakeholders' needs where they relate to the product.

- Product success entails satisfying project stakeholders' needs where they relate to the project goal and purpose. The key stakeholder here is the customer/user.

Ashley et al. (1987) debate in their research that Success is construed as results much better than expected or normally observed in terms of cost, schedule, quality, safety, and participant satisfaction. Results from this pilot study show successful construction projects result at least partially from more emphasis in the following areas:

(1) Planning effort (construction and design),

(2) Project manager goal commitment,

(3) Project team motivation,

(4) Project manager technical capabilities,

(5) Scope and work definition, and

(6) Control systems.

Griffith et al. (1999) concluded in their research that there does not seem to be a universally accepted definition or measurement of project success. The only consensus seems to be that project success is a complex and dynamic concept that cannot be measured with a simple test like the slump of a concrete mix. Despite the obvious difficulties, project management research and continuous project improvement efforts depend on some type of definition for project success. An objective measurement that can

be used to test the effects that specific inputs have on project outcomes, as well as making logical comparisons between different projects of different types and sizes, would be invaluable.

Kharbanda and Stallworthy, (1986) discussed in their book that "there is continual conflict between these three basic elements (cost, time and quality) and the Successful Project must be one that allows none of the three to dominate. The optimum should be the objective: a project built in reasonable time, economic in terms of cost and adequate so far as product and plant are concerned." The conflict is best illustrated in the following Figure 2.2.

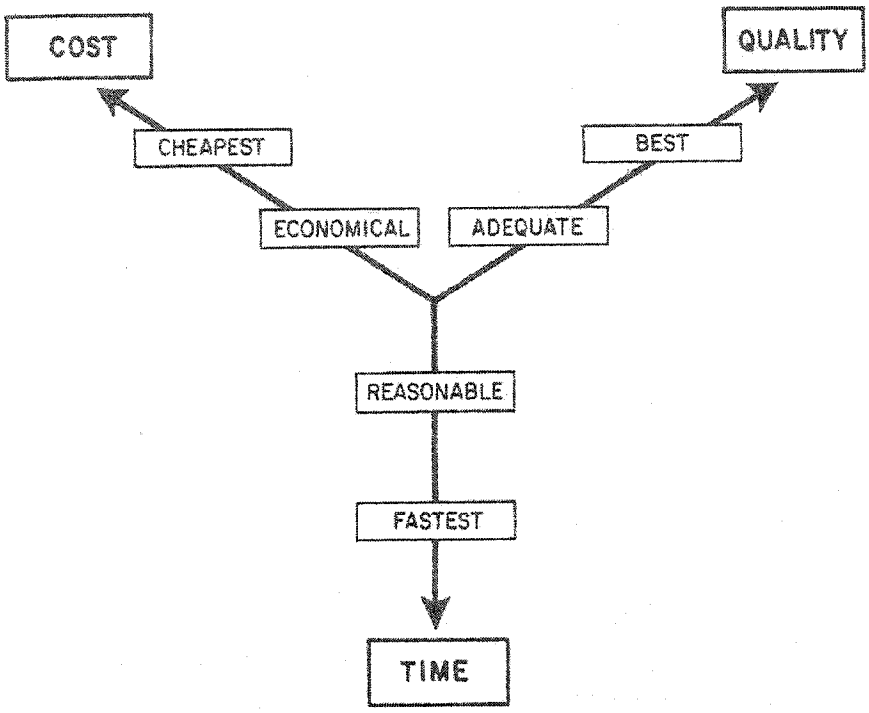

Figure 2.2: Time, Cost and Quality Conflict (Kharbanda and Stallworthy, 1986)

Sanvido et al. (1992) developed a list of typical success criteria for the Owner, Consultant/Designer and Contractor. He also claimed that no single list would ever be totally comprehensive when it comes to a definition of success for a project. The criteria developed for use with the CSF project does give a general overall impression of each of the three groups viewpoints. It determines the "envelope" of ideas that are used to evaluate success.

Owner's criteria for measuring success are:

(1) On Schedule,

(2) Within Budget,

(3) Quality,

(4) Function for intended use (satisfy users and customers),

(5) End results as envisioned,

(6) Aesthetically pleasing,

(7) Return on investment.

Consultants /Designer's criteria for measuring success are:

(1) Client Satisfaction,

(2) Quality architectural product,

(3) Design fee and profit goal,

(4) Experience gained, learned new skills,

(5) Met project budget and schedule,

(6) Minimal construction problems (disputes, liabilities),

(7) Well-defined scope of work.

Contractor's criteria for measuring success are:

(1) Meet schedule (pre-construction, construction, design),

(2) Profit,

(3) Under budget (savings),

(4) Quality specifications met,

(5) No claims,

(6) Safety,

(7) Client satisfaction,

(8) Good Communication (expectations of all parties clearly defined).

2.3 PROJECT OBJECTIVES

2.3.1 Project Budget (Cost)

Cost is defined as the monitory exchange of goods and services. Monitory exchange can be either a function of time or make up of product or services performed measured in terms of ones time and energy spend to fulfill the task. Every project has two end goals. The first is completion—getting the job done on time. The second is economy—achieving projected revenues or staying within budget in the process. Success comes when not one but both of these goals are realized.

The costs of a constructed facility to the owner include both the initial capital cost and the subsequent operation and maintenance costs. Each of these major cost categories consists of a number of cost components.

In the Project Management Body of Knowledge, Duncan (1996) has enunciated that the project cost management includes the processes required to ensure that the project is completed within the approved budget. Following are the major processes:

- Resource Planning: Determining what resources (people, equipment, materials) and what quantities of each should be used to perform project activities.
- Cost Estimating: Developing an approximation (estimate) of the costs of the resources needed to complete project activities.
- Cost Budgeting: Allocating the overall cost estimate to individual work items.
- Cost Control: Controlling changes to the project budget.

The capital cost for a construction project includes the expenses related to the initial establishment of the facility:

- Land acquisition, including assembly, holding and improvement
- Planning and feasibility studies
- Architectural and engineering design
- Construction, including materials, equipment and labor.

Construction costs are estimated to serve a variety of purposes, and much of the credit for the success or failure of a contracting enterprise can be ascribed to the skill and astuteness, or lack thereof, of its estimating staff. If the contracting firm obtains its work by competitive bidding, it must be the low bidder on a sufficient number of the projects it bids if it wishes to stay in business. However, the jobs it obtains must not be priced so low that it is impossible to realize a reasonable profit from them. In an atmosphere of intense competition, the preparation of realistic and balanced bids requires the utmost in good judgment and estimating skill. Although negotiated contracts frequently lack the competitive element, the accurate estimating of construction costs nonetheless constitutes an important aspect of such contracts. The contractor is expected to provide the owner with reliable advance cost information, and its ability to do so determines in large measure its continuing ability to attract owner-clients. In design-construct and construction management contracts, the contractor and the construction manager are called on to provide expert cost assistance and advice as the design develops. The advance estimation of costs is a necessary part of any construction operation and is a key element in the conduct of a successful construction contracting business (Clough and Sears, 1994).

2.3.2 Project Schedule (Time)

In addition to cost control, project managers must also give considerable attention to monitoring schedules. Construction typically involves a deadline for work completion, so contractual agreements will force attention to schedules. More generally, delays in construction represent additional costs due to late facility occupancy or other factors. Just as costs incurred are compared to budgeted costs, actual activity durations may be compared to expected durations. In this process, forecasting the time to complete particular activities may be required.

Timing of key decisions is likely to determine the pace of the project more than anything else. Bar charts and other graphical representations show when decisions have to be taken, but during the course of a case study project it became obvious that they did not always help in understanding what must be done to enable those decisions to take place. It is therefore necessary to expand the role of project planning (i.e. method and time management) to incorporate decision-making. The project plan is intended to show where in the process decisions have to be taken, who will be involved and the information required. It can be extremely helpful early in the project's life by acting as a checklist. The implications of a change of schedule, or design, can only be considered properly if there exists an understanding of the underlying processes and the flows of information and actions needed to maintain integrity of the project plan based on a comprehensive model of the entire process. Programs in the form of bar charts and precedence diagrams will be used in conjunction with the project plan. The use of a project plan, which is shared by everyone, will help to identify areas of risk as well as

keeping track of which actions are required when and by whom. Overall, this is likely to ensure that fewer risk items are overlooked.

In the Project Management Body of Knowledge, Duncan (1996) ascertained that project time management includes the processes required to ensure timely completion of the project. The following processes are an essential part of project time management:

- Activity Definition: Identifying the specific activities that must be performed to produce the various project deliverables.
- Activity Sequencing: Identifying and documenting interactivity dependencies.
- Activity Duration Estimating: Estimating the number of work periods, which will be needed to complete individual activities.
- Schedule Development: Analyzing activity sequences, activity durations, and resource requirements to create the project schedule.
- Schedule Control: Controlling changes to the project schedule.

These processes interact with each other and with the processes in the other knowledge areas as well. Each process may involve effort from one or more individuals or groups of individuals based on the needs of the project. Each process generally occurs at least once in every project phase. Although the processes are presented here as discrete elements with well-defined interfaces, in practice they may overlap and interact in ways not detailed here. On some projects, especially smaller ones, activity sequencing, activity duration estimating, and schedule development are so tightly linked that they are viewed as a single process (e.g., they may be performed by a single individual over a relatively short period of time).

2.3.3 Project Quality

Quality is defined as the "totality of features, attributes, and characteristics of a facility, product, process, component, service, or workmanship that bear on its ability to satisfy a given need: fitness for purpose. It is usually referenced to and measured by the degree of conformance to a predetermined standard of performance." (ASCE: Quality, 1988)

Project performance occurs on several different levels, all of which are important to the organization. At its most basic level, performance refers to conformance with technical specifications, i.e. ensuring that project activities meet the technical standards and guidelines set forth in the project plan or contractual agreements. At this level performance measures are objective the activity either does or does not meet the authorized technical standards.

Bubshait et al. (1999) in their research discuss quality practices having a bearing on the service quality of local design organizations and determine their prevalence among them. The most prevalent quality sections identified are design review, design changes, document control, and design planning, whereas the least prevalent sections are performance quality audit, employee training and education, working relationship, and interface control. Design organizations need to pay serious attention to their system to increase the prevalence of quality practices in the above mentioned four least prevalent quality sections.

In the Project Management Body of Knowledge, Duncan (1996) explained that project quality management includes the processes required to ensure that the project will satisfy the needs for which it was undertaken. It includes 'all activities of the overall

management function that determine the quality policy, objectives, and responsibilities and implements them by means such as quality planning, quality control, quality assurance, and quality improvement, within the quality system". The following processes are an essential part of project quality management:

- Quality Planning: Identifying which quality standards are relevant to the project and determining how to satisfy them.
- Quality Assurance: Evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards.
- Quality Control: Monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance.

These processes interact with each other and with the processes in the other knowledge areas as well. Each process may involve effort from one or more individuals or groups of individuals based on the needs of the project. Each process generally occurs at least once in every project phase. Although the processes are presented here as discrete elements with well-defined interfaces, in practice they may overlap and interact in ways not detailed here.

The basic approach to quality management described in this section is intended to be compatible with that of the International Organization for Standardization (ISO) as detailed in the ISO 9000 and 10000 series of standards and guidelines. This generalized approach should also be compatible with (a) proprietary approaches to quality

management and (b) non-proprietary approaches such as Total Quality Management (TQM), Continuous Improvement, and others.

2.4 PROJECT PARTICIPANTS

Mohsini and Davidson (1992) maintained that inter organizational conflicts in a construction project will adversely affect project performance. Attributes of project participants, therefore, cannot be overlooked. Project participants refer to the key players, namely the project manager (PM), client, contractor, consultants, subcontractors, and suppliers and manufacturers.

The active participation and cooperation of the other key players depend significantly on the capability of the key personnel and the overall competency of the team assigned to the project. Furthermore, the level of support from top management (Pinto and Slevin 1987) in their respective organizations is a factor that can determine the ease and the will to resolve difficulties that arise. Team turnover rate, track record and the level of service that the organization is obliged and willing to deliver are the other attributes considered (Jaselskis and Ashley 1991).

Following are the key project participants (Consultant/Engineer, Contractor, and Owner/Representative) which participated in this research.

2.4.1 Consultants

The consultant is the professional which is hired by the owner to provide consultation during the project various phases, this professional can be a constructor or the designer which just provide the concerned services on the requirement of owners.

Also an individual or firm providing professional services related to architecture, engineering, or land surveying, as a party to the agreement to complete the requirements of the project.

The consultant, also known as the design professional is the party, organization, or firm that designs the project. Because such design is architectural or engineering in nature, or often a combination of both, the term "architect-engineer" is used in this book to refer to the design professional, regardless of the applicable specialty or the relationship between the designer and the owner.

The Designer's, considering conventional practices, primary professional responsibility is to provide complete stipulated design documents of project with the consent of owner, act as the client's advisor and additionally to administer the building contract fairly between client and contractor (depending on the contract type).

The consultant can occupy a variety of positions with respect to the owner for whom the design is done. Many public agencies and large corporate owners maintain their own in-house design capability. In such instances, the consultant is a functional part of the owner's organization. The traditional and most common arrangement is one in which the consultant is a private and independent design firm that produces the project design under contract with the owner. In other instances, the owner contracts with a single party for both design and construction services, this being referred to as design-construct. In such a case, the consultant is a branch of, or is affiliated in some way with, the construction contractor.

There are also arrangements where large industrial firms have chosen to reduce their in-house design staffs and have established permanent relationships with outside consultants. Such "corporate partnerships" call upon the architect-engineer to provide a broad range of design, engineering, and related services on an open-ended basis. Such

arrangements are said to work to an owner's advantage by fostering a team approach and reducing litigation between the parties. (Clough and Sears, 1994)

The consultant or national constructor who acts as designer, inspector, and contract manager is, by the nature of his job, making every effort to get the project completed within the original estimate he furnished the owner for financing or budget purposes. Any savings he can make under the estimate improves his image in the owner's eyes and helps advertise his ability for references in securing work from other owners. His tendency is to be tough in enforcing specifications that he wrote to protect the owner and himself.

2.4.2 Contractors

The contractor, also known as the general contractor, is the business firm that is in contract with the owner for the construction of the project, either in its entirety or for some specialized portion thereof. The contractor is that party who brings together all of the diverse elements and inputs of the construction process into a single, coordinated effort.

The Contractor (constructor) provides all the relevant construction facilities to carry out the construction of project, which includes the provision of labor force, equipment and carry out the construction of project, which includes the provision of labor force, equipment and material (depends on the contract conditions). Conventional practice in construction industry indicates that constructors and architects don't have mutual working relationship to carryout the project with the essence of synergism.

The essential function of the contractor is close management control of construction. Ordinarily, this contractor is in complete and sole charge of the field operations, including the procurement and provision of necessary construction materials and equipment. The chief contribution of the prime contractor to the construction process is the ability to marshal and allocate the resources of manpower, equipment, and materials to the project in order to achieve completion at maximum efficiency of time and cost. A construction project presents the contractor with many difficult management problems. The skill with which these problems are met determines, in large measure, how favorably the contractor's efforts serve its own interests as well as those of the project owner. (Clough and Sears, 1994)

Builders who supervise the execution of construction projects are traditionally referred to as contractors, or more appropriately called constructors. The general contractor coordinates various tasks for a project while the specialty contractors such as mechanical or electrical contractors perform the work in their specialties. Material and equipment suppliers often act as installation contractors; they play a significant role in a construction project since the conditions of delivery of materials and equipment affect the quality, cost, and timely completion of the project. It is essential to understand the operation of these contractors in order to deal with them effectively.

The function of a general contractor is to coordinate all tasks in a construction project. Unless the owner performs this function or engages a professional construction manager to do so, a good general contractor who has worked with a team of superintendents, specialty contractors or subcontractors together for a number of projects

in the past can be most effective in inspiring loyalty and cooperation. The general contractor is also knowledgeable about the labor force employed in construction.

Specialty contractors include mechanical, electrical, foundation, excavation, and demolition contractors among others. They usually serve as subcontractors to the general contractor of a project. In some cases, legal statutes may require an owner to deal with various specialty contractors directly.

Major material suppliers include specialty contractors in structural steel fabrication and erection, sheet metal, ready mixed concrete delivery, reinforcing steel bar detailers, roofing, glazing etc. Major equipment suppliers for industrial construction include manufacturers of generators, boilers and piping and other equipment.

2.4.3 The Owner/Owner representative

The owner, public or private, is the instigating party for whose purposes the construction project is designed and built Public owners range from agencies of the government down through state, county, and municipal entities to a multiplicity of local boards, commissions, and authorities. Public owners must proceed in accordance with applicable statutes and administrative directives pertaining to the advertising for bids, bidding procedures, construction contracts, contract administration, and other matters relating to the design and construction process.

The Owners (Client) have an important role to influence the entire project at every phase of the project life cycle. They must provide adequate information on the project, site, budget, project time and should have clear understanding of project's final form as the architect engineer purse to finalize the stipulated design of project. Conventionally,

the owners are not much involved in projects various phases, therefore they seems only concerned with the financial aspects of project. Whereas, being the key authority in the project completion scenario, the owner should be involved in every phase to have very clear manifestation of the project and be available to take necessary action spontaneously to augment the construction or the design phase for completion of entire project.

In the main, most owners relegate by contract the design of their projects to professional architect-engineer firms and the field construction to construction contractors. However, there are some owners who, for various reasons, elect to play an active role in the design and construction phases of their projects. For example, some owners perform their own design, or at least a substantial portion of it. With respect to construction, some owners choose to act as their own construction managers or perhaps even to perform their own construction. Many industrial and public owners have established their own construction organizations that work actively and closely with the design and construction of their projects. (Clough and Sears, 1994)

Bubshait and Al-Musaid (1992) articulated that Owner involvement in construction phases is essential to project quality. Success or failure in many cases is related directly to the level of owner involvement. Owners who exercise close involvement are usually satisfied with the final project quality. They must set the desired level of quality through communicating the project objectives and requirements. The owner should maintain a frequent dialogue with the project team and approve key quality-control programs to ensure quality in constructed projects. The levels of owner involvement in public projects in Saudi Arabia were characterized. The important tasks in the three construction phases (planning, design and construction) were identified.

2.5 DEFINITION OF CRITICAL SUCCESS FACTORS

Following table provides definition of critical success factors as found in the literature reviewed.

Table 2.2: Definition of Critical Success Factors

SOURCE	DEFINITION
Rockart, 1982	Those few areas of activities in which favorable results are absolutely necessary for a particular manager to reach his or her goals.
Ferguson and Dickinson, 1982	They are events or circumstances that require the special attention of management because of their significance to the corporation. They may be internal or external and be positive or negative in their impact. Their essential character is the presence of a need from special awareness or attention to avoid unpleasant surprises or missed opportunities or objectives. They may be identified by evaluating corporate strategy, environment, resources, and operations.
Boynton and Zmund, 1984	Those few things that must go well to ensure success for a manager or organization, therefore, they represent those managerial or enterprise areas that must be given special and continual attention to bring high performance. Critical Success Factors include issues vital to an organization's current operating activities and its future success.
Sanvido et al. 1992	Critical success factors are defined as those factors predicting success on projects.
Lim and Mohamed, 1999	Critical success factors are those needed to produce the desired deliverables for the customer. Critical Success Factors measure end results.
Ghosh et al. 2001	Key Success Factor is defined for our purpose as factors which are critical for excellent performance of the company, rather than just survival which is the function of Critical Success Factors (CSFs).

2.6 CRITICAL SUCCESS FACTORS FROM PREVIOUS RESEARCHES

This section deals with the critical success factors used in the previous researches conducted in different parts of the globe. The investigation on project success has attracted the interest of many researchers and practitioners. These researches are arranged in a chronological order as it is difficult to categorize them according to different project types, geographical location or subject of objective of research.

Murphy et al. (1974) concluded in their research about some of the strongest factors determining project success:

(1) Co-ordination and relation patterns,

(2) Avoidance of initial over-optimism and conceptual difficulty, and

(3) Clarity of success criteria and consensus.

Baker et al. (1983) reported the result of a survey pertaining to project success. Although the survey was not focused on construction activities, and the variables considered leaned towards conceptual strategies, the results nonetheless provide a good starting point for studying the more specific critical success factors for construction projects. The critical success factors for construction projects identified by Sanvido et al. (1992) were also broad strategic principles, which would definitely require further refinement to identify lower level factors that can be implemented as project strategies.

Prafitt and Sanvido, (1993) provided a checklist of critical success factors, that can be used by building professionals as a guideline in predicting the success of a project. This checklist was developed based on an atmosphere in which the building owner,

designer and contractor work together as a team to develop techniques and relationships for project success. The checklist includes the following items:

Facility Team

Have adequate steps been taken to assemble and build a facility team with the common goals and "chemistry" appropriate to this specific project?

- Is a sense of respect for the role and services of each team member evident?
- Is there an open and honest communication flow?
- Are goals set related to the issues of building function, life cycle costs, esthetics, constructability, and maintainability?

Contracts, Changes and Obligations

Has there been a fair assignment of liability and risk?

- Do the contracts reflect the established objectives in clear language as close as legally possible?
- Is the owner adequately funded to perform the work to the desired level of excellence?
- Have fair rewards been established, such as fee or profit?

Facility experience

Do all the members, organizations, subcontractors and others involved have the proper qualifications and experience level for this project?

- Did you verify the overall experience level of the team members?
- Have you checked the staff qualifications related to the current project?
- Do the key players in the team have experience in similar facilities?

Optimization information

- Do you think your personal expertise was used in optimizing the design of this facility?
- Has a format been developed to integrate the expertise from the design and operation of other facilities to the design and construction of this facility?
- Was constructability of the various building systems taken into consideration in the planning and design of this facility?

Boynton and Zmund, (1984) in attempting to explain the causes of project success and failure, generated sets of "success factors" that are assumed to account for much of the variance in project performance. These sets of factors have been identified through a variety of methods, including single-case studies, anecdotal evidence, and multi-project empirical studies. In the majority of cases, however, the methods identifying these critical success factors tend to be theory based rather than empirically proven. In order to address the question of the practical relevance of many of these success factors, a method has recently been developed for generating implementation-related critical success factors on a company-by-company basis.

Nahapiet and Nahapiet (1985) made a comparative study on the building construction practice in the US and UK, with particular reference to the managerial and organizational aspects of projects. A more detailed investigation on the relationships between project execution strategies and project performance can be found in the works of Jaselskis and Ashley (1991), and Alarcon and Ashley (1996). They recognize the

primary role of project management team in planning, executing, and coordinating the project.

Might and Fischer, (1985) believed that the following factors are important for a successful project:

(1) The structure of the project organization,

(2) The nature of the projects managers' authority, and

(3) The size of the project (measured by total cost).

Kerzner, H., (1987) identified six critical success factors for successful projects from their research:

(1) Corporate understanding of project management,

(2) Executive commitment to project management,

(3) Organizational adaptability,

(4) Project manager selection criteria,

(5) Project manager's leadership style, and

(6) Commitment to planning and control.

Ashley et al. (1987) reported the following ten construction project success factors in their research and pictorially summarized the results in a "project success influence diagram" (Figure 2.3), which expresses relationship between factors and success criteria toward achieving project success:

(1) Project manager goal commitment,

(2) Project manager capabilities and experience,

(3) Planning efforts,

(4) Project team motivation and goal orientation,

(5) Scope and work definition,

(6) Control systems,

(7) Safety,

(8) Design-construction interface management,

(9) Technical uncertainty,

(10) Risk identification and management,

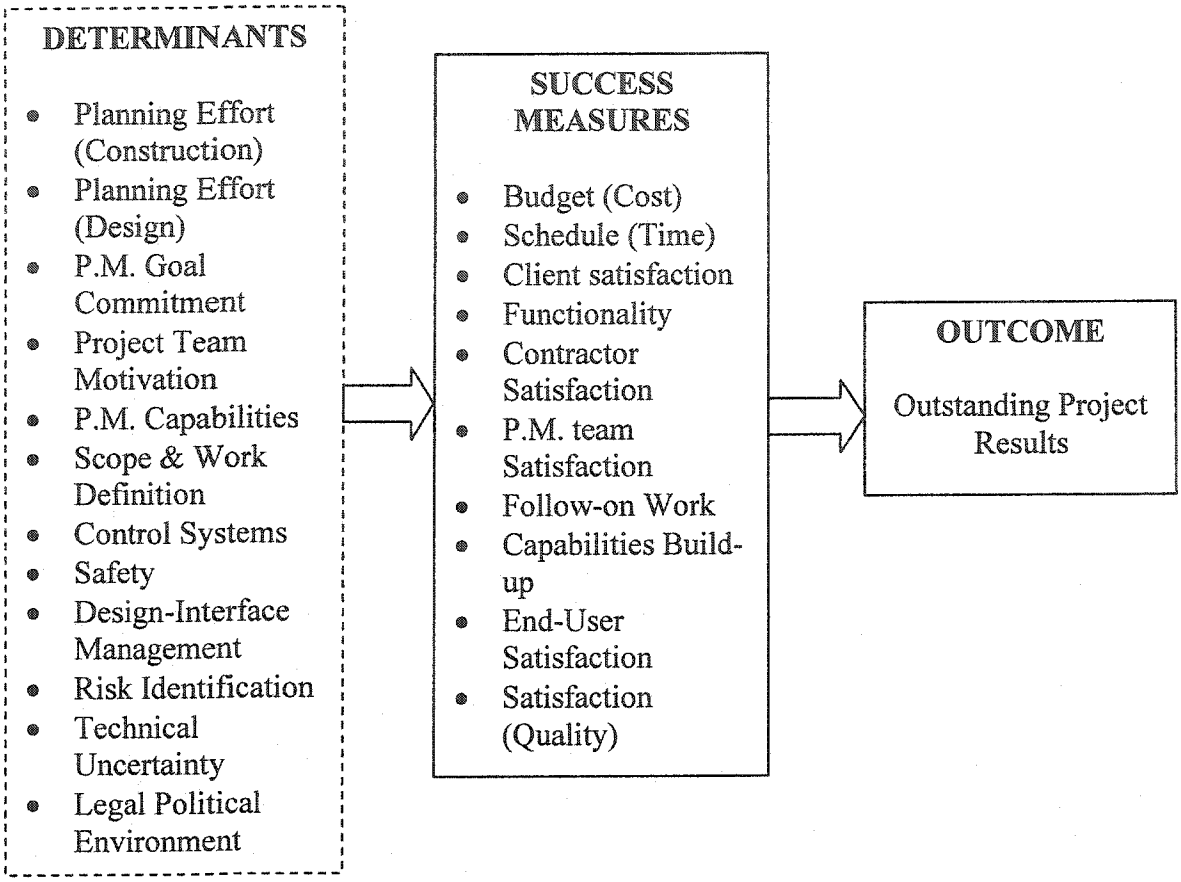

Figure 2.3: Project Success Influence Diagram (Ashley et al., 1987)

Pinto and Slevin, (1987) identified in their research the following ten critical success factors:

(1) Project mission: Initial clearly defined goals and general directions,

(2) Top management: Willingness of top management to provide the necessary resources and authority/power for project success,

(3) Project schedule/plan: A detailed specification of the individual action steps for project implementation,

(4) Client consultation: Communication, consultation, and active listening to all impacted parties,

(5) Personnel: Recruitment, selection, and training of the necessary personnel for the project team,

(6) Technical tasks: Availability of the required technology and expertise to accomplish the specific technical action steps,

(7) Client acceptance: The act of "selling" the final project to its ultimate intended users,

(8) Monitoring and feedback: Timely provision of comprehensive control information at each stage in the implementation process,

(9) Communication: The provision of an appropriate network and necessary data to all key actors in the project implementation, and

(10) Trouble-shooting: Ability to handle unexpected crises and deviations from plan.

Baker et al. (1988) gave a list of seven factors along with their components:

(1) Coordination and relations factor.

- Unity between project manager and contributing department managers.
- Project team spirit.
- Project team sense of mission.
- Project team goal commitment.
- Project team capability.
- Unity between project manager and public officials.
- Unity between project manager and client contact.
- Unity between project manager and his superior.

- Project manager's human skills.
- Realistic progress reports.
- Project manager's administrative skills.
- Supportive informal relations of team members.
- Authority of project manager.
- Adequacy of change procedures.
- Job security of project team.
- Project team participation in decision making.
- Project team participation in major problem solving.
- Owner enthusiasm.
- Availability of back-up strategies.

(2) Adequacy of project structure and control factor.

- Project manager's satisfaction with planning and control.
- Team's satisfaction with organization structure.

(3) Project uniqueness, importance and public exposure factor.

- Extent of public enthusiasm.
- Project larger in scale than most.
- Initial importance of state-of-art advancement.
- Project was different than most.
- Owner experience with similar project scope.
- Favorability of media coverage.

(4) Success criteria salience and consensus factor.

- Importance to project manager-budget.

- Importance to project manager-schedule.
- Importance to owner-budget.
- Importance to owner-schedule.
- Importance to owner-technical performance.
- Importance to project manager-technical performance.

(5) Competitive and budgetary pressure factor (negative impact).

- Fixed price (as opposed to cost reimbursement) type of contract.
- Highly competitive environment.
- Owner heavy emphasis upon staying within the budget.
- Project manager heavy emphasis upon staying within the budget.

(6) Initial over-optimism, conceptual difficulty factor (negative impact).

- Difficulty in meeting project schedules.
- Difficulty of staying within original budget.
- Original cost estimates too optimistic.
- Difficulty in meeting technical requirements.
- Project was more complex than initially conceived.
- Schedule overrun.
- Difficulty in freezing design.
- Unrealistic schedules.
- Project was different than most.

(7) Internal capabilities build-up factor.

- Extent to which project built up owner capabilities.
- Original total budget.

- Total cost of project.

Pinto and Prescott (1988) gave ten success factors, which are pictorially represented in Figure 2.4:

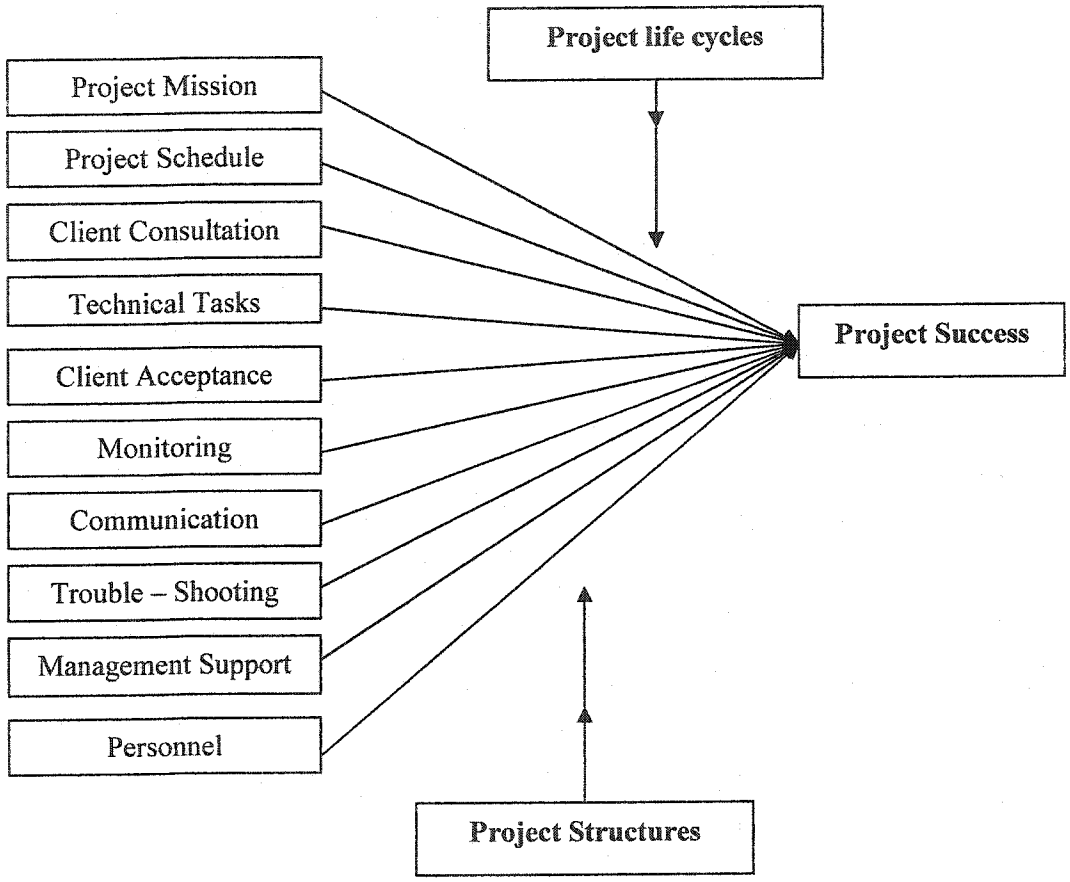

Figure 2.4: Success Factors (Pinto and Prescott, 1988)

Pinto and Covin (1989) gave a list of fourteen success factors from their research. To a greater or lesser extent, the first ten of these factors are within the control of the

project team. For example, the project team will often make the effort of involving the prospective user in the early project formulation process (Client Consultation) in the expectation that the client will then be more satisfied with and make use of the project's output. The final four factors, while also having a significant impact on ultimate project success or failure, may not be within the control of the project team. For example, external events (Environmental effects) can have important implications for project implementation, but may remain unforeseen until they actually occur.

These factors are listed and briefly defined below:

(1) Mission: Initial clarity of goals and general directions.

(2) Top Management Support: Willingness of top management to provide the necessary resources and authority/power for project success.

(3) Project Schedule/Plans: A detailed specification of the individual action steps required for project implementation.

(4) Client Consultation: Communication, consultation, and active listening to all impacted parties.

(5) Personnel: Selection, recruitment, and training of the necessary personnel for the project team.

(6) Technical Tasks: Availability of the required technology and expertise to accomplish the specific technical action steps.

(7) Client Acceptance: The act of 'selling' the final project to its ultimate intended users.

(8) Monitoring and Feedback: Timely provision of comprehensive control information at each stage in the implementation process.

(9) Communication: The provision of an appropriate network and necessary data to all key actors in the project implementation.

(10) Trouble-shooting: The ability to handle unexpected crises and deviations from plan.

(11) Characteristics of the Project Team Leader: Competence of the project leader (administratively, interpersonally, and technically) and the amount of authority available to perform his/her duties.

(12) Power and Politics: The degree of political activity within the organization and the perception of the project as furthering an organization member's self interests.

(13) Environmental Effects: The likelihood of external organizational or environmental factors impacting on the operations of the project team, positively or negatively.

(14) Urgency: The perception of the importance of the project or the need to implement the project as soon as possible.

White and Patton, (1990) gave a list of eight critical success factors in their paper:

(1) Visible top management commitment and support.

(2) Simple, flexible, phased stage / gate process.

(3) Loose-tight controls capable of operating in chaotic environments.

(4) Clear and communicated prioritisation to align and focus scarce resources on the most important changes.

(5) Organizational integration: vertically (top-down) / horizontally (across functions) / externally (customers, suppliers, partners).

(6) Clear, open, timely, free-flowing communications across all levels and functions.

(7) Continuous innovation, incubation, and improvement of the products, processes, and technologies.

(8) Integrated state-of-the-art technology infra-structure where advantageous.

Mohsini and Davidson (1992) examined the effect of six variables of inter organizational conflict on project performance in the traditional building process. Based on the stepwise regression analysis of data provided by 21 project participants, they reported that sufficiency of information and time required to procure further information accounted for more than 60 and 45% of variance of project cost performance and time performance, respectively, while tasks' dependence upon others explained 25% of quality performance variance. The importance of communication among project participants to project performance was evident in the findings of their research.

Bentley and Rafferty, (1992) argued that construction projects differ in scope, size, complexity and degrees of success or failure. Successful projects however are alike in ways that count; they are built by people who follow certain key principles criteria. They discuss the following ten success factors in their research:

(1) Goals and commitment: common goals should be spelled out,

(2) Contract provisions: state the scope of work and performance,

(3) Project team and staffing: responsible, experienced and knowledgeable construction team leads to successful projects,

(4) Communication: give and take attitude is to be maintained,

(5) Pre-construction planning sessions: informal brainstorming sessions are required,

(6) Procedures manual: it outlines the specific methods, systems, and flow of information required to attain stated goals,

(7) Schedule control: derived from project goals and contract provisions,

(8) Cost control: detailed actual costs, plan vs. actual costs on a cash-flow curve,

(9) Meetings / monthly progress reports: teams should meet regularly and redress any deviations from actual plan,

(10) Quality control: must be closely scrutinized during the entire project.

Shenhar, et al. (1997) used 13 success measures adapted from previous research and showed that these measures could be grouped into four dimensions:

(1) Meeting design goals,

(2) Benefit to the customer,

(3) Commercial success, and

(4) Future potential.

Clearly, not all four-success dimensions are of the same importance. Lipovetsky et al. (1997), who analysed defence projects, concluded that the success dimensions meeting design goals and benefit to the customer are the most important ones to all stakeholders in the projects (customer, developer or purchasing organization). In this research he followed a similar approach and looked at success through the eyes of the main stakeholders involved in the project: the end-user, the project manager, and the contractor.

Wong and Maher, (1997) identified the following Key Success Factors from their research:

1. Organization.

- Adopting long-term view of China's evolving market.
- Top management's role.
- Company integrity a.
- The relevance of Western-style management in China.

2. Strategy.

- Technology transfer.
- Enhancing the visibility of Western product quality.
- Converting to local sourcing.
- Capturing regional markets by moving industrial manufacturing sites to the interior as soon as possible.
- Pursuing the firm's core competence.

3. Human Resource Management.

- Increasing the number of indigenous middle managers and technical personnel.
- Choosing the right expatriates.

The change in the key success factors identified by the interviewees in their study was consistent with the proposition that environmental change results in corresponding changes in a firm's strategy and organization that attempt to maintain and hopefully enhance its competitive posture. Because China's market has now entered the growth stage of its life cycle, its infrastructure and its commercial and financial systems will continue to develop. Foreign firms will face increasing competition from Chinese firms, as well as from those of their own kind. They must now advance beyond their initial market-entry concerns that dealt largely with culture, implement these new key success

factors, and prepare for further change as China's market approaches the shakeout and maturity stages.

Chua et al. (1997) identified the critical success factors for construction budget and schedule performance, respectively, using neural network approach. The potential critical success factors considered in the studies covered 27 factors related to the project management, project team, planning, and control effort. These factors are confined to measurable factors and the data were based on completed projects in the United States of America, following is a categorized list:

Project manager:

(1) Number of meetings per month during lifetime of project,

(2) Percentage of time project manager devoted to project,

(3) Frequency of field visits per month during the construction phase,

(4) Number of organizational levels between project manager and craftsmen,

(5) Total years of project management experience,

(6) Experience as project manager on projects with similar cost, duration and technology type (number of projects).

Project Team:

(7) Percentage of project-team-turnover rate per year,

(8) Monetary incentive to designer (% of design contract),

Planning:

(9) Percentage of detailed design complete at construction start,

(10) Number of activities in project execution plan,

(11) Percentage of contingency budgeted for project,

(12) Implementation of constructability program,

Controls:

(13) Number of formal progress inspections per month during construction,

(14) Number of formal quality inspections per month during construction,

(15) Number of formal safety inspections per month during construction,

(16) Control system budget for project (% of total budget),

(17) Frequency of control meetings per month during the construction phase

(18) Frequency of project schedule updates per year,

(19) Frequency of project budget updates per year.

Dvir at al. (1998) concluded that most of their findings are not in conflict with previous studies. For example, they found that following factors have a considerable impact on the results of most types of projects especially in relation to meeting budget and schedule goals and the same holds for systematic control of projects:

(1) Client satisfaction,

(2) Pre-contract activities,

(3) Project Managers competency,

(4) Involvement of the customer follow-up team,

(5) Presence of Key Personnel during the entire duration of the project,

(6) Communication and reports,

(7) Project control schedule (resource & schedule),

(8) Project milestones,

(9) Design considerations (Quality and Reliability, Producibility, Design to cost),

(10) Budget management (Profit & loss report), and

(11) Management policy.

Lim and Mohamed, (1999) discussed in their research about Macro and Micro viewpoints (Figure 2.5 & 2.6) of project success. They suggested that two criteria are sufficient to determine the Macro viewpoint of project success: completion and satisfaction. Whereas the completion criterion alone is enough to determine the Micro viewpoint of project success. They are represented below to help in better understanding of the project success concepts:

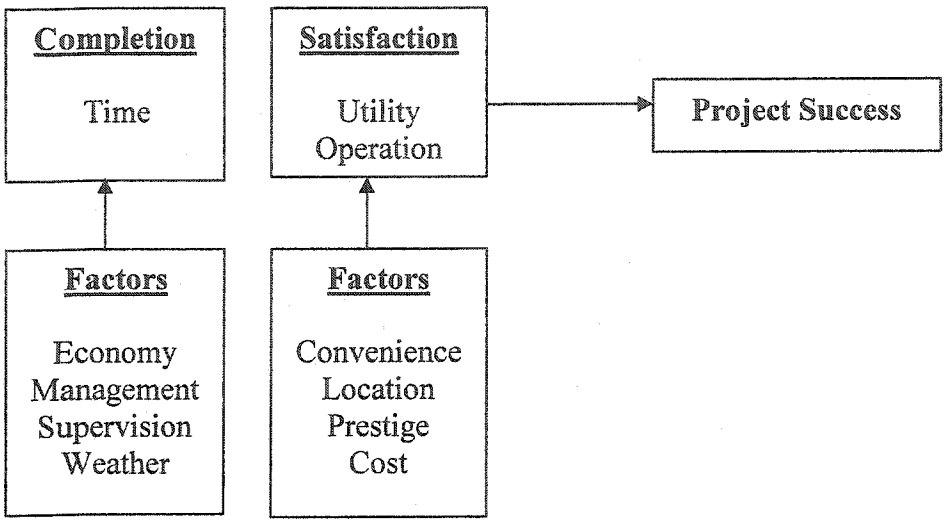

Figure 2.5: Macro Viewpoint of project success (Lim and Mohammad, 1999)

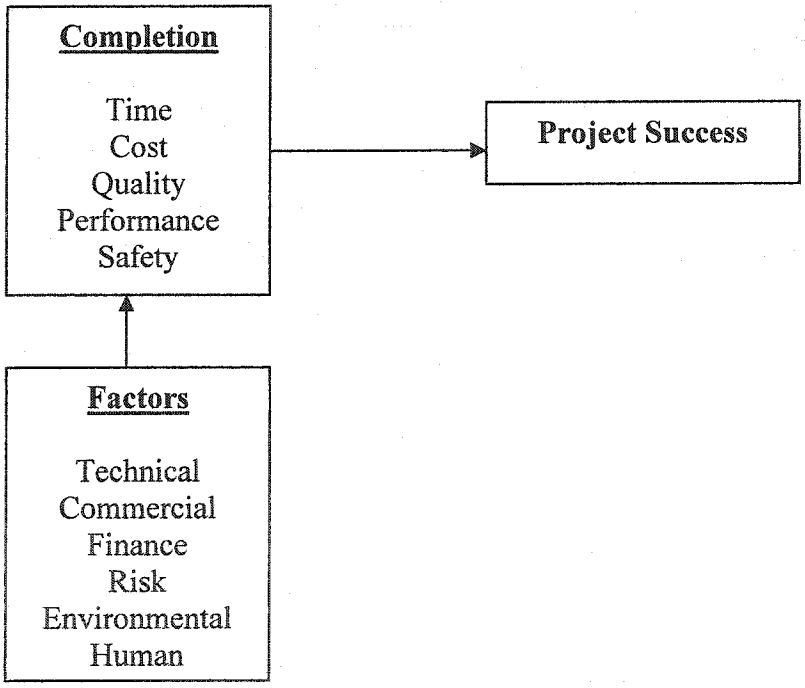

Figure 2.6: Micro Viewpoint of project success (Lim and Mohammad, 1999)

Clarke, (1999) enunciated in her research that there are a number of approaches, methods and activities which organisations can adopt to improve their effectiveness in project management. All of the suggestions made here relate in some way to key success factors identified as drivers for successful project management on the basis that focusing on the `important few' will deliver greater benefit. However, it is recommended that a holistic approach to project management is taken, looking overall at project management and the main problems and issues associated with its use. Then, applying the Pareto principle of using the key success factors to provide solutions to these problems will help ensure more effective project management.

Clarke, (1999) identified four factors as critical to the success of these projects:

(1) Communication throughout the project.

(2) Clear objectives and scope.

(3) Breaking the project into `bite sized chunks'.

(4) Using project plans as working documents.

Kerzner, (1998) identified the following critical success factors in his book:

(1) Adherence to schedules,

(2) Adherence to budgets,

(3) Adherence to quality standards,

(4) Appropriateness and timing of sign-offs,

(5) Adherence to change control processes,

(6) Accomplishment of contract add-ons.

Most of the past work has only identified the critical success factors (CSFs) for project success in general. Various factors contribute differently to different project objectives (Jaselskis and Ashley 1991). Pursuant to the Analytical Hierarchy Process approach, the contribution of the factors towards the three main objectives of budget, schedule and quality can be determined and separate lists of critical success factors can be identified.

Chua et al (1999) identified the critical success factors for construction projects, based on accumulative knowledge and judgment of experts in the industry. The analytical hierarchy process (AHP) was adopted to solicit consistent subjective expert judgment. The AHP procedure developed by Saaty (1990) has been widely used for multi-criteria decision-making. In this study a hierarchical model for construction project success was presented, where success is determined by a variety of factors pertaining to four main project aspects, namely, project characteristics, contractual arrangements, project participants, and interactive processes. Through a survey with experts from leading construction related organizations, the critical success factors for the objectives of budget, schedule, and quality were identified. They categorized the list into the four project aspects:

- Project Characteristics:
- Contractual arrangements
- Project participants
- Interactive Processes

In addition, this approach allows both tangible and intangible factors to be considered in the study. It is also interesting to note that as far as project participants and

interactive processes are concerned, the CSFs identified based on inputs from two different geographical areas exhibit a very high degree of similarity.

The list of top ten CSFs for each project objective is presented in Figure 2.7. Evidently, each set of CSFs differs depending on the project objective. Nonetheless, adequacy of plans and specifications, and constructability emerge prominently as the two most CSFs regardless of project objective. Adequacy of plans and specification will significantly reduce the uncertainties during tender submissions or other contractual negotiations and hence minimize project risks. Furthermore, many of the CSFs were identified from categories pertaining to project characteristics and contractual arrangement.

Success-related factor (1)	Av (2)	Organization Type O1 (3)	O2 (4)	O3 (5)	O4 (6)	Av (7)	Organization Type O1 (8)	O2 (9)	O3 (10)
	Budget performance					Schedule performance			
Adequacy of plans and specifications	1	1	1	1	3	1	2	3	2
Constructability	2	3	4	2	—	2	4	5	1
Economic risks	3	4	—	3	2	—	—	—	—
Realistic obligations/clear objectives	3	—	2	—	5	6	—	1	3
PM competency	5	2	—	—	4	4	1	—	—
Adequacy of funding	6	5	—	—	—	—	—	—	—
Budget updates	7	—	3	—	—	—	—	—	—
PM commitment and involvement	8	—	—	—	—	3	5	—	—
Contractual motivation/incentives	9	—	5	—	—	5	3	—	—
Risk identification and allocation	10	—	—	3	—	—	—	—	—
Political risks	—	—	—	4	—	—	—	—	—
PM authority	—	—	—	—	1	—	—	—	—
Schedule updates	—	—	—	—	—	7	—	2	5
Construction control meetings	—	—	—	—	—	8	—	4	—
Capability of contractor key person	—	—	—	—	—	9	—	—	—
Site inspections	—	—	—	—	—	10	—	—	—
Pioneering status	—	—	—	—	—	—	—	—	4
	Quality performance					Overall			
Adequacy of plans and specifications	1	1	2	1	4	1	2	1	2
Constructability	2	3	3	3	5	2	3	3	1
Site inspections	3	4	4	2	—	7	—	—	5
PM commitment and involvement	4	—	—	—	—	3	5	—	—
Realistic obligations/clear objectives	5	—	1	5	2	4	—	2	3
PM competency	6	2	—	—	3	4	1	—	—
Construction control meetings	7	—	5	—	—	8	—	—	—
Formal communication (construction)	8	—	—	—	—	9	—	—	—
Capability of contractor key person	9	—	—	—	—	—	—	—	—
Design control meetings	10	—	—	—	—	—	—	—	—
Contractual motivation/incentives	10	—	—	—	—	6	4	4	—
Pioneering status	—	5	—	—	—	—	—	—	—
PM authority	—	—	—	—	1	—	—	—	—
Supplier level of service	—	—	—	3	—	—	—	—	4
Economic risks	—	—	—	—	—	9	—	—	—

Note: Av = average rank; O1 = consultant; O2 = contractor; O3 = client; O4 = project management.

Figure 2.7: Ranking of CSFs for different Project Objectives (Chua et al 1999)

Kayworth and Leidner, (2000) summarized some critical success factors, from their research:

(1) Communication

- Emphasize continuous communication
- Set meeting schedules and rules of engagement
- Conduct periodic face-to-face meetings
- Engage in team building activities at onset of virtual team creation

(2) Culture

- Instill a sense of cultural awareness
- Create teams from complementary cultures

(3) Technology

- Ensure infrastructure compatibility among geographic locations
- Assess political and economic barriers to international telecommunications

(4) Project management (leadership)

- Set clear team goals and provide continuous performance feedback
- Build team cohesiveness
- Express flexibility and empathy towards team members
- Exhibit cultural awareness

Ghosh et al. (2001) determined the strategy dynamics and key success factors (KSFs) for excellence in performance of projects. The companies interviewed showed that they can excel, even in the current highly competitive and high operation cost environment. Their performance can be attributed to their dynamism and a few KSFs that

are apparently universal to these successful companies. The top six Key Success factors were found to be:

(1) A committed, supportive, and strong management team.

(2) A strong, visionary, and capable leadership.

(3) Adopting the correct strategic approach.

(4) Ability to identify and focus on market.

(5) Ability to develop and sustain capability.

(6) A good customer and client relationship.

The importance placed by organizations adopting different strategy types on their strategic posture are different although KSFs and capabilities are generally universal. Comparing proactive with passive strategy types, the degree of emphasis given various success factors by proactive type companies was generally found to be higher. Specifically, proactive type companies placed higher importance on the following factors for excellent performance:

(1) Satisfying customers needs i.e. ability to deal effectively with customer complaints,

(2) Close working relationship between top management and employee,

(3) Regionalization,

(4) Leadership,

(5) Availability of financial and technology resources and support.

Chan et al (2001), reported six project success factors from their research,

(1) Project team commitment,

(2) Contractor's competencies,

(3) Risk and liability assessment,

(4) Client's competencies,

(5) End-users' needs, and

(6) Constraints imposed by end-users.

These were extracted by factor analysis on 31 variables developed through a synthesis of empirical studies and project participants' opinions. These factors formed the basis for Design and Build project evaluation. Three of the factors were found to be critical in explaining the overall Design and Build project performance from the multiple regression results. Specifically, the project team commitment, client's competencies, and contractor's competencies are important to bring about the successful outcome for public-sector Design and Build projects. The contractor's competencies also contribute to project time performance. All of these factors highlight that the Design and Build project success rests on the commitment of and efforts input by all parties to the project.

Davies, (2002), while discussing the "Real" success factors articulated that, the first surprise thrown up by the analysis was that when schedule delay and cost escalation were compared for individual projects there was the expected strong correlation between the two, but only a small amount of the cost escalation was accounted for by schedule delay.

These practices that correlate to on-time performance are:

(1) Adequacy of company-wide education on the concepts of risk management.

(2) Maturity of an organisation's processes for assigning ownership of risks.

(3) Adequacy with which a visible risk register is maintained.

(4) Adequacy of an up-to-date risk management plan.

(5) Adequacy of documentation of organisational responsibilities on the project.

(6) Keep project (or project stage duration) as far below 3 years as possible

(1 year is better).

On the other hand, those that correlate to on-cost performance are:

(7) Allow changes to scope only through a mature scope change control process.

(8) Maintain the integrity of the performance measurement baseline.

Dvir et al. (2002) in their research discussed the relationship between project planning and project success. They argued that the four success-measures are highly inter-correlated, implying that projects perceived to be successful are successful for all their stakeholders. The four success-measures are:

(1) Meeting planning goals. (success at the project manager level)

(2) End-user benefits. (success from the end-user point f view)

(3) Contractor benefits. (success at the contractor's level,)

(4) Overall success measure.

Tables A to C (Figure 2.8) below shows elements or essential components for each of the three measures of success used in their study.

Table A **Essential components for "Meeting planning goals" items**
Meeting Functional Requirement as defined during the design phase Meeting Technical Specifications as defined during the design phase Meeting Schedule Meeting Budget goals Meeting Procurement goals (number of items supplied compared to plan)
Table B **Essential components for "End-user benefits" items**
Satisfying end-user operational need Project end-product is in use Systems delivered to end-user on time System has significant usable life expectancy Performance level superior to previous release End-user capabilities significantly improved End-user satisfied from project end-product
Table C **Essential components for "Contractor benefits" items**
Profit exceeded plans Profit exceeded similar projects Created new market Created new product line Developed new technologies and infrastructures Developed new knowledge and expertise Generated positive reputation Responded to business or competitive threat

Figure 2.8: Essential components for different users (Dvir et al., 2002)

In Table A (Figure 2.8) there were 81 observations with valid responses to all five items. The factor analysis carried out on these observations yielded a single factor that explains 61% of the variance. Consequently, for the correlation analysis, they used the average of the response to these five items. In Table B (Figure 2.8) there were 60 observations with valid responses to all seven items. The factor analysis carried out on these observations yielded a single factor explaining 66% of the variance. Here again, in the rest of the analysis they used the average response to these items. In Table C (Figure 2.8) there were 87 observations with valid responses to all eight items.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

The research encircled those project participants (experts) belonging to three major groups i.e. (owner/owner representative, consultant, contractor), who had a minimum of ten (10) years experience in the Saudi Arabian construction industry. Experts interviewed were experienced in industrial, commercial, and residential projects belonging to private sector, semi-government or government sectors.

First of all whole concentration of research was on acquiring the knowledge through extensive literature review about different project objectives, project participants and critical success factors from the point of view of researchers and project participants throughout the world.

The research methodology constitutively distributed into following phases of research program as shown in the following flowchart:

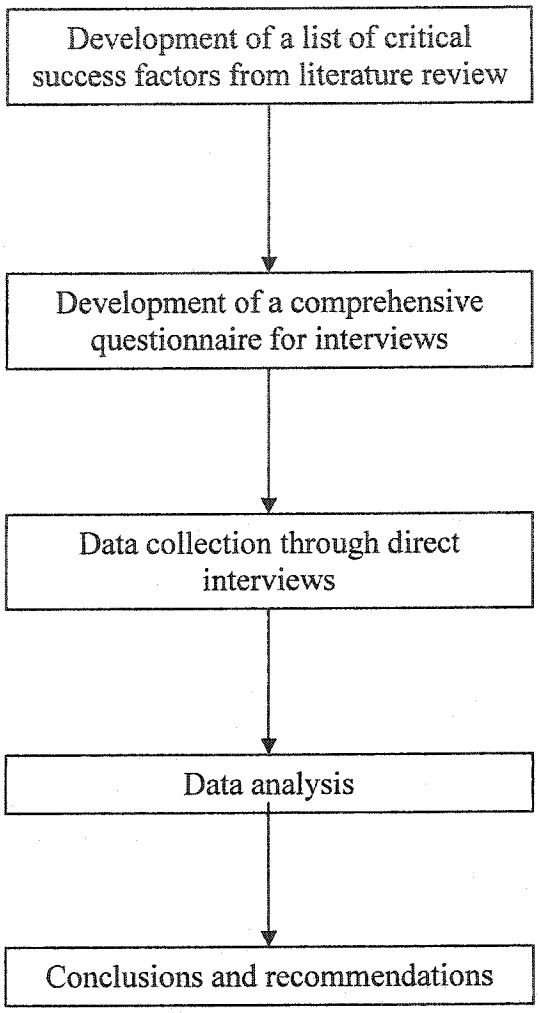

Figure 3.1: Methodology Flowchart

3.2 DEVELOPMENT OF A LIST OF CRITICAL SUCCESS FACTORS FROM THE LITERATURE ANALYSIS

In this phase of research methodology, a comprehensive list of sixty (60) critical success factors as identified by various researches in the construction industry was developed. These factors were grouped under three main project aspects, namely, project participants, management communication & control and project characteristics. There are two major reasons for grouping the success-related factors under separate sub-hierarchies. First, factors of similar nature should logically be grouped into one cluster to facilitate pairwise comparisons during the survey. Second, it is known that an individual cannot simultaneously compare more than 7 ± 2 elements with satisfactory consistency and hence hierarchical decomposition is desirable (Saaty and Vargas 1991).

3.2.1 LIST OF CRITICAL SUCCESS FACTORS DEVELOPED FOR THE PRESENT RESEARCH

Following Table shows a list of Sixty (60) factors that will be used in the questionnaire survey/interviews. This list includes top most important factors from previous researches conducted in the construction industry, in various parts of the globe. The factors are grouped into three categories for two reasons. First, factors of similar nature should logically be grouped into one cluster to facilitate pairwise comparisons during the survey. Second, it is known that an individual cannot simultaneously compare more than 7 ± 2 elements with satisfactory consistency and hence hierarchical decomposition is desirable (Saaty and Vargas 1991).

Table 3.1 Success factors considered in this study

Project aspect	Success-related Factor
Project participants	(1)Owner enthusiasm, (2)Owner commitment to established budget & schedules, (3)Owner satisfaction with the delivered project, (4)Frequent feedback from the owner, (5)PM competency & authority, (6)On-site project manager, (7)Project team capability and commitment, (8)PM commitment to established budget & schedules, (9)Nature of the projects managers' authority, (10)Capability of contractor key person, (11)Contractor commitment to established budget & schedules, (12)Contractor team capability and commitment, (13)Consultant team capability and commitment, (14)Consultant commitment to established budget & schedules, (15)Capability of Consultant key person.
Management, communication & control	(16)Absence of bureaucracy, (17)Flexible parent organization, (18)A good customer and client relationship, (19)Accomplishment of Contract add-ons, (20)Meeting design goals, (21)Pre-contract activities, (22)Budget management (Profit & loss report), (22)Risk identification and management, (24)Design-Construction interface management, (25)Frequent feedback from the parent organization, (26)Monitoring and feedback from the project, (27)Communication throughout the project, (27)Beneficial coordination between professionals, (29)Construction control meetings, (30)Design control meetings, (31)Site inspections, (32)Adherence to schedules, (33)Adherence to budgets, (34)Adherence to quality standards, (35)Adherence to change control processes, (36)Quality Control Program, (37)Safety Control Program.
Project Characteristics	(38)Site limitation and location, (39)Constructability, (40)The size of the project (measured by total cost), (41)Pioneering status, (42)Economic risks, (43)Clearly defined project mission, objective & scope, (44)Breaking the project into `bite sized chunks', (45)Using project plans as working documents, (46)Design considerations (Quality and Reliability, Producibility, Design to cost), (47)Adequacy of plans and specifications, (48)Realistic obligations/clear objectives, (49)Formal dispute resolution process, (50)Contractual motivation/incentives, (51)Accurate initial cost estimates, (52)Adequate funding to completion, (53)Adequate planning and control techniques, (54)Sufficient Working Drawing details, (55)Minimal start-up difficulties, (56)Availability of back-up strategies, (57)The perceived value of the project, (58)Lack of legal encumbrances, (59)Minimized number of Public/government agencies involved, (60)Constraints imposed by end-users.

3.3 DEVELOPMENT OF A COMPREHENSIVE QUESTIONNAIRE FOR INTERVIEWS

After retrieving the most influential critical success factors through comprehensive analysis of data and the allegations of the participants, in this phase a questionnaire was developed, attached as Appendix I. Initially a pilot study was done. At least nine people were interviewed and this helped in further simplification of the questionnaire, based on their opinions. As a result of these pilot stage interviews, the initial sixty five (65) factors were reduced to sixty (60) and also these were grouped in three project aspects as already discussed. Final questionnaire was developed for interviews of selected grade-1 or grade-2 contractors, eminent consultants and project managers representing owner organizations, in the Eastern Province of Saudi Arabia.

3.3.1 SAMPLE SIZE

At least twenty (20) experts from each group were required for the interview from each group. The relatively small sample size is mainly attributed to two reasons. Firstly only those with about 10-15 years experience on projects greater than 5 Million Saudi Riyal, were to be approached in order to preserve the quality of the opinions gathered in the survey. Secondly, some experienced practitioners contacted might be reluctant to participate in the survey because of the commitment expected from them, bearing in mind that they have to make pair wise comparisons of 60 success-related factors across three project objectives. In order to secure good quality data, a brief presentation with regard to the object and methodology of the study was made to every respondent individually. The respondents were specifically reminded of the importance of observing consistency in

their answers. They were made to understand that their responses should not be biased towards any particular project whether it was highly successful or disastrous.

3.4 DATA COLLECTION THROUGH DIRECT INTERVIEWS

In this phase of research study, direct interviews were be conducted with the consultant engineers, contractors/representatives and owners/ owners representatives, in order to do the pair wise comparison of various critical success factors identified earlier, for different project objectives (budget, schedule and quality). These interviews were conducted in two phases. In the first phase only nine (9) experts were interviewed. The main objective of this phase was solely to refine the questionnaire.

The second phase of interviews began, after the refinement of the initial questionnaire. During the second phase of interviews, an introduction letter, explaining the objective of the research and also seeking their interest in the participation of this research was sent to randomly selected companies belonging to the three groups, through email and fax, attached as Appendix II. Meetings were arranged with those experts who showed interest in the study, and responded to the initial faxes or emails. A set of brief definitions of all the factors was also developed and taken to all the interviews, to help the experts in better understanding what each factor meant. The data collected belonged to the Ordinal class as it was measured on a scale whose values were categories that have a natural order but no quantitative relationship.

3.5 DATA ANALYSIS

Data collected by means of interviews was separated and screened, for different project participants. A hierarchical model was developed in order to do a detailed analysis of the findings, using Expert Choice, software based on the Analytical Hierarchy Process (AHP). The analysis assisted to point out the most important critical success factors, according to each project participant as well as for the overall construction industry. Agreement between different project participants was also calculated using Spearman's and Kendall's technique.

3.5.1 THE AHP STEPS

The AHP involves four steps:

1. Constructing a decision hierarchy by breaking down the decision problem into a hierarchy of inter-related elements.
2. Performing pair-wise comparisons of the inter-related elements.
3. Estimating the weights of the decision elements by using eigen-value method.
4. Aggregating the relative weights of the decision elements to provide a set of ratings for the decision alternatives.

Three major principles of analytic thought associated with AHP are the construction of hierarchy, establishment of priorities and logical consistency (Saaty, 1990).

3.5.1.1 Constructing Hierarchy:

Once the decision factors that will ensure the achievement of the goals are selected, they are arranged in a hierarchic structure descending from an overall goal to criteria, sub-criteria and alternatives in successive levels. When constructing hierarchies, one must include enough relevant detail to (Saaty, 1980):

- Represent the problem as thoroughly as possible, but not at the expense of loosing sensitivity to change in the elements;
- Consider the environment surrounding the problem;
- Identify the issues or attributes that contribute to the solution; and
- Identify the participants associated with the problem.

Structuring the problem into hierarchy serves two purposes. First, it provides an overall view of the complex relationship of variables inherent in the problem; and second; it helps the decision maker in making judgment on comparison of elements that are homogeneous and on the same level of the decision hierarchy.

There are rules on how to construct a hierarchy. Approach depends on the type and complexity of the decision to be made (Saaty, 1990). The most common technique is to start from top and move downward. Based on the assumption that the human mind has a limited capacity to compare 7 ± 2 elements simultaneously (Saaty, 1990), the number of elements at each level of the hierarchy should not exceed nine. This constraint, however, is not a necessary condition of the method and has not been adhered to in all applications (Zahedi, 1986).

At the top of the hierarchy lies the most general objective of the problem, such as the objective of making the best decision or selecting the best alternative. The number of

levels depends on the complexity of the problem and on the degree of detail. Each level of hierarchy contains attributes or objectives that influence the decision. Details of the attributes increase at hierarchy. The last level of hierarchy contains alternatives or selection choices. (Al-Jaroudi, 1998)

3.5.1.2 Establishing Priorities:

A hierarchy of levels is meaningless if priorities are not determined. A method is therefore needed to decide how much various elements are rated relative to each other and how much this level influences elements of the next higher level, so that the relative strength of the impact of the elements in the lower level on the overall hierarchy can be calculated (Saaty, 1990).

Every input is rated on a 1-9 judgment scale to determine relative importance of the different attributes on one level of the hierarchy to one another. The 1 to 9 scales used is tabulated in Table 3.2:

Table 3.2 Pairwise Comparison Scale (Saaty, 1990)

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**
Reciprocals	**For the inverse comparison**

After scales of judgment have been identified for all levels of the hierarchy, matrices are constructed for each level starting from the top of the hierarchy.

Suppose we wish to compare a set of *n* attributes in pairs according to their relative weights, as shown in Figure 3.2. The top left entry of the matrix represents the attributes that are being compared and denoted by A1, A2, A3,..., A*n* and their weights by w1, w2, w3, ..., w*n*. The pairwise comparisons may be represented by a matrix of underlying ratios as shown in figure below. The matrix satisfies the reciprocal property $a_{ji} = 1/a_{ij}$. Thus, reciprocals of the judgments are obtained by reversing the comparison. For example, when A1 scores 5 in the level of importance with A2, then A2 receives 1/5 when compared with A1.

$A =$

Criterion	***A1***	***A2***	***A3***	...	***An***
A1	**W1/w1**	**w1/w2**	**w1/w3**	...	**w1/w*n***
A2	**W2/w1**	**w2/w2**	**w2/w3**	...	**w2/w*n***
A3	**W3/w1**	**w3/w2**	**w3/w3**	...	**w3/w*n***
	.				
	.				
	.				
An	**W*n*/w1**	**W*n*/w2**	**W*n*/w3**	...	**W*n*/w*n***

Figure 3.2: A simple matrix of pair-wise comparisons (Saaty, 1990)

To find overall priorities, the subjective judgments (1-9) must be synthesized to estimate the relative priorities of the objectives with respect to each other criterion. To do so, the values in each column of the comparison matrix must be added, dividing each entry in the matrix by the total of the corresponding column to obtain the normalized matrix. Finally, the entries of each row of the normalized matrix must be added, dividing the total by the number of entries of each row to obtain the averages. Those averages are

the estimates of the overall priorities for the lower level alternatives. These values are between 0 and 1, and their total should be unity.

Next, a hierarchy composition (synthesis) is used by multiplying the vectors of priority by the weight of the criteria, and taking the sum over all weighted priority entries corresponding to those in the next lower level, and so on. The result is the overall priority for the lowest level of the hierarchy.

The priorities are derived from the matrices of judgment based on the mathematical principles of the eigenvector and the corresponding eigen-value. The eigenvector provides priority ordering while the eigen-value is a measure of the consistency of judgment (Saaty, 1990)

3.5.1.3 Logical Consistency:

Although, perfect consistency is hard to achieve, especially when considering multiple conflicting criteria, AHP provides a mechanism of measuring the consistency of the decision made, and allows for revisions of the decision in order to reach an acceptable level of consistency.

The AHP measures the consistency of judgment by means of Consistency Ratio (CI). If the value of the ratio is 10 percent or less, the decision is "good". If the value exceeds 10 percent, the judgment may somehow be random and should be revised (Saaty, 1990).

Calculating the CR starts with multiplying each entry of the pair-wise comparison matrix by the relative priority (the average) corresponding to the column, and then

totaling the row entries. Next, the row totals are divided by the corresponding entry from the priority vector. The average of those entries is the eigen-value λ_{max}.

Consistency Index (CI) is then measured using the formula

$$CI = (\lambda_{max} - n)/(n - 1)$$

Where n is the number of elements being compared in the matrix. The CI is then divided by its random index (RI) to get the consistency ratio, which is a measure of how much variation is allowed. The model was built in the software, Expert Choice, 2000.

3.5.2 SPEARMEN CORRELATION (r_s)

Spearman *R* can be thought of as the regular Pearson product-moment correlation coefficient (Pearson *r*); that is, in terms of the proportion of variability accounted for, except that Spearman *R* is computed from ranks. Spearman Correlation coefficient can range from -1.00 to +1.00. -1.00 represents a perfect negative correlation, +1.00 represents a perfect positive correlation and 0.00 represents a lack of correlation. The Spearmen correlation is used to find and compare how well any two parties agree while ignoring the third party completely. It is calculated by the following formula: (Thondike, 1978)

$$\mathbf{r_s = 1 - 6\,\Sigma d^2/(n^3 - n)}$$

Where;

r_s = The Spearmen correlation

d = the difference between ranking for each group of judges

n = number of factors to be ranked

3.5.3 KENDALL'S CONCORDANCE ANALYSIS (τ)

The Kendall coefficient of concordance (τ) is a measure of degree of association or agreement among sets of rankings. Range of the coefficient of concordance (τ) is from zero to one. One indicates a perfect agreement and zero indicates no agreement. To calculate the Kendall coefficient τ, the data is first arranged into a 'k x n' matrix. Each row (n) representing ranks assigned by a particular judge (k) to (n) factors or aspects of a concept or problem. It can be calculated by using the following formula: (Thondike, 1978)

$$\tau = \frac{\sum_{i=1}^{k} (R_i - R)^2}{n(n^2-1)/12}$$

R_i = average of the ranks assigned by an individual.

R = average of the ranks assigned to the nth variable factor (sum of R_i / n)

k = Number of judgments

n = the number of aspects of a problem or factor being ranked (60)

n (n^2-1) /12 = the maximum possible squared deviations; i.e. the numerator which will occur if there were perfect agreement among k sets of ranks, and the average ranking were 1,2,3,.....,n

3.6 CONCLUSIONS

Results are tabulated for each project objective as well as for overall project success. The results of this study will provide a forecasting tool to enable parties to rapidly assess the possibility of a successful project from the viewpoint of experts. Based on the conclusions further recommendations are developed as the base for further research in the very context of the critical success factors in construction industry of Saudi Arabia.

CHAPTER FOUR

CRITICAL SUCCESS FACTORS IN SAUDI ARABIA

4.1 INTRODUCTION

This chapter apportions the definition of success as provided by different project participants, review of the model built in Expert Choice software, discussion of results obtained after the analysis of the pairwise comparisons for all the factors done by the three project participants as well as all participants for overall success and for each of the project objectives, level of agreement between project participants. The questionnaire comprised of two parts. The first part consisted of general information of the interviewee, while the second part consisted of the actual pairwise comparison matrices. None of the questionnaires were rejected as only those experts from the construction industry were approached who met the requirements of minimum work experience of 10 years and minimum experience on projects worth 5 million Saudi Riyals.

4.2 DEFINITIONS OF SUCCESS FROM THE EXPERTS IN THE SAUDI ARABIAN CONSTRUCTION INDUSTRY

Table 4.1 shows some definitions of successful projects as defined by the experts from the Saudi Arabia construction industry.

Table 4.1: Definition of project success according to project participants

Project Participant	Definition
Consultant	Completed within the budget and agreed schedule and meeting the specifications. It should produce the desired end result and customer/owner satisfaction.
	A project which has attained full customer satisfaction with regard to its use, cost and time effective completion.
	A successful project can be judged by timely completion, smooth start-up, customer satisfaction for quality and nominal variance on budgeted cost
Contactor	A successful project is one which meets the project objectives, schedule and completed without any over run.
	Meeting the budget, time and quality with minimum problems occurring during the time of project.
Owner	When we talk about government projects, especially 'Municipal Projects' the successful project should meet the required factors; cost, time and quality. For many reasons, the governmental agencies give more attention to 'Cost'. The governmental system gives the projects to the lowest bidder (lowest cost) directly without evaluating the quality. To make governmental projects successful, we should take the 'Quality Factor' as a core element.
	A successful project is one that is completed on or before the completion date, within budget and meets the job specification.
	The best compromise between Cost and Quality achieved during the given Time frame.

Table 4.1 shows definition of success as given by the three project participants. The definitions given by each participants reflect the objectives whose achievement mark success and that is why each participant defined success based on the achievement of their own objectives. The consultants laid great emphasis on the achievement of quality and owner satisfaction, the contractors relate success of a project to its timely completion and the owners apart from timely completion are also concerned with the lack of quality in government projects.

4.3 MODEL DEVELOPED IN EXPERT CHOICE

The model is developed in Expert Choice (EC) software is a multi-objective decision support tool based on the Analytic Hierarchy Process (AHP), a powerful and comprehensive methodology designed to facilitate sound decision making by using both empirical data as well as subjective judgments of the decision-maker. (www.expertchoice.com)

Pursuant to this approach, the research problem is decomposed into a hierarchy, as shown in Figure 4.1 with three levels of hierarchy. At the top (Level 1) of the hierarchy is the goal or overall objective of the research i.e. "critical success factor". Level 2 of the hierarchy comprises the main criteria i.e. time, cost and quality to achieve the goal. The sub-objectives are at the third level of the hierarchy followed by the critical success factors or the alternatives at the bottom or last level of the hierarchy.

Figure 4.2 shows the hierarchy model developed in Expert Choice 2000 software. Figure 4.3 shows the pairwise comparison data grid in which factors for projects

characteristics are being compared for the cost objective. Weights are assigned to each factor from a scale varying form 1 to 9.

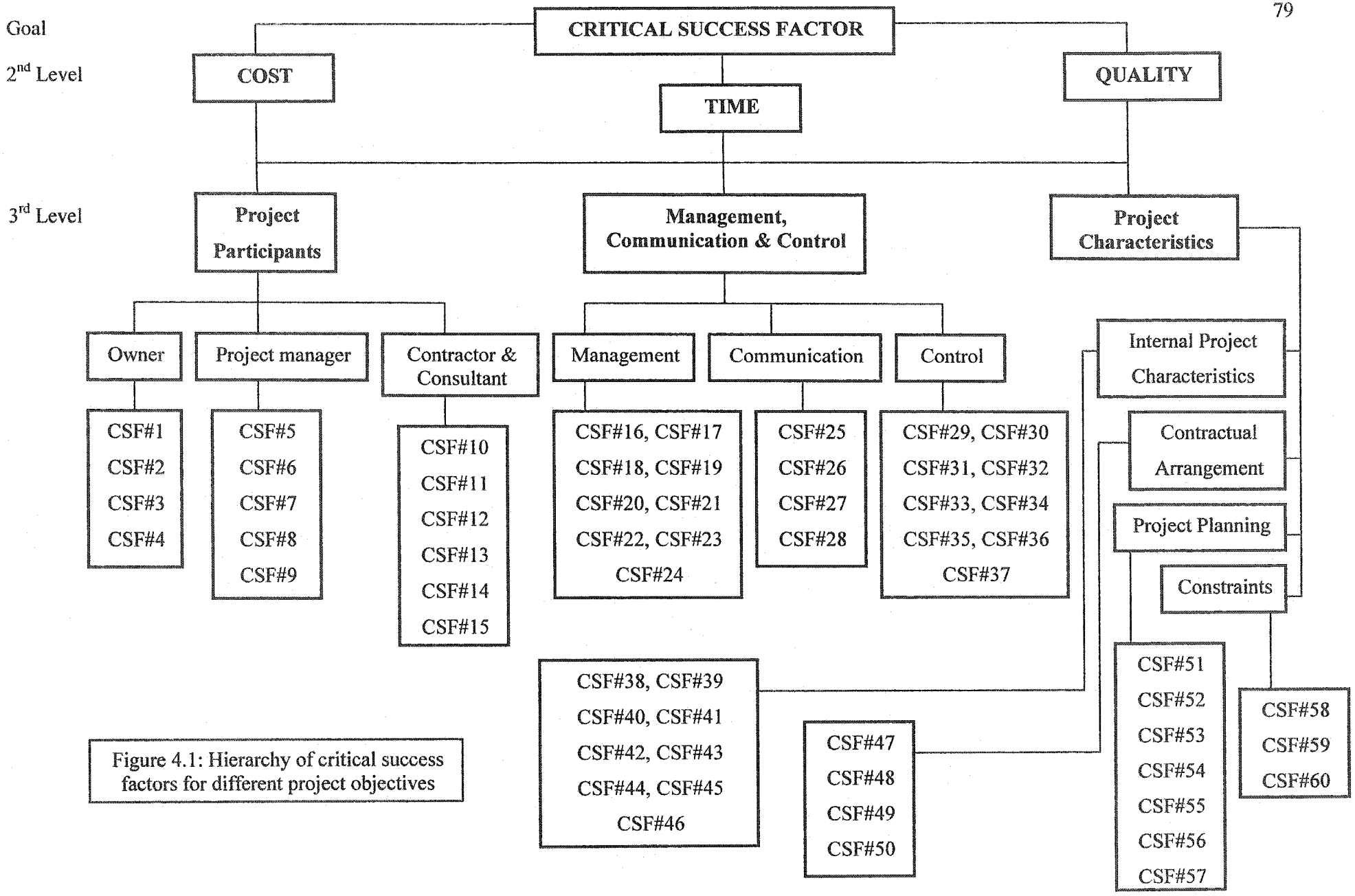

Figure 4.1: Hierarchy of critical success factors for different project objectives

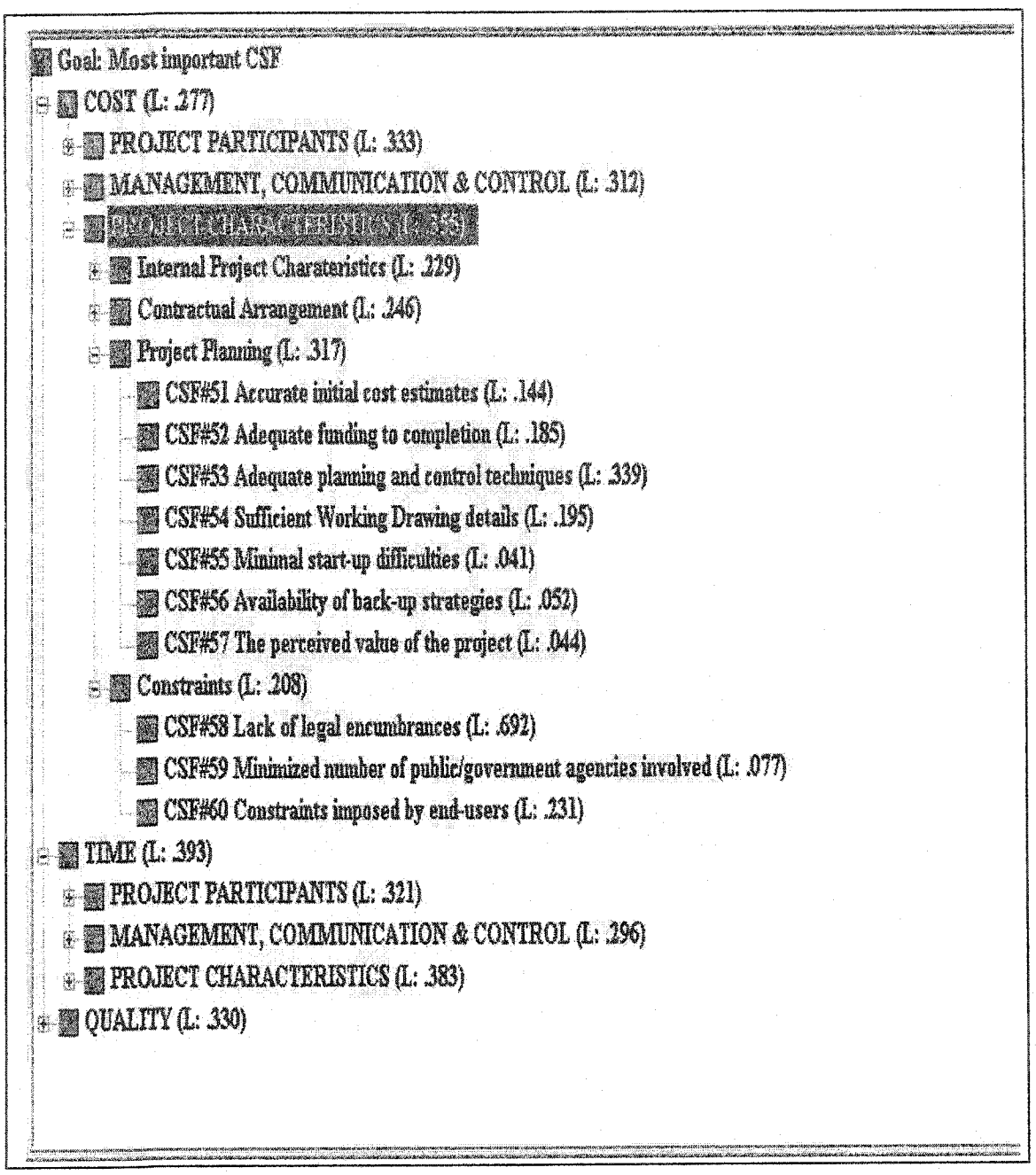

Figure 4.2: Hierarchy model developed in Expert Choice, 2000 software

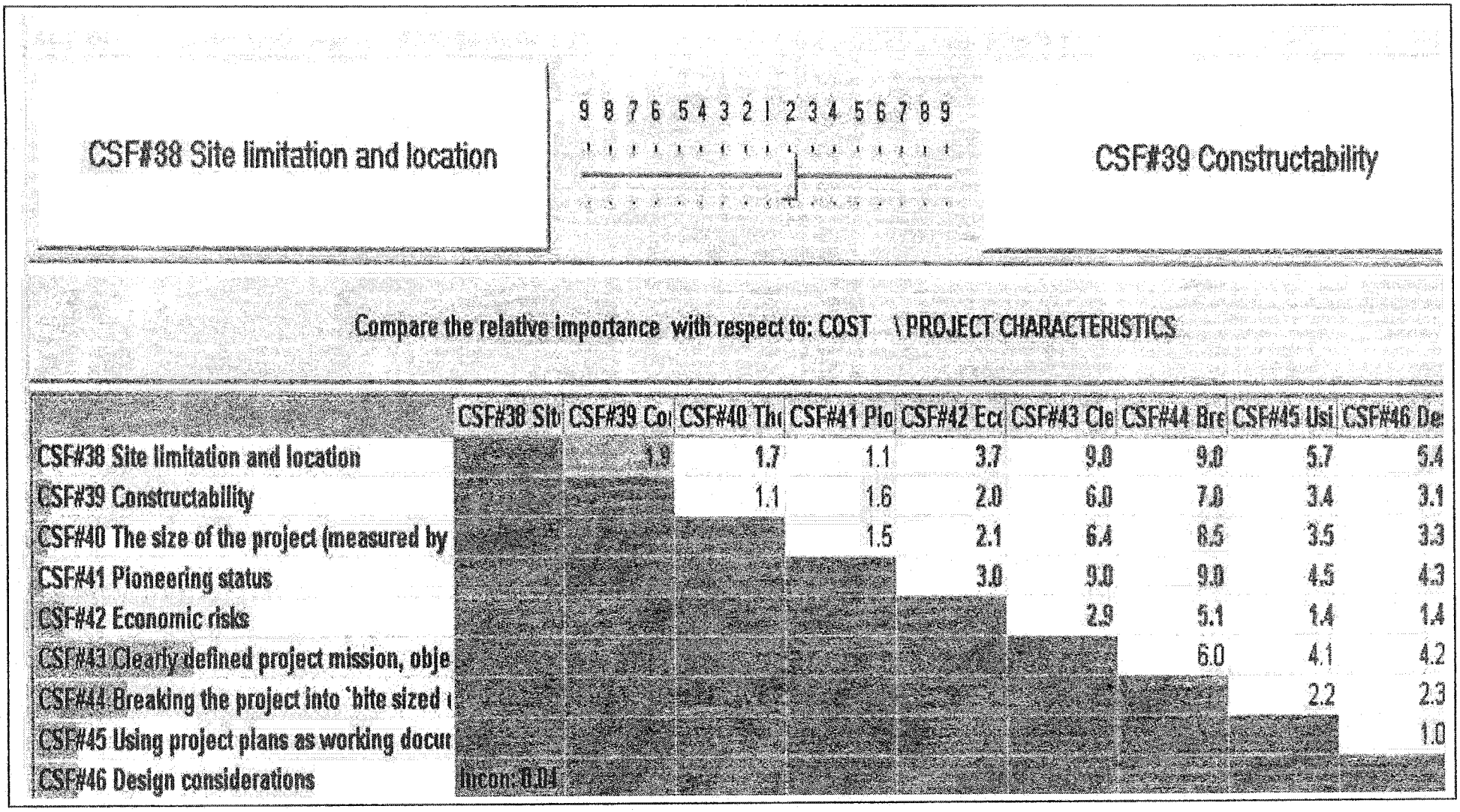

Figure 4.3: Pairwise comparison data grid built in Expert Choice 2000

4.4 CONSULTANTS

4.4.1 GENERAL PROFILE

Major portion i.e. 73% of the experts contacted from consultant firms for this research study had 10 years experience and 27% with more than 15 years of professional experience in construction industry. The experts contacted mostly had experience in projects worth 10 – 15 million Saudi Riyals, well above the lower limit of 5 million Saudi Riyals. The completed projects were 35% government projects, 35% were private projects, and 30% were semi government projects. All the experts contacted had substantial experience in all the three types of projects i.e. commercial, residential and industrial.

4.4.2 PROJECT OBJECTIVE

Project objective rankings are shown in Figure 4.4. These rankings have been normalized for one (1) for easy perception. Consultants have preferred *quality* to both *cost* and *time*, only because major proportion of the experts interviewed had experience in private sector projects, and in private sector quality has always been a prime objective. It is know that quality in construction is defined as conformance with requirements, as defined by the owner, designer, contractor, and the regulatory agencies. The present survey shows that achieving high quality is their main aim. The attainment of acceptable levels of quality in the construction industry has long been a feature of the debate about the future direction of the construction industry.

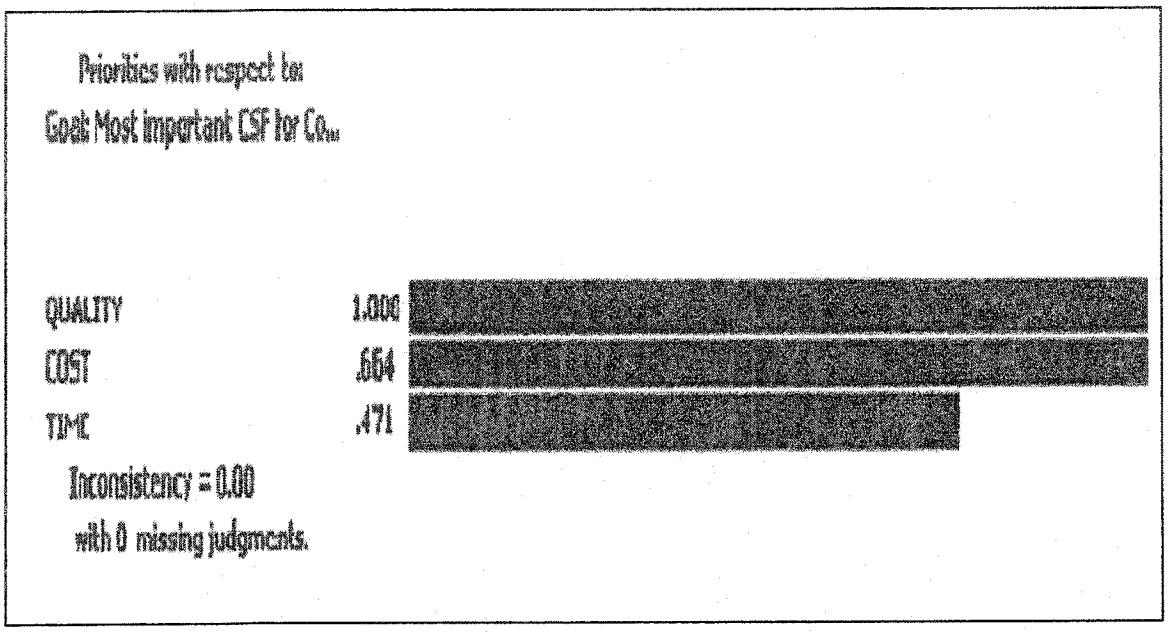

Figure 4.4: Project objective rankings done by consultants

Consultant/Design organizations play a major role in construction industry. They are the media that transfer the requirements of the client to the contractor and ensure that they are met. Thus they need to provide a high quality of service to ensure that their client's project achieves the best possible standards of cost, time and quality (Bubshait et al, 1999). The present study is therefore in conformance with the studies of the past conducted in this region.

4.4.3 OVERALL PROJECT SUCCESS

The overall ranking of top fifteen success factors for overall project objective is shown in Figure 4.5. Top five (5) factors are as follows and discussed in the following section:

1. Owner satisfaction with the delivered project.
2. Adequate planning and control techniques.
3. Capability of the consultant key person.
4. Frequent feedback from the owner.
5. Accurate initial cost estimates.

4.4.3.1 Owner satisfaction with the delivered project

Owner satisfaction with the delivered project has been ranked as the most important factor for all the project objectives. In recent decades, client dissatisfaction with both the products and services delivered by the sector has placed increasing pressure on service providers to improve performance. This result is in conformance with the study carried out by Sanvido et al. in 1992. The owner's role in Saudi public construction project management is diversified. Al-Jarallah (1983) stated: "Management of a construction project, has not been standardised and is largely a function of the ingenuity and experience of a particular construction company. This diversity is very visible in Saudi Arabia due to the different nationalities of the construction professionals." owner's role was highlighted in the ASCE manual of Professional Practice: "Quality, in the constructed project (1988)". The manual describes the high impact that the owner has on quality of a constructed project, which in many cases will determine the project's success

or failure. Thrush et al. (1987) concluded from their research that "owners who exercise close involvement seem to be the most satisfied with their project results." So the owner's satisfaction is only possible if he is involved in the project in all the stages of the project.

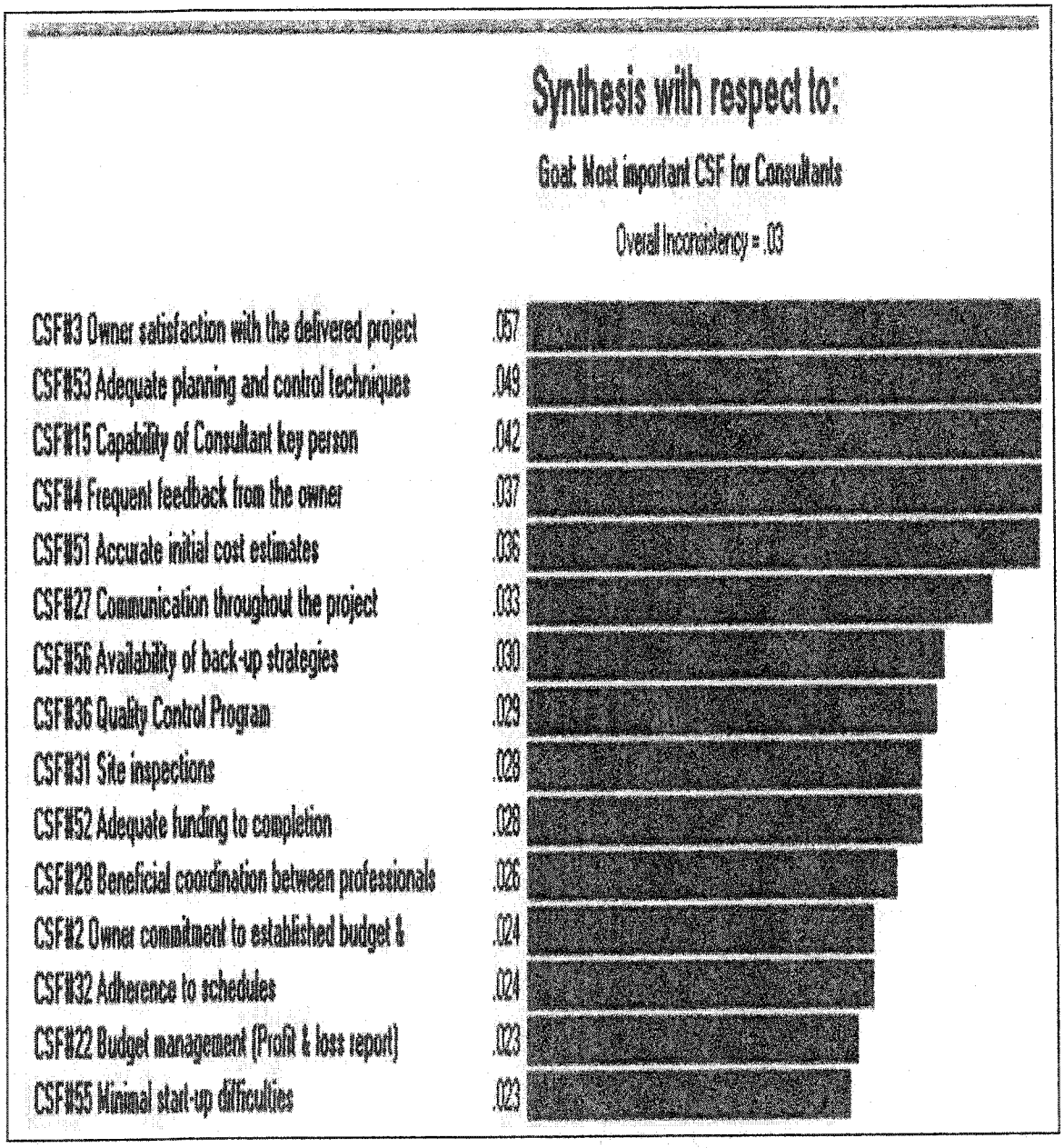

Figure 4.5: Overall ranking of success factors done by consultants

4.4.3.2 Adequate planning and control techniques

Planning and controlling has always been a key ingredient in a projects success. Construction planning is a fundamental and challenging activity in the management and execution of construction projects. It involves the choice of technology, the definition of work tasks, the estimation of the required resources and durations for individual tasks, and the identification of any interactions among the different work tasks. Programs should be in place to deal with initial plans and project scheduling. A good construction plan is the basis for developing the budget and the schedule for work. Developing the construction plan is a critical task in the management of construction, even if the plan is not written or otherwise formally recorded. In addition to these technical aspects of construction planning, it may also be necessary to make organizational decisions about the relationships between project participants and even which organizations to include in a project.

Project planning usually may begin with a clear understanding of project objectives and project execution plan. Usually the first step is the development of the work breakdown structure (WBS) and required levels of schedule detail. It is followed by identification of known key/critical restraints and interfaces.

An adequate control process is used for collecting, measuring and presenting facts relating to time, cost and accomplishment of quality standards, all measured against a specific plan. It shows the process, status, background, timing and phasing of the project activities, thus providing management with measuring tools that help:

- Comparing actual progress with a formal objective plan.

- Examining only the deviations from established plans, and gauging their degree of severity with respect to the remainder of the project.
- Receiving timely information concerning trouble areas and indicating areas where appropriate corrective action is required.
- Forecasting future performance.

This result is in conformance with a study conducted by Dvir et al in 2002. Their research examined the relationship between project planning efforts and project success. The findings suggested that project success is insensitive to the level of implementation of management processes and procedures, which are readily supported by modern computerized tools and project management training.

4.4.3.3 Capability of the consultant key person

Capability of the consultant key person is the third most important factor is a very predictable result. All the consultants interviewed had a firm belief that capability of the person handling the project is very important for the success or failure of a project. Capability includes many aspects like management, experience with similar projects, public relations, leadership abilities and many more. Consultant key person should have the following organizational requirements:

- Competence: The consultant key person and his project management organization must be competent.
- Internal Authority: The consultant key person must have the necessary managerial authority within his organization to ensure response to his requirements.

- Commitment Authority: The consultant key person should have capability and authority to control the commitment of funds within prescribed limits.
- Project Team: The consultant key person should have a say in the assembly of his project team. Functional and discipline personnel assigned to the project must also be competent.
- External Authority: The consultant key person must be identified as the authoritative agent in dealing with outside parties, and be the responsible and single formal contact with them.
- Involvement in Major Decisions: No major technical, cost, schedule, or performance decisions should be made without the consultant key person's participation.

4.4.3.4 Frequent feedback from the owner

Owner has the ability to review the project status, make suggestions, and corrections through formal feedback channels or review meetings. Frequent feedback may ensure timely completion within specified limits of budget and accepted quality. Frequent feedback from the owner or his representative organization reflects enthusiasm, involvement and commitment to established project objectives. Consultants are of the firm opinion that regular feedback from the owner may lead a project to success.

4.4.3.5 Accurate initial cost estimates

Cost estimation is the determination of quantity and the predicting or forecasting, within a defined scope, of the costs required to construct and equip a facility, to

manufacture goods, or to furnish a service. Initial cost estimation provides the basis for project management, business planning, budget preparation, and cost and schedule control. Included in these costs are assessments and an evaluation of risks and uncertainties.

The first step in cost estimating is establishing the project's scope of work and the format for providing information for factual business decisions. Historically, preliminary estimates for capital expenditure projects are a basic requirement for a company's strategic planning. Before feasibility studies or conceptual work for a project can start, some sort of estimate must be prepared. Initial estimates are considered the benchmark estimates and are continually, modified and improved as the project is better defined.

4.4.4 SUCCESS FOR QUALITY OBJECTIVE

The overall ranking of top fifteen success factors for quality objective is shown in Figure 4.6. Top five (5) factors are as follows and discussed in the following section:

1. Owner satisfaction with the delivered project.
2. Capability of consultant key person.
3. Quality control program.
4. Adequate planning and control techniques.
5. Communications throughout the project.

4.4.4.1 Owner satisfaction with the delivered project

As already discussed owner satisfaction is very important for a achieving the quality objective at the end of a project.

4.4.4.2 Capability of consultant key person

As already discussed a capable project manager representing the consultant can take necessary actions based on his experience and authority to accomplish the quality objective.

4.4.4.3 Quality control program

Quality control in construction typically involves insuring compliance with minimum standards of material and workmanship in order to insure the performance of the facility according to the design. These minimum standards are contained in the specifications described in the previous section. For the purpose of insuring compliance, random samples and statistical methods are commonly used as the basis for accepting or rejecting work completed and batches of materials. Rejection of a batch is based on non-conformance or violation of the relevant design specifications.

The traditional microeconomic view of quality control is that there are an optimum proportion of defective items. Trying to achieve greater quality than this optimum would substantially increase costs of inspection and reduce worker productivity. However, many researches have proved that commitment to quality control has substantial economic benefits that had been unappreciated in traditional approaches. Expenses associated with inventory, rework, scrap and warranties can be reduced, worker enthusiasm and commitment improved. Customers often appreciate higher quality work and would pay a premium for good quality. A strong quality control program can become a competitive advantage and result in achieving the acceptable quality index in the delivered project.

4.4.4.4 Adequate planning and control techniques

As already discussed proper planning and scheduling can deliver a project that has high a quality index.

4.4.4.5 Communications throughout the project

Used effectively, communication can reduce non-productive effort, avoid duplication and help eliminate mistakes. It can help to manage uncertainty, may lead to problems being identified sooner or may generate ideas that lead to better solutions.

Many of the major issues in construction projects require effective interventions by individuals, groups and organizations. The fundamental challenge is to enhance communication among individuals, groups and organizations so that obstacles in the way of improving interpersonal relations may be removed. Cooperation and communication between the parties are often discouraged for fear of the effects of impending litigation. This barrier to communication results from the ill-conceived notion that uncertainties resulting from technological problems can be eliminated by appropriate contract terms. The net result has been an increase in the costs of constructed facilities and lower quality. Proper coordination throughout the project duration and good organizational communication can avoid delays and costs resulting from fragmentation of services, even though the components from various services are eventually integrated. In other words beneficial communication between project participants will help in achieving the quality objective.

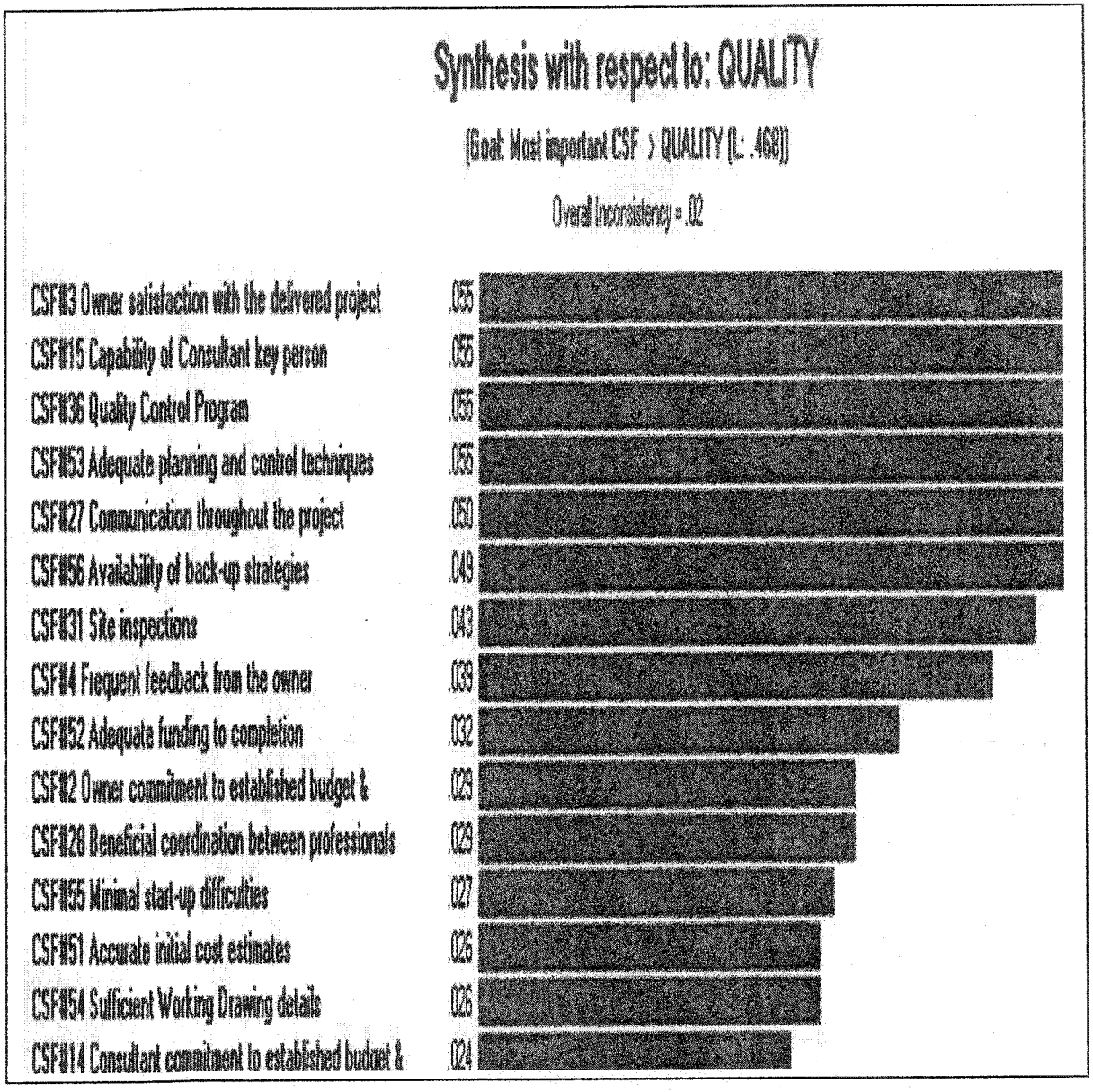

Figure 4.6: Ranking of success factors for quality done by consultants

4.4.5 SUCCESS FOR COST OBJECTIVE

Figure 4.7 shows factors for cost objective. Top five (5) factors successfully leading to the achievement of cost objective are as follows:

1. Owner's satisfaction with the delivered project.
2. Budget management.
3. Accurate initial cost estimates.
4. Adequate planning and control techniques.
5. Meeting design goals.

4.4.5.1 Owner's satisfaction with the delivered project

Owner's satisfaction as already discussed has also been ranked as the top most important factor for achieving the cost objective. If the owner is satisfied with the delivered project, it would result in less amount of rework and thus will ensure the completion of project within the specified budget.

4.4.5.2 Budget management

Budget management will give a basis for updating and recording the status of the project. Any discrepancies will tell if the project is over or under budget. Relationship of project and financial accounting/budget management is generally used for three distinct purposes:

- Internal reporting to project managers for day-to-day planning, monitoring and control.
- Internal reporting to managers for aiding strategic planning.

- External reporting to owners, government, regulators and other outside parties.

External reports are constrained to particular forms and procedures by contractual reporting requirements or by generally accepted accounting practices. In contrast, cost or managerial accounting is intended to aid internal managers in their responsibilities of planning, monitoring and control.

Project costs are always included in the system of financial accounts associated with an organization. At the heart of this system, all expense transactions are recorded in a general ledger. The general ledger of accounts forms the basis for management reports on particular projects as well as the financial accounts for an entire organization. Other components of a financial accounting system include:

- The accounts payable journal is intended to provide records of bills received from vendors, material suppliers, subcontractors and other outside parties.
- Accounts receivable journals provide the opposite function to that of accounts payable.
- Job cost ledgers summarize the charges associated with particular projects, arranged in the various cost accounts used for the project budget.
- Inventory records are maintained to identify the amount of materials available at any time.

With proper budget management techniques adopted the accomplishment of cost objective becomes achievable.

4.4.5.3 Accurate initial cost estimates

Accurate initial cost estimation as already discussed is very important in order to get a project which finishes with some cost savings.

4.4.5.4 Adequate planning and control techniques

Adequate project planning and control as already discussed may deliver a project which is completed well within the established budget. These techniques provide guidelines and baseline for cost control tasks.

4.4.5.5 Meeting design goals

Design goals include functional specifications, technical specifications, schedule goals and budget goals. The concept of "one vision one team" is very important to accomplish the design goals set at the initiation of a project. All the project participants should harmoniously work together towards achieving the design goals. Cost overruns may occur if the goals initially set are not met.

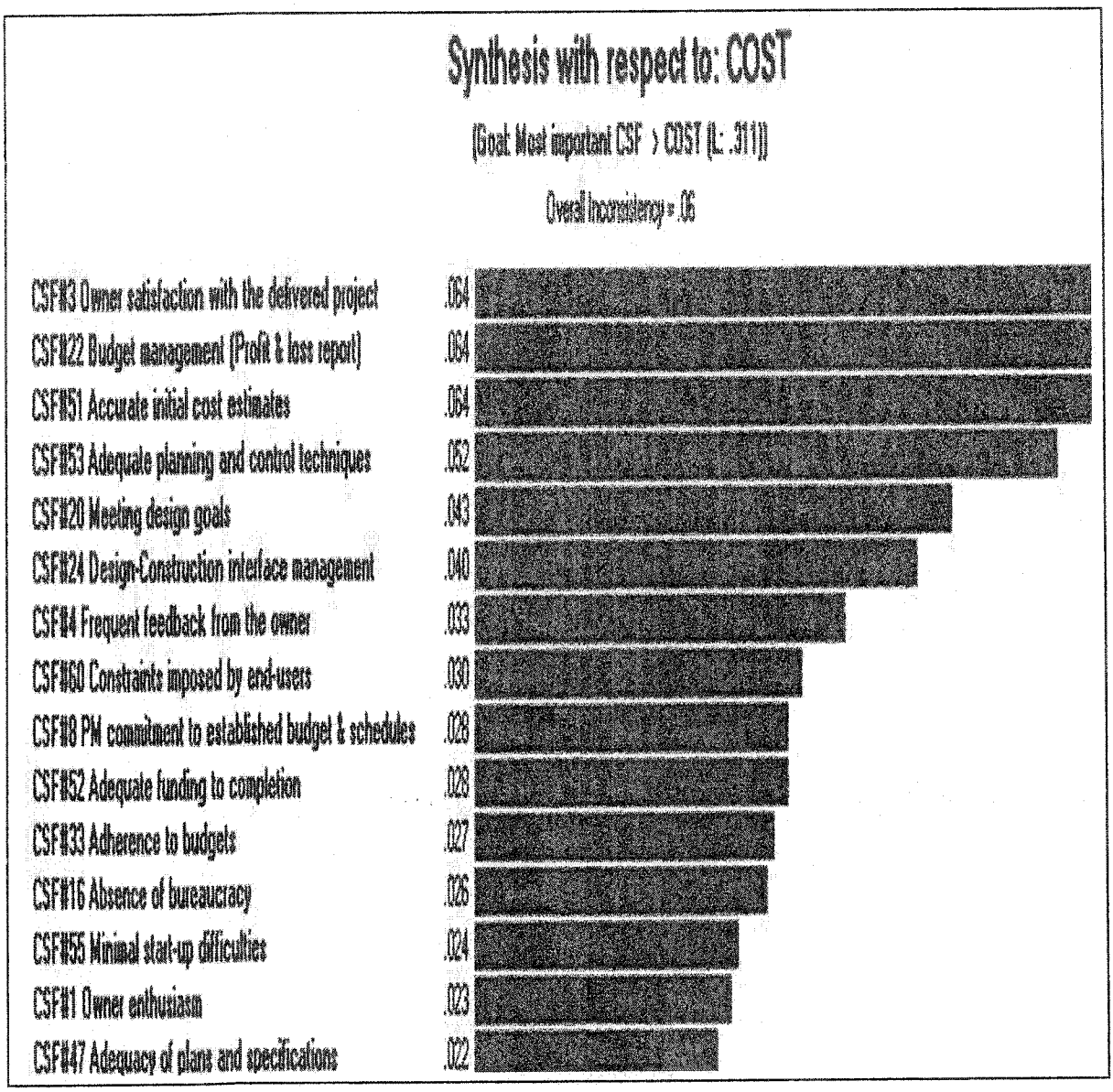

Figure 4.7: Ranking of success factors for cost done by consultants

4.4.6 SUCCESS FOR TIME OBJECTIVE

Figure 4.8 shows ranking of factors for time objective. Top five (5) factors successfully leading to the achievement of time objective are as follows:

1. Owner's satisfaction with the delivered project.
2. Capability of the consultant key person.
3. Adherence to schedules.
4. Constructability.
5. Frequent feedback from the owner.

4.4.6.1 Owner satisfaction with the delivered project

For a project to be completed in time owner satisfaction as already discussed is very important. Close involvement, frequent feedback, enthusiasm from the owner will result in satisfaction with the delivered project.

4.4.6.2 Capability of consultant key person

Capability of the Engineer representing the consultant's office effects the timely completion of a project, as already discussed. It is the duty of the responsible person representing the consultant's side to take necessary actions and decisions on time in order to achieve the time objective.

4.4.6.3 Adherence to schedules

Adherence to schedules deals with all the project participants and adherence to schedules established at the initiation of the project. All parties must coordinate between

themselves in order to finish the project within specified limits of time to deliver a successful project. A clear project mission or objective is required from the owner so that the consultant may start preparing detailed activity schedule which includes duration estimation and sequencing. The contractor can bid for the project based on these initial schedule estimates, and the project can smoothly start.

Many owners require detailed construction schedules to be submitted by contractors as a means of monitoring the work progress. The actual work performed is commonly compared to the schedule to determine if construction is proceeding satisfactorily. After the completion of construction, similar comparisons between the planned schedule and the actual accomplishments may be performed to allocate the liability for project delays due to changes requested by the owner, worker strikes or other unforeseen circumstances. All project participants should work as one team to accomplish the time objective.

4.4.6.4 Constructability

It is a measure of the ease or expediency with which a facility can be constructed. It is often described as integrating construction knowledge, resources, technology and experience into the engineering and design of a project. A high level of constructability may reflect minimal start-up difficulties and amount of rework. Constructability analyses are focused on the construction phase. The intent is to save construction time and cost without compromising any other project objectives such as quality, reliability, operability, maintainability, durability and appearance. Thus constructability decisions are oriented towards:

- Reducing total construction time by creating conditions that maximize potential for more concurrent construction, and minimize rework and wasted time.
- Reducing work-hour requirements by creating conditions that promote better productivity or creating designs that demand less labour.
- Creating the safest workplace possible, since safety and work efficiency go hand in hand.

4.4.6.5 Frequent feedback from the owner

Feedback from the owner as already discussed will indicate owner's satisfaction or dissatisfaction with the progress of the project. If the owner is giving inputs at regular intervals then the project is going in the right direction towards timely completion, otherwise it may eventually result in project closeout.

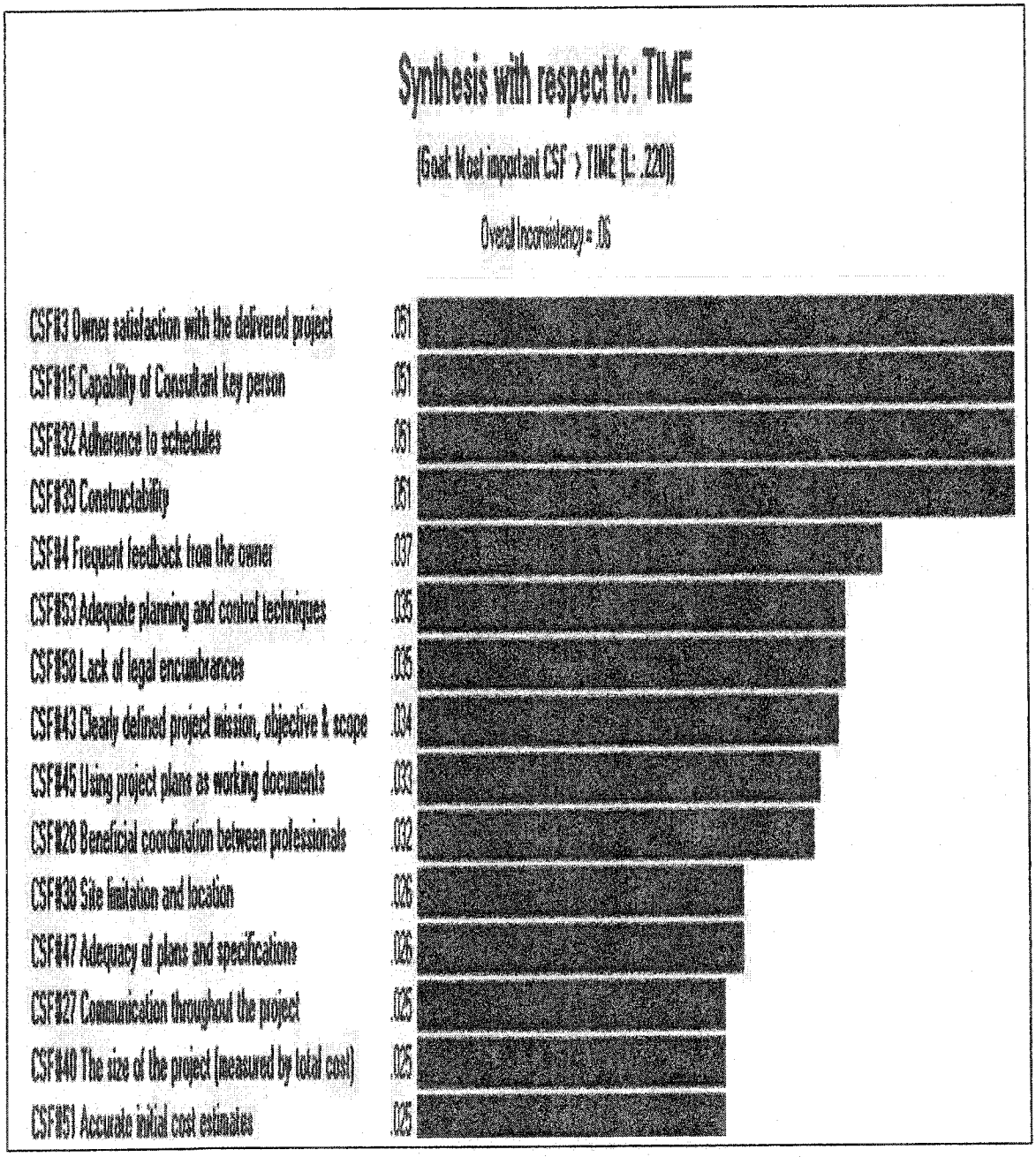

Figure 4.8: Ranking of success factors for time done by consultants

4.5 CONTRACTORS

4.5.1 GENERAL PROFILE

The experts contacted from contractor firms for this research study were all belonging to Grade 01 category as classified by the Ministry of Public Works and Housing (www.alahli.com). The years of professional experience in large building projects are classified according to the number of years in construction industry. 33% were with 10-15 years experience and 67% with more than 15 years of professional experience in construction industry. The experts contacted mostly had experience in projects worth 10 – 15 million Saudi Riyals, well above the lower limit of 5 million Saudi Riyals. The completed projects were 70% Government projects, 15% were Private Projects, and 15% were Semi Government projects. All the experts contacted had substantial experience in all the three types of projects i.e. commercial, residential and industrial.

4.5.2 PROJECT OBJECTIVE

Project objective rankings are shown in Figure 4.9. Contractors prefer *time* to both *quality* and *cost*. Government agencies usually want their projects completed well within the allotted time schedule, and most of the experts interviewed had major experience in government projects. Timing of key decisions is likely to determine the pace of the project more than anything else. Bar charts and other graphical representations show when decisions have to be taken, but during the course of the case study project it became obvious that they did not always help in understanding what must be done to enable those

decisions to take place. It is therefore necessary to expand the role of project planning (i.e. method and time management) to incorporate decision-making.

In addition to cost control, project managers must also give considerable attention to monitoring schedules. Construction typically involves a deadline for work completion, so contractual agreements will force attention to schedules. More generally, delays in construction represent additional costs due to late facility occupancy or other factors. Just as costs incurred are compared to budgeted costs, actual activity durations may be compared to expected durations. In this process, forecasting the time to complete particular activities may be required.

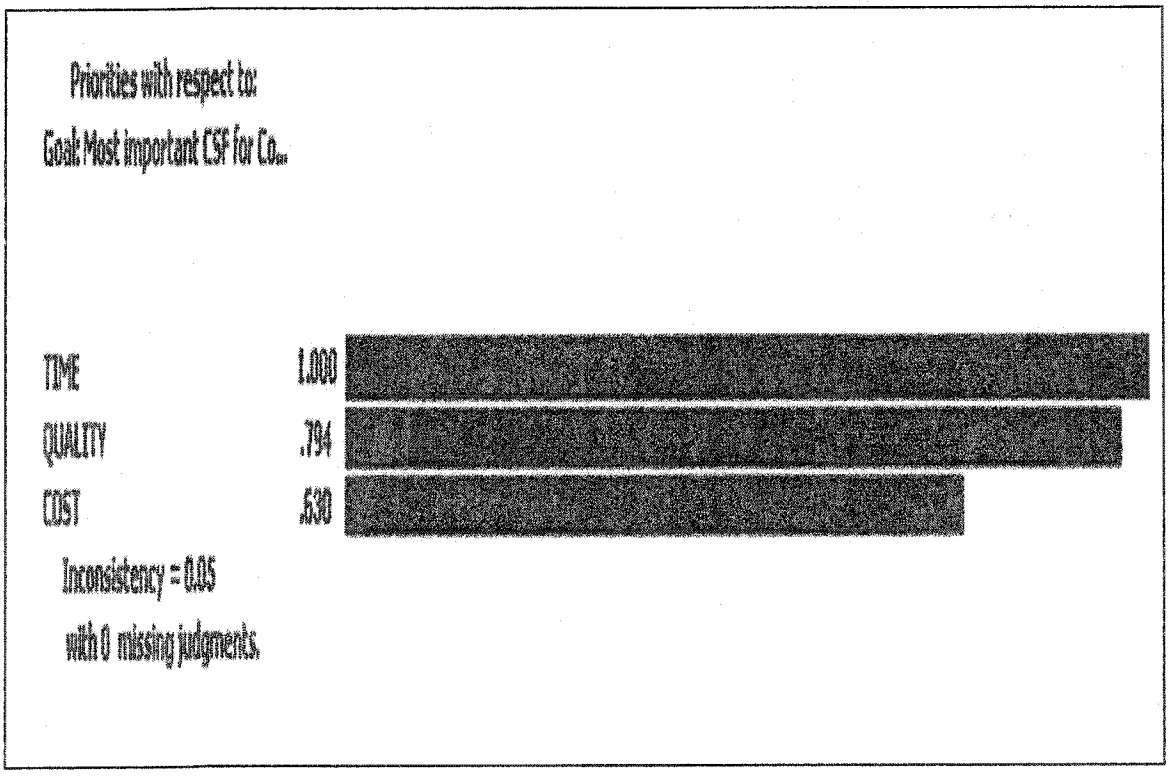

Figure 4.9: Project objective rankings done by Contractors

4.5.3 OVERALL PROJECT SUCCESS

The overall ranking of top fifteen Success Factors for each project objective is shown in Figure 4.10. Top five (5) factors are as follows:

1. Clearly defined project mission, objective & scope.
2. Breaking the project into `bite sized chunks'.
3. Adequacy of plans and specification.
4. Owner enthusiasm.
5. Design-Construction interface management.

4.5.3.1 Clearly defined project mission, objective & scope

Clearly defined project mission, objective & scope have been ranked as the most important factor for all the project objectives. Apart from clearly defined project mission, objective and scope, the general project philosophy of the project should be very clear and well defined. It will ensure commitment to those goals on part of project team members.

Although objectives and scope as often regarded as separate entities (because one is concerned with the outcomes of the project and the other is concerned with the limits of the project), there is good reason for grouping them together. Without a well-defined scope, the project objectives can become fuzzy and people may start to lose sight of what they are trying to achieve (Clarke, 1999).

Definition and agreement of objectives must include a common understanding by all people involved. The project will become goal and results-oriented, rather than activity-based. Having a few key objectives focuses the team on the target and creates

commitment and agreement about the project goals. (Richardson, 1995) The result is that the progress of a project can be monitored effectively.

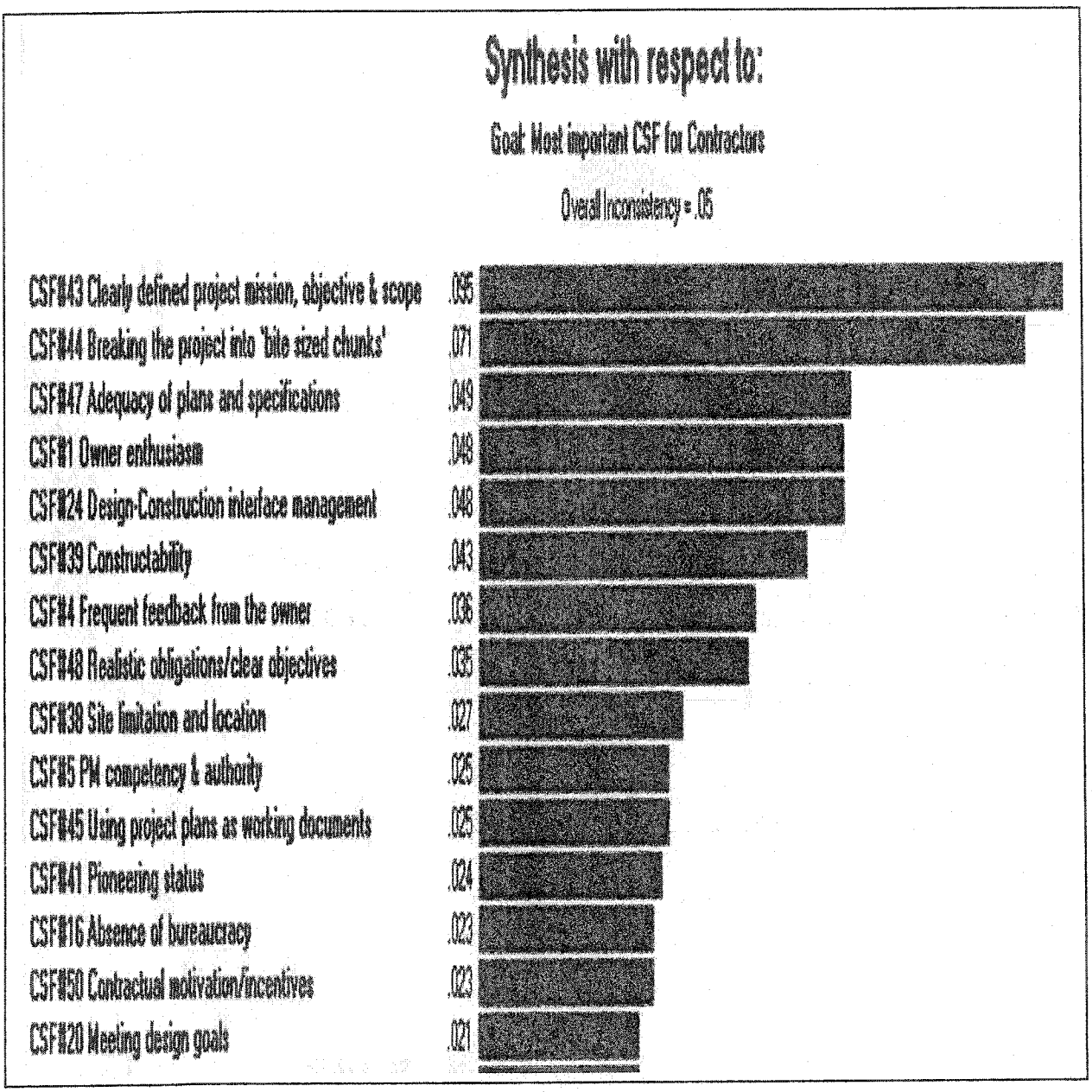

Figure 4.10: Overall ranking of top 15 success factors done by contractors

Ultimately, success will be measured more easily because the objectives are clearly stated at the outset of the project. If the scope is defined at the start of the project, the project should stay within its intended boundaries and not expand to include more than originally planned. If not, mission creep occurs, i.e. the project boundaries extend beyond the intended limits. A well-defined scope means also that there is less likelihood of a vital part of the project being missed.

4.5.3.2 Breaking the project into 'bite sized chunks'

Breaking the project into 'bite sized chunks' or breaking large projects down into sub-projects or work packages is regarded as one of the most important tasks in new or development projects. It ensures greater ownership by all those owning a 'chunk' of the project, spreading responsibilities and accountability across a greater number of people. Furthermore, it is easier to manage in a number of ways: delegating responsibilities to the project team, monitoring against the objectives, communicating progress of the project, identifying problems upfront and making modifications to the project (changes may affect only one work package rather than the whole project). However, care must be taken not to have too many work packages, which then make the project unmanageable (Lewis, 1996).

If the project is managed with a structured approach, by breaking down the project into manageable elements, this allows scope definition, responsibility assignment, planning, monitoring and reporting at the levels of detail chosen for visibility and control. Project breakdown structures are used to:

- Promote coherence between the technical, administrative, financial and other activities of the project.
- Identify the responsibilities of each participant, both corporate and individual.
- Provide a framework for planning, scheduling, costing.
- Provide a framework for control of the project.

4.5.3.3 Adequacy of plans and specifications

Adequacy of plans and specification will significantly reduce the uncertainties during tender submissions or other contractual negotiations and hence minimize project risks. Defective designs and inadequate plans and specifications provide fertile ground for construction claims. By plans we mean the official drawings or exact reproductions which show the location, character, dimensions and details of the work to be done and which are to be considered as a part of the contract, supplementary to the specifications. Similarly specifications refer to part of the contract containing the written directions and requirements for completing the contract work.

The contractor usually is expected to carefully examine the site of the proposed work, the proposal, plans, specifications, and contract forms. He should satisfy himself as to the character, quality, and quantities of work to be performed, materials to be furnished, and as to the requirements of the proposed contract. The submission of a proposal after the careful examination on plans and specifications is thus a prima facie evidence that the contractor has made such examination and is satisfied as to the conditions to be encountered in performing the work and as to the requirements of the

proposed contract, plans, and specifications. For the successful completion of a project, plans and specifications must be suitable for the purpose intended.

4.5.3.4 Owner Enthusiasm

Owner enthusiasm to new ideas has always been a key ingredient to project success. The degree to which the owner is personally involved in the project will cause great variation in their support of the processes related to the project. Owner enthusiasm to new ideas is important for the achievement of overall objectives and ultimately for the success of a project.

The Owners have an important role to influence the entire project at every phase of the project life cycle. They must provide adequate information on the project, site, budget, project time and should have clear understanding of project's final form as the architect engineer purse to finalize the stipulated design of project. Conventionally, the owners are not much involved in projects various phases, therefore they seems only concerned with the financial aspects of project. Whereas, being the key authority in the project completion scenario, the owner should be involved in every phase to have very clear manifestation of the project and be available to take necessary action spontaneously to augment the construction or the design phase for completion of entire project.

4.5.3.5 Design-Construction interface management

There is a huge advantage in having a construction expert review the concept of a project before even preliminary plans begin. A construction expert will review what the project is intended to achieve, the proposed location of the project, the duration for design

and construction, and the various design alternatives. This review involves an extensive dialogue with the project's owner, designer and constructor.

Researches have showed that the most important problems present in the designs are: defects of individual specialists and the lack of coordination among specialties, lack of information and wrong information, changes introduced by the owner and the designers, inconsistencies among drawings and specifications, designers with little construction knowledge and non technical specifications. These problems produce a series of impacts in the construction works such as loss of labour, idle times, rework, abnormal use of machinery and equipment, delays, etc.

Four forms of actions are proposed to introduce continuous improvement to take care of design-construction interface problems:

1) Improve coordination through:

- A planning scheme of the design sequence for building projects, in order to stabilize and control the information flow, to establish priorities among the specialties to avoid the lack of information or the use of assumptions when information is not available.
- A plan to control and evaluate changes introduced during the execution stage, determining their impacts on the project.

2) Introduce standardization through:

- The development of task lists, in order to generate for each one of the designers, the input data for their own design process.
- The development of work specifications, in order to standardize the presentation of the information and to establish requirements for the different designers.

3) Reduce the impact of the lack of construction knowledge of the designers by introducing construction criteria, in the task list and work specifications.

4) Improve control by developing check lists to control the parameters established in the task list and the requirements imposed in the work specifications.

4.5.4 SUCCESS FOR TIME OBJECTIVE

The overall ranking of top fifteen (15) success factors for time objective is shown in Figure 4.11. Top five (5) factors are as follows:

1. Clearly defined project mission, objective & scope.
2. Breaking the project into `bite sized chunks'.
3. Owner enthusiasm.
4. Design-Construction interface management.
5. Adequacy of plans and specification.

4.5.4.1 Clearly defined project mission, objective & scope

As already discussed clearly defined objective and scope are very important for the timely completion of a project.

4.5.4.2 Breaking the project into 'bite sized chunks'

As already discussed breaking a project into manageable components will ensure timely completion of all activities.

4.5.4.3 Owner enthusiasm

As already discussed an owner who is enthusiastic for the timely completion of his project, may be open to new suggestions and alternatives in case of problems.

4.5.4.4 Design-Construction interface management

As already discussed utilization of contractors knowledge in design phase may speed up the processes and activities.

4.5.4.5 Adequacy of plans and specification

As already discussed correct plans and specifications will ensure timely completion of the project.

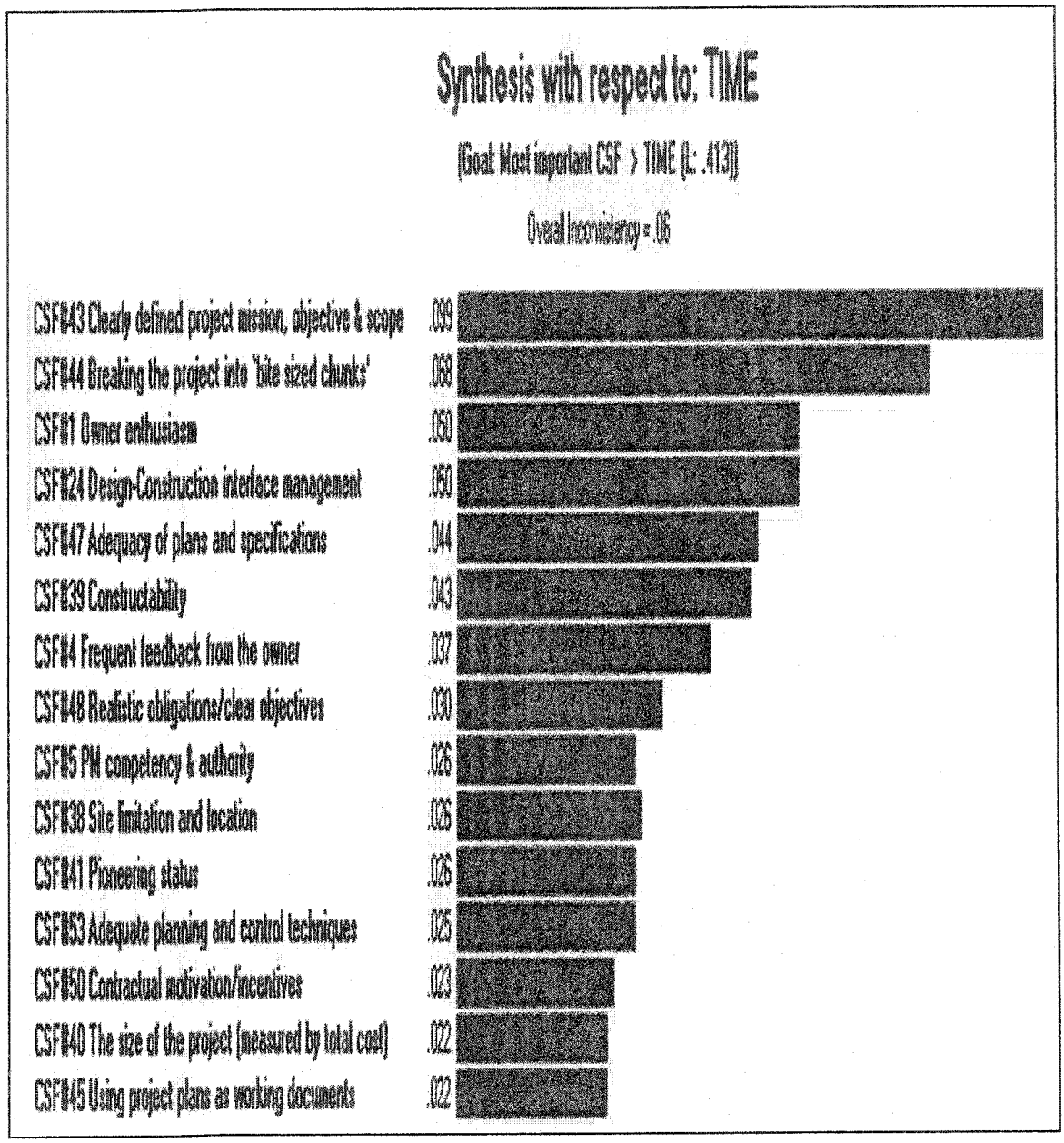

Figure 4.11: Ranking of success factors for time done by contractors

4.5.5 SUCCESS FOR QUALITY OBJECTIVE

The overall ranking of top fifteen (15) success factors for quality objective is shown in Figure 4.12. Top five (5) factors are as follows:

1. Clearly defined project mission, objective & scope.
2. Breaking the project into `bite sized chunks'.
3. Owner enthusiasm.
4. Design-Construction interface management.
5. Adequacy of plans and specification.

4.5.5.1 Clearly defined project mission, objective & scope

As already discussed clearly defined objective and scope are very important for the completion of a project with specified quality.

4.5.5.2 Breaking the project into 'bite sized chunks'

As already discussed breaking a project into manageable components will ensure completion of all activities with approved quality index.

4.5.5.3 Owner enthusiasm

As already discussed an owner who is enthusiastic to new suggestions and alternatives in case of problems, will deliver a quality project at the end.

4.5.5.4 Design-Construction interface management

As already discussed utilization of contractors knowledge in design phase may help to achieve the quality objective.

4.5.5.5 Adequacy of plans and specification

As already discussed correct plans and specifications will ensure completion of the project with high quality.

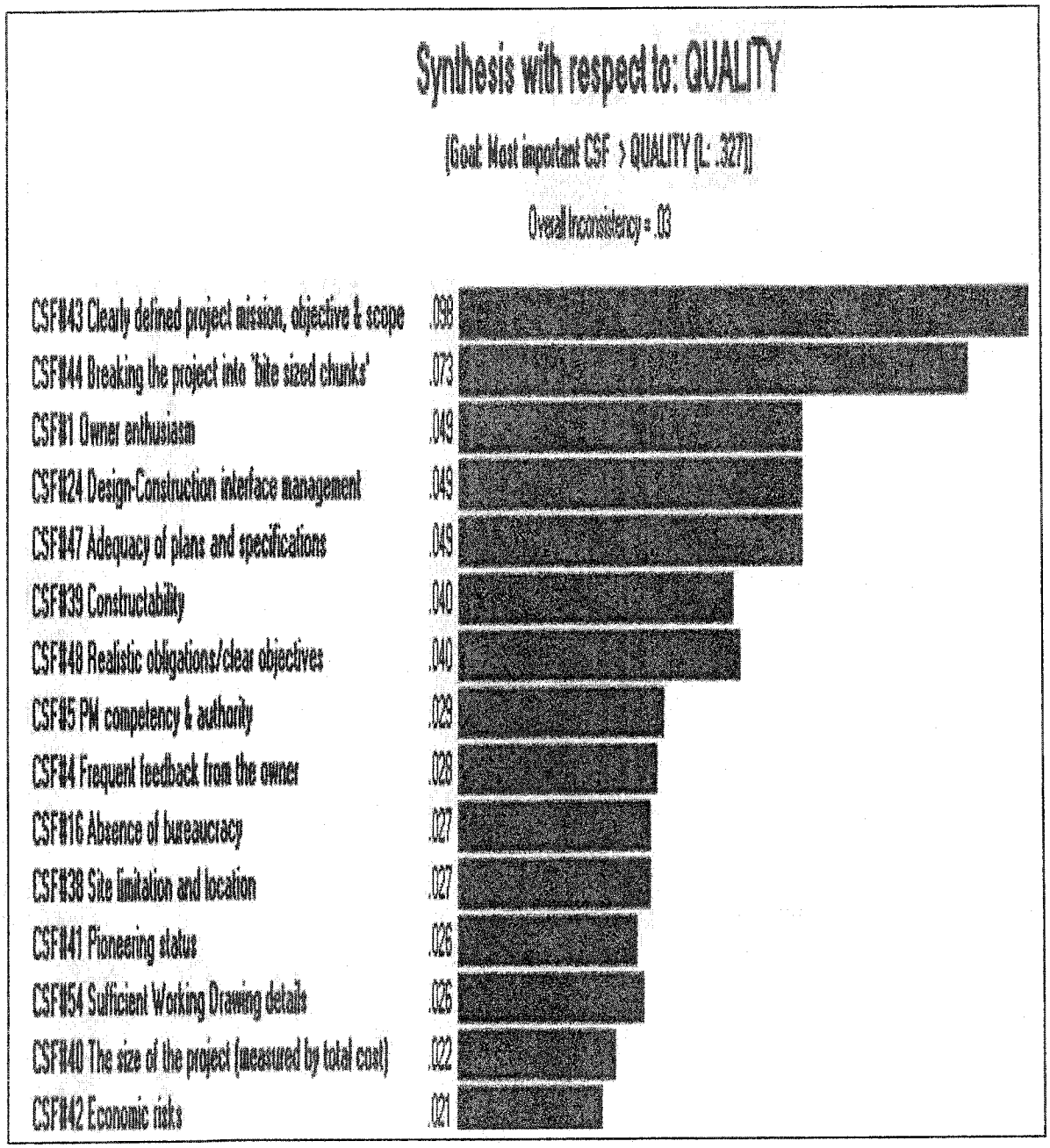

Figure 4.12: Ranking of success factors for quality done by contractors

4.5.6 SUCCESS FOR COST OBJECTIVE

The overall ranking of top fifteen (15) success factors for cost objective is shown in Figure 4.13. Top five (5) factors are as follows:

1. Clearly defined project mission, objective & scope.
2. Breaking the project into `bite sized chunks'.
3. Adequacy of plans and specification.
4. Constructability.
5. Owner enthusiasm.

4.5.6.1 Clearly defined project mission, objective & scope

As already discussed clearly defined objective and scope are very important for the completion of a project within the specified budget.

4.5.6.2 Breaking the project into 'bite sized chunks'

As already discussed breaking a project into manageable components will ensure completion of all activities well within approved budget.

4.5.6.3 Adequacy of plans and specification

As already discussed correct plans and specifications will ensure completion of the project with high monetary savings.

4.5.6.4 Constructability

Constructability has also been ranked forth for the achievement of time objective by the consultants. Constructability can also be defined as "optimum integration of construction knowledge and experience in planning, engineering, procurement and field operations to minimize overall project cost."

Al-Yousif (2001) retrieved in his research about the constructability, and filtered down the barriers discussed above into the following concluding reviewed barriers (general contractor perception);

1) Design without construction input is the traditional form of contracting.
2) Owners don't care about constructability in the contracting strategy.
3) Owners don't choose constructability in their projects.
4) No proven benefits of constructability.
5) Designer's lack of construction experience and knowledge of construction technology.
6) The concept is unknown to the owners.

Constructability is too often thought of as a property that is addressed at the end of design or at the start of construction. Some view constructability as an issue that the contractor solely addresses while planning and coordinating the construction activities. This view ignores the beneficial impacts of constructability reviews. Consultants and contractors both consider constructability very important for the achievement of their objectives and finally for the overall success of a project.

4.5.6.5 Owner enthusiasm

As already discussed an owner who is enthusiastic to new suggestions and alternatives in case of problems, will deliver a project with significant savings at the end.

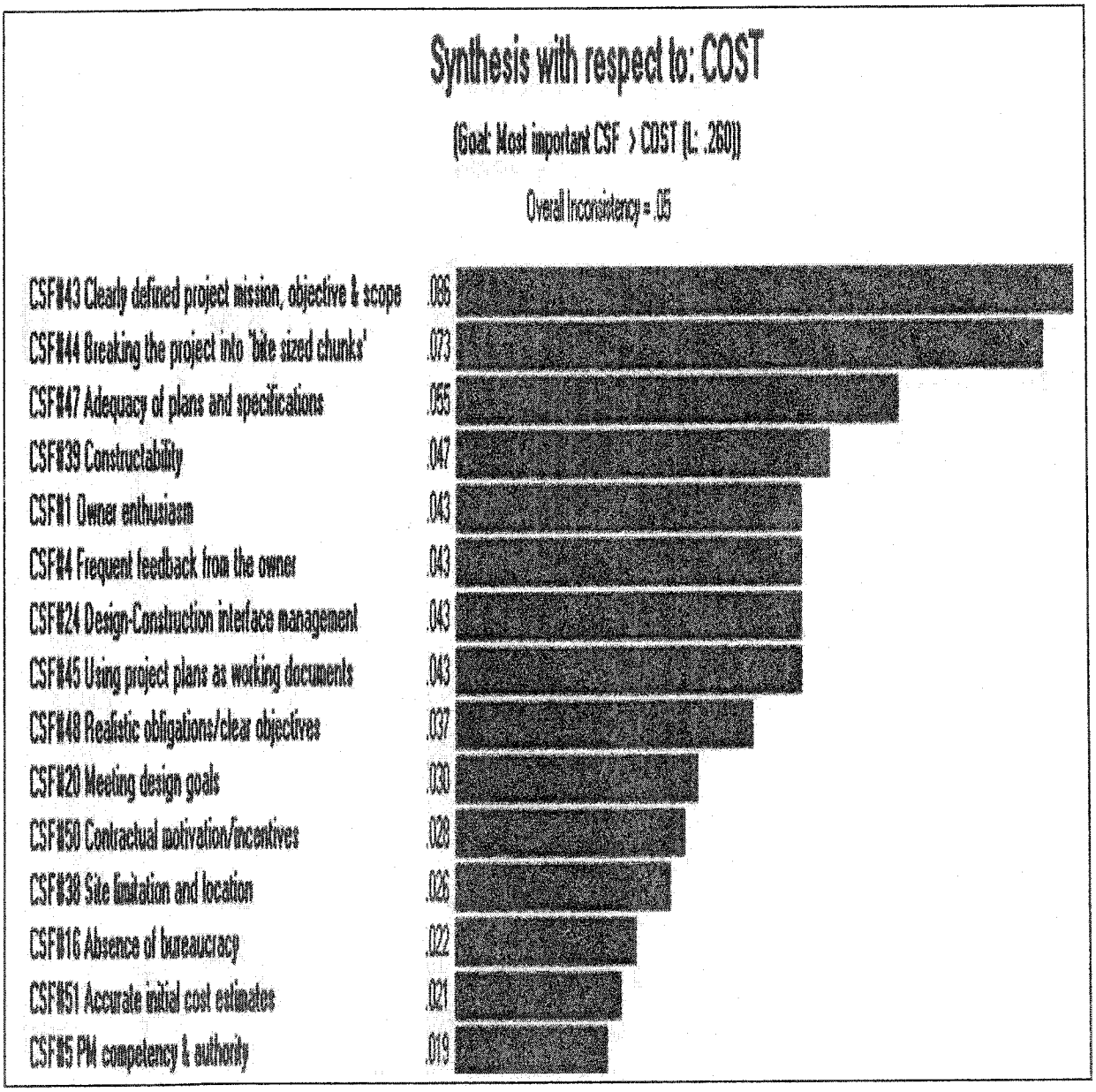

Figure 4.13: Ranking of success factors for cost done by contractors

4.6 OWNERS

4.6.1 GENERAL PROFILE

Experts contacted from owner organizations belonged to Sabic, Aramco, Dammam municipality and Petrokemya. 43% of the owners/owners representatives interviewed had 10-15 years experience and 57% were with more than 15 years of professional experience in construction industry. The experts contacted mostly had experience in projects worth 10 – 15 million Saudi Riyals, well above the lower limit of 5 million Saudi Riyals. The completed projects were 35% government projects and 65% were semi government projects, none of the experts from owners group were contacted from the private sector. All the experts contacted had substantial experience in all the three types of projects i.e. commercial, residential and industrial.

4.6.2 PROJECT OBJECTIVE

Owners have ranked *time* more than both *quality* and *cost*. Figure 4.14 shows normalized ranking of the objectives. One reason maybe that a large portion of the experts interviewed belonged to semi government and government organizations, who usually are concerned more with the timely completion of projects.

Time requirements range from no critical requirement and early completion unwelcome to shortest time (overall or for construction work) and earliest start. Reliable guaranteed completion dates and provision for phased completions are also included as needs. Thus predictability of lowest cost and shortest time for sections or phases of the project are regarded as different objectives applicable to different owners and projects.

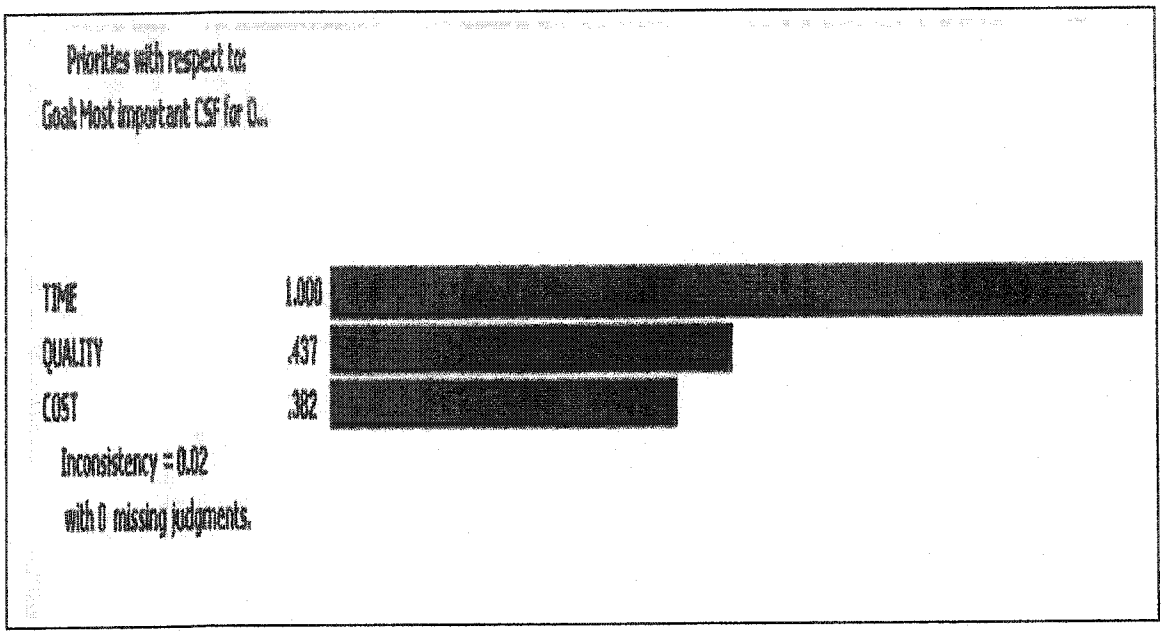

Figure 4.14: Project objective ranking done by owners

4.6.3 OVERALL PROJECT SUCCESS

The overall ranking of top fifteen success factors for overall project objective is presented in Figure 4.15. Top five (5) factors are discussed as follows:

1. Adequate planning and controlling techniques.
2. Adequacy of plans and specifications.
3. Lack of legal encumbrances.
4. Clearly defined project mission, objective & scope.
5. Sufficient working drawing details.

4.6.3.1 Adequate planning and controlling techniques

This critical success factor has been ranked as the most important factor for all the project objectives by the owners. This factor has also been ranked as second most important objective to achieve overall project success, by the consultants. Owners have a firm opinion that if adequate planning and controlling techniques are used during different phases of the project, then a project is foreseeable that meets all the requirements. Owners have to play a vital role at the planning stage as well as in controlling and monitoring of a project.

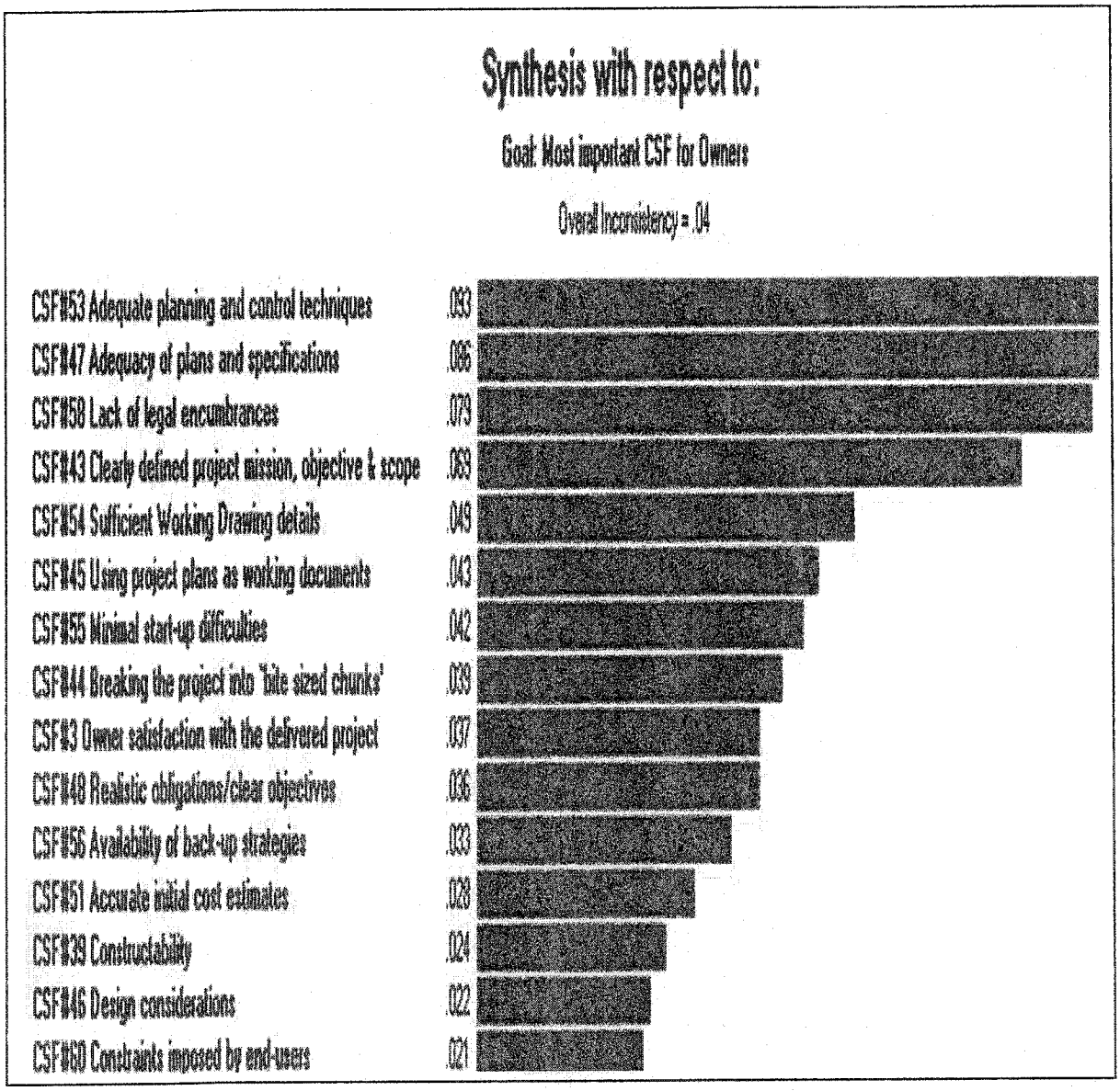

Figure 4.15: Overall ranking of top 15 success factors done by owners

4.6.3.2 Adequacy of plans and specification

Adequacy of plans and specifications has also been ranked as third most important critical success factor by the contractors. Owners agree with the contractors over the importance of accurate project plans and specifications.

The owner usually hires a consultant to prepare accurate plans and specifications. In other words a consultant materialises the owner's ideas and objectives. If there is any fault in the drawings prepared, it will lead to claims, counter claims, disputes, delays and other associated hindrances in the project. A contractor usually prepares his own estimates based on the plans and specifications provided by the owner, if the initial plans and specifications are not correct then, it is not possible that the project will smoothly run. For the successful completion of a project, plans and specifications must be suitable for the purpose intended. Every participant should do efforts to obtain a superior solution for every problem faced in the faster completion of a project with optimum costs incurred.

4.6.3.3 Lack of legal encumbrances

Legal encumbrances involve permits and regulations which are permanent guests at the construction feast. Encumbrances are legally binding rights of the government agency or previous owner to exploit natural resources of the property, e.g., minerals, timber, water, etc. lesser number of legal encumbrances will ensure smooth running of different processes to yield a successful project. Bonds, liens or other general long-term obligations, grants, transfers from other funds, interest and taxes specifically designated for project, are some forms of encumbrances that may hinder in the smooth running of

the project. Sometimes financial commitments related to unperformed contracts for goods or services for which part of an appropriation is reserved, may also become hindrances. They cease to be encumbrances when the obligations are paid or otherwise terminated.

A compilation of city council/municipality approved ordinances in various categories, for example, civil service rules, traffic regulations, sanitation and health standards, building regulations, and planning and zoning regulations, may result in time overruns, exceeding budget and may sometimes also result in project closeout.

4.6.3.4 Clearly defined project mission, objective & scope

Clearly defined project mission, objectives and scope has also been ranked as most important factor for achieving projects success by the contractors. One common relation between the owner and contractor group is that major portion of the experts interviewed had experience in government projects. Success of government projects usually depends upon how clearly the objectives, project mission and scope or constraints are defined.

Clear project objectives are crucial because project success will be determined by how closely they are met. A clear project objective has to be both specific and measurable and for objectives to be effective, it is important that all project stakeholders officially agree to them. Project objectives may include:

- A list of project deliverables.
- Specific due dates, both for the ultimate completion of the project and for intermediate milestones.
- Specific quality criteria the deliverables must meet.

- Cost limits the project will not exceed.

4.6.3.5 Sufficient working drawing details

Working drawings are a final set of production drawings providing all of the necessary details and specifications needed to manufacture and assemble a product or system.

Working drawings are a means of communication for transforming the design concepts and specifications into actual work. Hence, the content, organization and presentation of working drawings should preferably be on the following lines:

- The set of working drawings should consist of general arrangement (GA) drawings and other detailed drawings deriving reference from the GA drawings with key plans.
- The drawings should be prepared in a standardized manner and should have distinctly unique numbers for reference.
- As far as possible, the drawings should be drawn to scale. More intricate details should be depicted in bigger scales.
- The drawings should have adequate notes, sectional details, brief material specifications, legend, references to other relevant drawings and judicious use of hatching and shading.
- Wherever applicable, the drawings may contain bill of quantities.
- Whenever revisions are incorporated, the drawings should clearly indicate the revision number near the drawing number. The date and nature of revision should be listed in the table for revisions and changes/ alterations should be predominantly marked with the revision number.

- Whenever drawings are released for a certain purpose, the date of release and the purpose should be stamped on the prints.

4.6.4 SUCCESS FOR TIME OBJECTIVE

The overall ranking of top fifteen success factors for time objective is presented in Figure 4.16. Top five (5) factors are discussed as follows:

1. Adequate planning and controlling techniques.
2. Adequacy of plans and specifications.
3. Lack of legal encumbrances.
4. Clearly defined project mission, objective & scope.
5. Sufficient working drawing details.

4.6.4.1 Adequate planning and controlling techniques

As already discussed utilization of adequate planning and controlling techniques for a project are crucial for the achievement of time objective.

4.6.4.2 Adequacy of plans and specifications

As already discussed correct plans and specifications will help in finishing a project within the specified schedule.

4.6.4.3 Lack of legal encumbrances

As already discussed timely completion of a project is only possible if legal hindrances are not present which affect the smooth running of different activities.

4.6.4.4 Clearly defined project mission, objective & scope

As already discussed if the project starts with clearly defined project mission, objectives and constraints, then it is more likely to be finished with the approved schedule.

4.6.4.5 Sufficient working drawing details

As already discussed working drawings have to be accurate to avoid any delays and to ensure timely completion of a project.

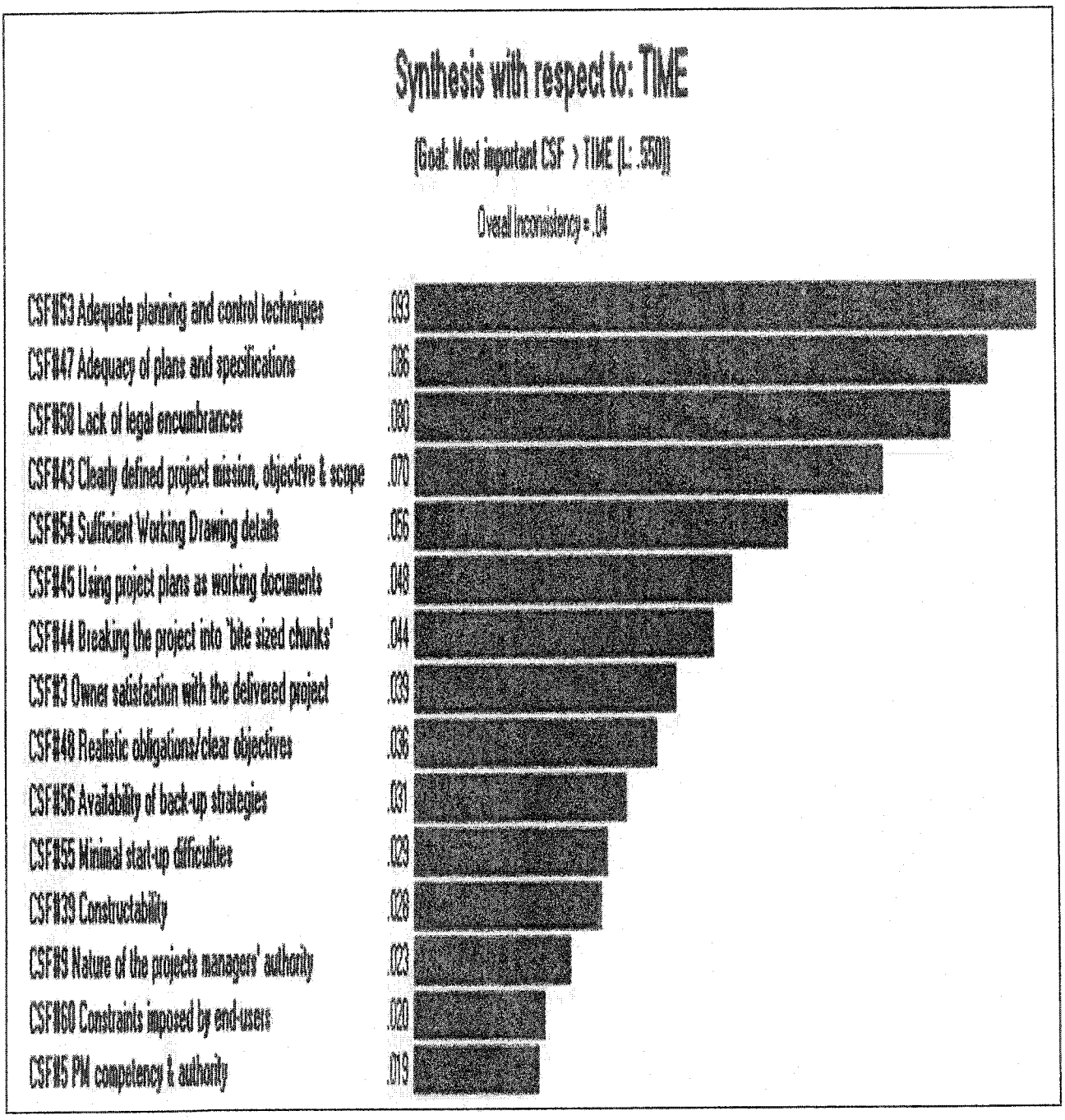

Figure 4.16: Ranking of success factors for time done by owners

4.6.5 SUCCESS FOR QUALITY OBJECTIVE

The overall ranking of top fifteen success factors for quality objective is presented in Figure 4.17. Top five (5) factors are discussed as follows:

1. Adequate planning and controlling techniques.
2. Minimal start-up difficulties.
3. Adequacy of plans and specifications.
4. Lack of legal encumbrances.
5. Clearly defined project mission, objective & scope.

4.6.5.1 Adequate planning and controlling techniques

As already discussed utilization of adequate planning and controlling techniques for a project are crucial for the achievement of quality objective.

4.6.5.2 Minimal start-up difficulties

Minimal start-up difficulties means having few difficulties at the end of a project. Start-up is the period prior to occupancy when systems are activated and checked out, and the owner's operating and maintenance staff assumes the control and operation of the systems. Quality is also defined as getting a deliverable at the end of the project, achieving what was intended. In order achieve the specified quality it is very necessary that the constructor delivers a facility that is operational, meets the owner's requirements and free from all legal bindings. In order to attain this minimum start-up difficulty state, efforts from the very beginning of the project are required. It may not be incorrect to state that efforts from the inception stage have to start. Coordinated efforts from all

project participants is required to overcome difficulties, that could be in the form of defining project objectives, presence of sufficient technology, site location (Sometimes a project is situated at a confined site, which creates logistical problems. Each time an item of material is moved, its cost to install in place increases), legal encumbrances, pioneering project, economic risks etc.

4.6.5.3 Adequacy of plans and specifications

As already discussed correct plans and specifications will help in finishing a project with acceptable quality standards.

4.6.5.4 Lack of legal encumbrances

As already discussed achievement of quality objective in a project is only possible if legal hindrances are not present which affect the smooth running of different activities.

4.6.5.5 Clearly defined project mission, objective & scope

As already discussed if the project starts with clearly defined project mission, objectives and constraints, then it is more likely to be finished with the acceptable quality.

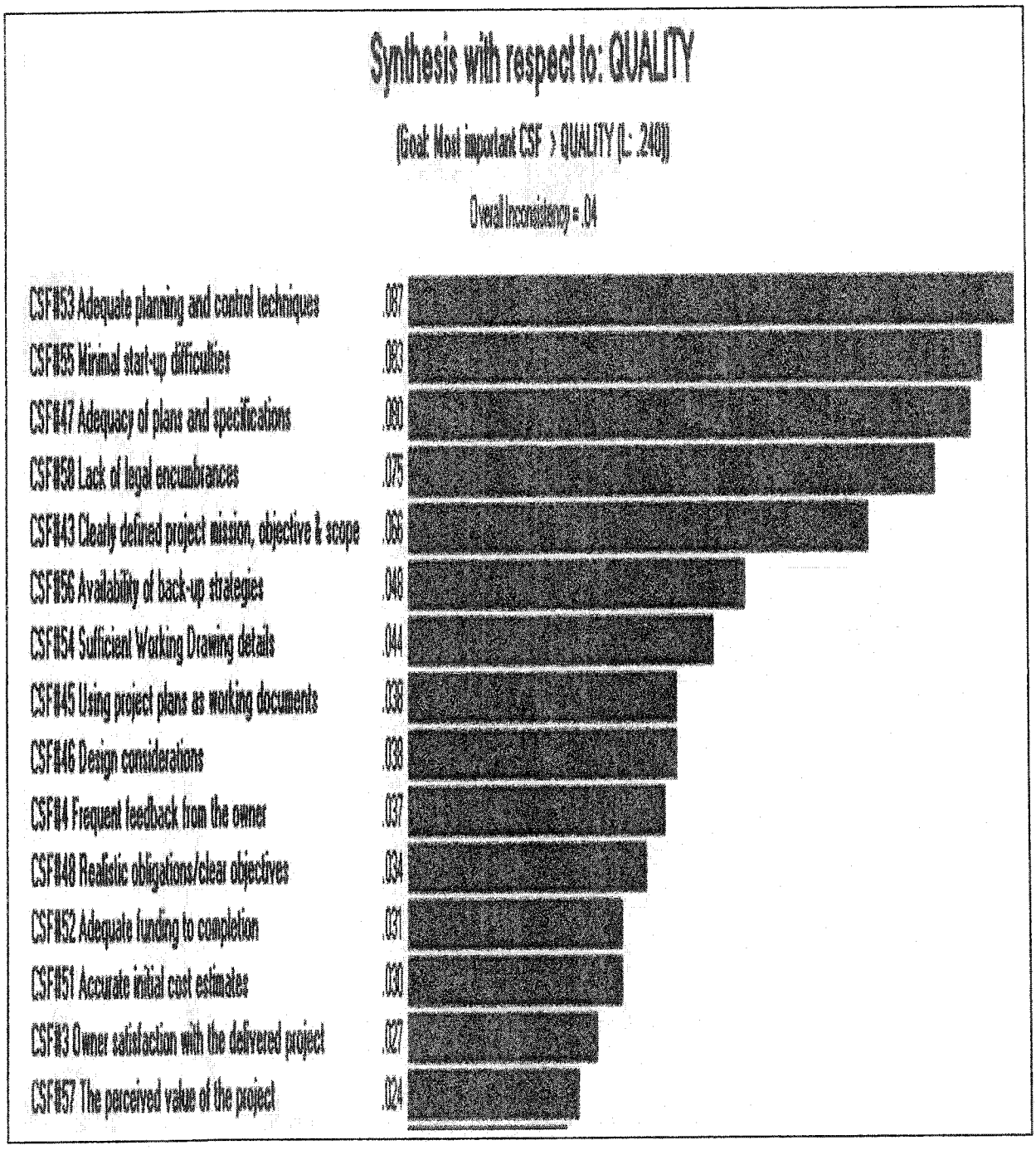

Figure 4.17: Ranking of success factors for quality done by owners

4.6.6 SUCCESS FOR COST OBJECTIVE

The overall ranking of top fifteen success factors for cost objective is presented in Figure 4.18. Top five (5) factors are discussed as follows:

1. Adequate planning and controlling techniques.
2. Adequacy of plans and specifications.
3. Lack of legal encumbrances.
4. Clearly defined project mission, objective & scope.
5. Accurate initial cost estimates.

4.6.6.1 Adequate planning and controlling techniques

As already discussed utilization of adequate planning and controlling techniques for a project are crucial for the achievement of cost objective.

4.6.6.2 Adequacy of plans and specifications

As already discussed correct plans and specifications will help in finishing a project within budget.

4.6.6.3 Lack of legal encumbrances

As already discussed achievement of cost objective in a project is only possible if legal hindrances are not present which affect the smooth running of different activities.

4.6.6.4 Clearly defined project mission, objective & scope

As already discussed if the project starts with clearly defined project mission, objectives and constraints, then it is more likely to be finished within the approved budget.

4.6.6.5 Accurate initial cost estimates

This factor has also been ranked by the consultants group as fifth most important factor to achieve project success. The reliability of initial cost estimates at every stage in the project development process is necessary for responsible fiscal management. Initial cost estimates include all capital outlay costs, including right of way, structures and landscaping, but does not normally includes capital outlay support costs. Initial cost estimates should never be artificially reduced to stay within the funding limits, nor should they be reduced to make available more project funding. Likewise, initial cost estimates should not be artificially raised beyond the contingency percentages.

No two infrastructure projects will cost the same amount of money no matter how similar they are. These basic costs will vary depending upon a number of factors which are discussed below:

- Project specification: The specification defines the physical attributes of a project. Generally, the more detailed the specification and the larger the project, the more expensive it will be.
- Location: Location affects project costing via institutional factors (consent procedures, legal encumbrances) and through geographical realities (varying

distances from suppliers, climate and weather conditions, and general market conditions).

- Form of procurement/contract: Form of procurement and contract used by the project sponsor can alter the estimated cost of a project (design-build, lump sum etc).
- Site characteristics: A site can be affected by soil and drainage conditions and access restrictions which can affect the original cost estimates.
- New build or improvements: Generally, the construction of new infrastructure is more expensive than improvements to existing infrastructure, or the refurbishment of buildings.
- Tax liabilities: An organization will be liable to pay tax on its purchases.
- Timescale: Longer a project takes, the greater the project costs will be. Project timescales are dependent on the specification of a project.
- Inflation: Longer the expected construction period, the more account will need to be taken of expected inflationary price increases over time.

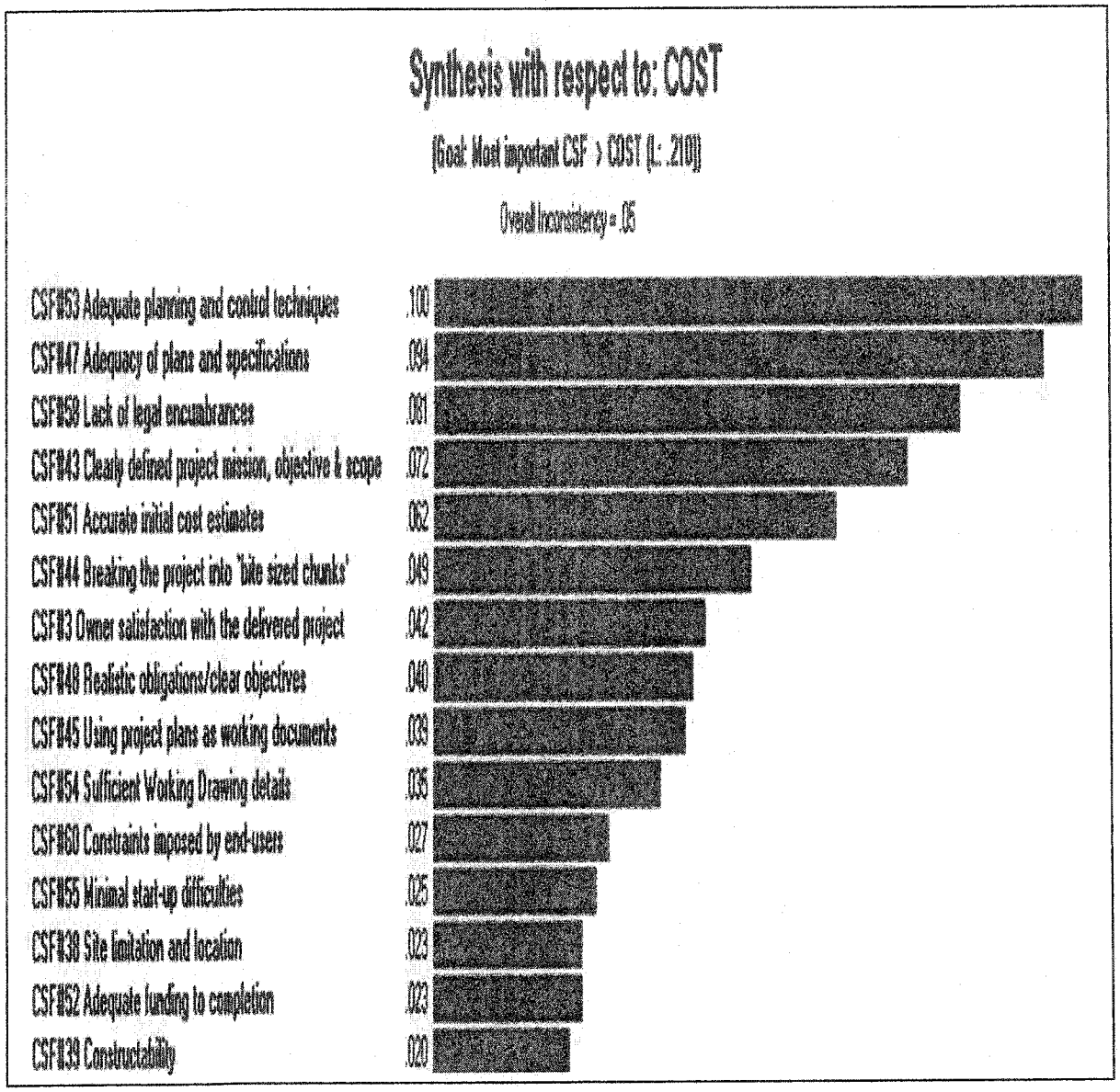

Figure 4.18: Ranking of success factors for cost done by owners

4.7 ALL PARTICIPANTS

4.7.1 GENERAL PROFILE

Considering the combined evaluation of all the respondents, nearly 50% respondents had 10-15 years and just above 50% with more than 15 years professional experience in the construction industry. The experts contacted mostly had experience in projects worth 10 – 15 million Saudi Riyals, well above the lower limit of 5 million Saudi Riyals. The completed projects were 47% government projects, 17% were private projects, and 37% were semi government projects. All the experts contacted had substantial experience in all the three types of projects i.e. commercial, residential and industrial.

4.7.2 PROJECT OBJECTIVE

In this section, results for all the participants are discussed. Figure 4.19 shows rankings for overall project objectives. Combined result of all the project participants yield that time is of great importance for the construction industry of Saudi Arabia. Time is followed by quality and cost objectives. One reason might be that the experts contacted had most of the experience in government projects, followed by semi-government and private sectors. Usually time is of great importance in government projects as timing of key decisions is likely to determine the pace of the project more than anything else.

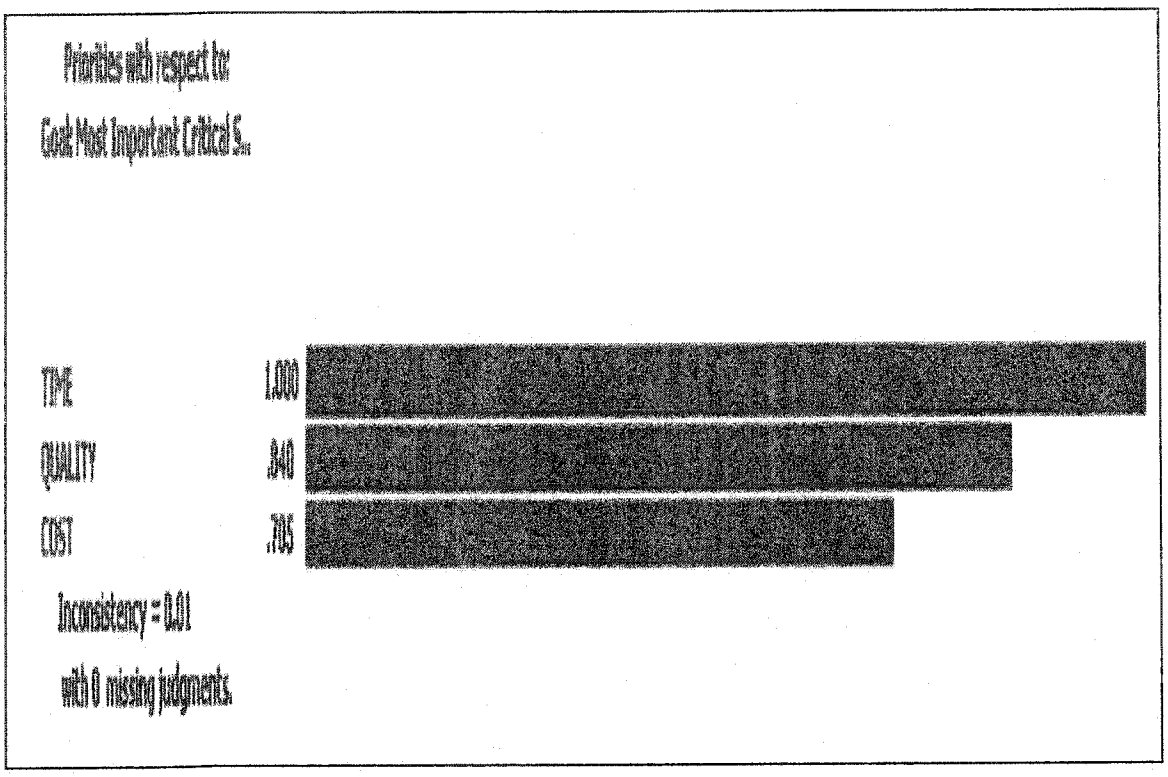

Figure 4.19: Project objective overall rankings

4.7.3 OVERALL PROJECT SUCCESS

The overall ranking of top fifteen success factors for overall project objective is presented in Figure 4.20. Top five (5) factors are discussed as follows:

1. Clearly defined project mission, objective and scope.
2. Adequate planning and controlling techniques.
3. Owner satisfaction with the delivered project.
4. Adequacy of plans and specifications.
5. Lack of legal encumbrances.

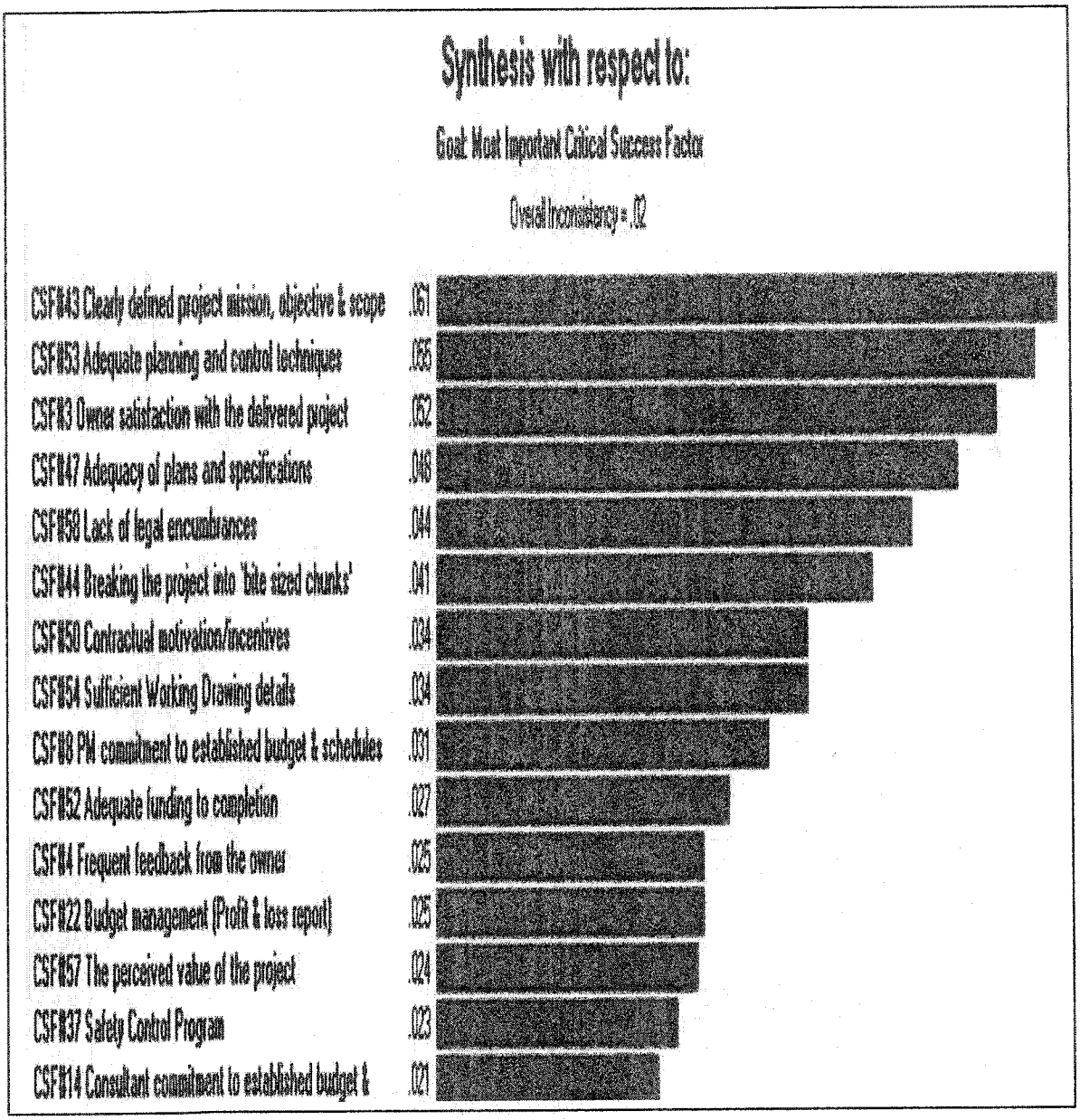

Figure 4.20: Overall Ranking of top 15 success factors done by all project participants

4.7.3.1 Clearly defined project mission, objective and scope

Consultants have ranked this factor as thirty eighth (38^{th}) most important, contractors have ranked this factor as top (1^{st}) most important factor while the owners have ranked it as fourth (4^{th}) most important factor for the overall success of a project. Importance of this factor has already been discussed while discussing each group separately. Although participants belonging to the three groups have ranked this factor differently, it does not mean that this factor is not important for them for the success of a project. Different rankings of the same factor indicate different project objectives or preferences which these participants are working toward. Nevertheless clearly defined project mission, objectives and scope is a necessary ingredient in the recipe for project success. These rankings may also indicate that this factor is more important in government and semi government projects, than private projects, as contractors and owners have ranked this factor within the top five ranking.

4.7.3.2 Adequate planning and controlling techniques

Consultants have ranked this factor as second (2^{nd}) most important, contractors have ranked this factor as nineteenth (19^{th}) most important while owners have ranked it as top (1^{st}) most important factor for the overall success of a project. Here again different rankings for the same factor indicate different project objectives or preferences which these participants are aiming at. Nevertheless adequate planning and controlling techniques play a major role in the success of a project. These rankings may also indicate that this factor is more important in both semi government and private projects, as owners and consultants have ranked this factor within the top five ranking.

4.7.3.3 Owner satisfaction with the delivered project

Consultants have ranked this factor as top (1^{st}) most important, contractors have ranked it as twenty fourth (24^{th}) most important factor while owners have ranked it as ninth (9^{th}) most important factor for the overall success of a project. A wide range of rankings have been given to this factor by the participants. Consultants usually work more close to the owner to achieve the objectives set at the start of a project. Contractors usually work towards their own goals and may not be able to achieve full owner satisfaction, owners on the other hand are more concerned about timely completion and savings and may sometimes settle for a project with lesser quality standards. Owner satisfaction with the delivered project is very important for the success of a project. These rankings may also indicate that this factor is more important in both semi government and private projects, as owners and consultants have ranked this factor within the top five ranking.

4.7.3.4 Adequacy of plans and specifications

Consultants have ranked this factor as nineteenth (19^{th}) most important, contractors have ranked this factor as third (3^{rd}) most important while owners have ranked it as second (2^{nd}) most important factor for the overall success of a project. Consultants are generally of the opinion that the plans and specifications produced in their design offices are accurate and unchallengeable. Contractors and owners give great importance to the accuracy of plans and specifications as the progress of different activities of a project immensely depends on these documents. Accurate plans and specifications are very important for the success of a project. These rankings may also

indicate that this factor is more important in both government and semi government projects, as contractors and owners have ranked this factor within the top five ranking.

4.7.3.5 Lack of legal encumbrances

Consultants have ranked this factor as sixteenth (16^{th}) most important, contractors have ranked this factor as thirty third (33^{rd}) most important while owners have ranked this factor as third (3^{rd}) most important factor for the overall success of a project. Owners have ranked this factor within the top five notch as they are usually concerned with the permits, bonds and other legal bindings set by the municipalities and other concerned departments. They have to provide a site for construction which is free from all legal issues, and also advise the designer to devise such a facility that follows that building codes and rules set by the local building authority/municipality. Lack of legal encumbrances is an important component for the achievement of different project objectives and later on for project success. These rankings may also indicate that this factor is more important in semi government projects, than both private and semi government projects, as owners have ranked this factor within the top five ranking.

4.7.4 SUCCESS FOR TIME OBJECTIVE

The overall ranking of top fifteen success factors for the time objective is presented in Figure 4.21. Top five (5) factors are discussed as follows:

1. Clearly defined project mission, objective and scope
2. Adequate planning and controlling techniques
3. Owner satisfaction with the delivered project
4. Adequacy of plans and specifications
5. Adherence to schedules

4.7.4.1 Clearly defined project mission, objective and scope

Consultants have ranked this factor as eight (8^{th}) most important, contractors have ranked this factor as top (1^{st}) most important factor while the owners have ranked it as fourth (4^{th}) most important factor for the achievement of time objective in a project. All the participants agree that clearly defined project mission, objective and scope are very important for finishing the project within approved schedule.

4.7.4.2 Adequate planning and controlling techniques

Consultants have ranked this factor as sixth (6^{th}) most important, contractors have ranked this factor as twelfth (12^{th}) most important factor while the owners have ranked it as top (1^{st}) most important factor for the achievement of time objective in a project. All participants may have ranked this factor differently but they agree that adequate planning and controlling techniques are necessary for finishing the project in time.

4.7.4.3 Owner satisfaction with the delivered project

Consultants have ranked this factor as top (1^{st}) most important, contractors have ranked this factor as twenty seventh (27^{th}) most important factor while the owners have ranked it as eight (8^{th}) most important factor for the achievement of time objective in a project. All participants agree that owner satisfaction is important for accomplishing the time objective.

4.7.4.4 Adequacy of plans and specifications

Consultants have ranked this factor as twelfth (12^{th}) most important, contractors have ranked this factor as fifth (5^{th}) most important factor while the owners have ranked it as second (2^{nd}) most important factor for the achievement of time objective in a project. All project participants are of the opinion that accurate plans and specifications may aid in finishing a project within specified duration.

4.7.4.5 Adherence to schedules

Consultants have ranked this factor as third (3^{rd}) most important, contractors have ranked this factor as seventeenth (17^{th}) most important factor while the owners have ranked it as twenty fifth (25^{th}) most important factor for the achievement of time objective in a project. All project participants firmly agree that adherence to schedules set at the initiation of a project will help finish a project well within time.

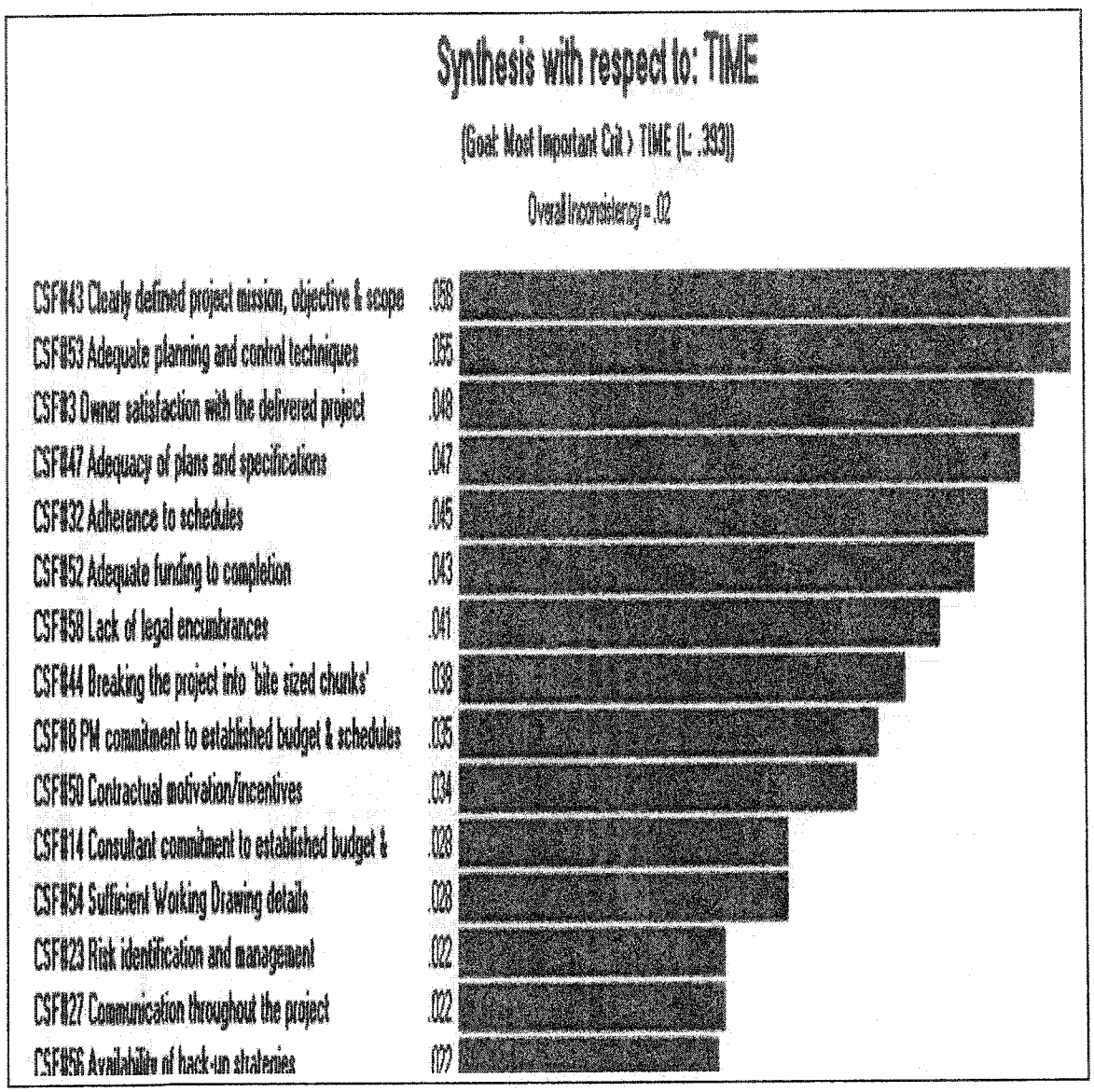

Figure 4.21: Ranking of success factors for time done by all participants

4.7.5 SUCCESS FOR QUALITY OBJECTIVE

The overall ranking of top fifteen success factors for the quality objective is presented in Figure 4.22. Top five (5) factors are discussed as follows:

1. Clearly defined project mission, objective and scope
2. Adequate planning and controlling techniques
3. Adequacy of plans and specifications
4. Lack of legal encumbrances
5. Owner satisfaction with the delivered project

4.7.5.1 Clearly defined project mission, objective and scope

Consultants have ranked this factor as fifty third (53^{rd}) most important, contractors have ranked this factor as top (1^{st}) most important factor while the owners have ranked it as fifth (5^{th}) most important factor for the achievement of quality objective in a project. As already discussed all participants agree that clearly defined project mission, objective and scope is very important to finish a project which meets the specified quality standards.

4.7.5.2 Adequate planning and controlling techniques

Consultants have ranked this factor as fourth (4^{th}) most important, contractors have ranked this factor as thirty fourth (34^{th}) most important factor while the owners have ranked it as top (1^{st}) most important factor for the achievement of quality objective in a project. Meticulous planning and controlling of a project as agreed by all project participants can deliver a quality project at the end.

4.7.5.3 Adequacy of plans and specifications

Consultants have ranked this factor as thirty second (32^{nd}) most important, contractors have ranked this factor as fifth (5^{th}) most important factor while the owners have ranked it as third (3^{rd}) most important factor for the achievement of quality objective in a project. Adequate plans and specifications as agreed by all project participants ensure a project meeting the quality objective.

4.7.5.4 Lack of legal encumbrances

Consultants have ranked this factor as sixteenth (16^{th}) most important, contractors have ranked this factor as twenty sixth (26^{th}) most important factor while the owners have ranked it as fourth (4^{th}) most important factor for the achievement of quality objective in a project. Legal encumbrances tend to affect the quality objective in a project. All participants agree that less presence of these hindrances will allow the project participants to concentrate towards the achievement of quality objective.

4.7.5.5 Owner satisfaction with the delivered project

Consultants have ranked this factor as top (1^{st}) most important, contractors have ranked this factor as twenty second (22^{nd}) most important factor while the owners have ranked it as fourteenth (14^{th}) most important factor for the achievement of quality objective in a project. All participants agree that owner satisfaction with the delivered project will help in accomplishing the quality objective.

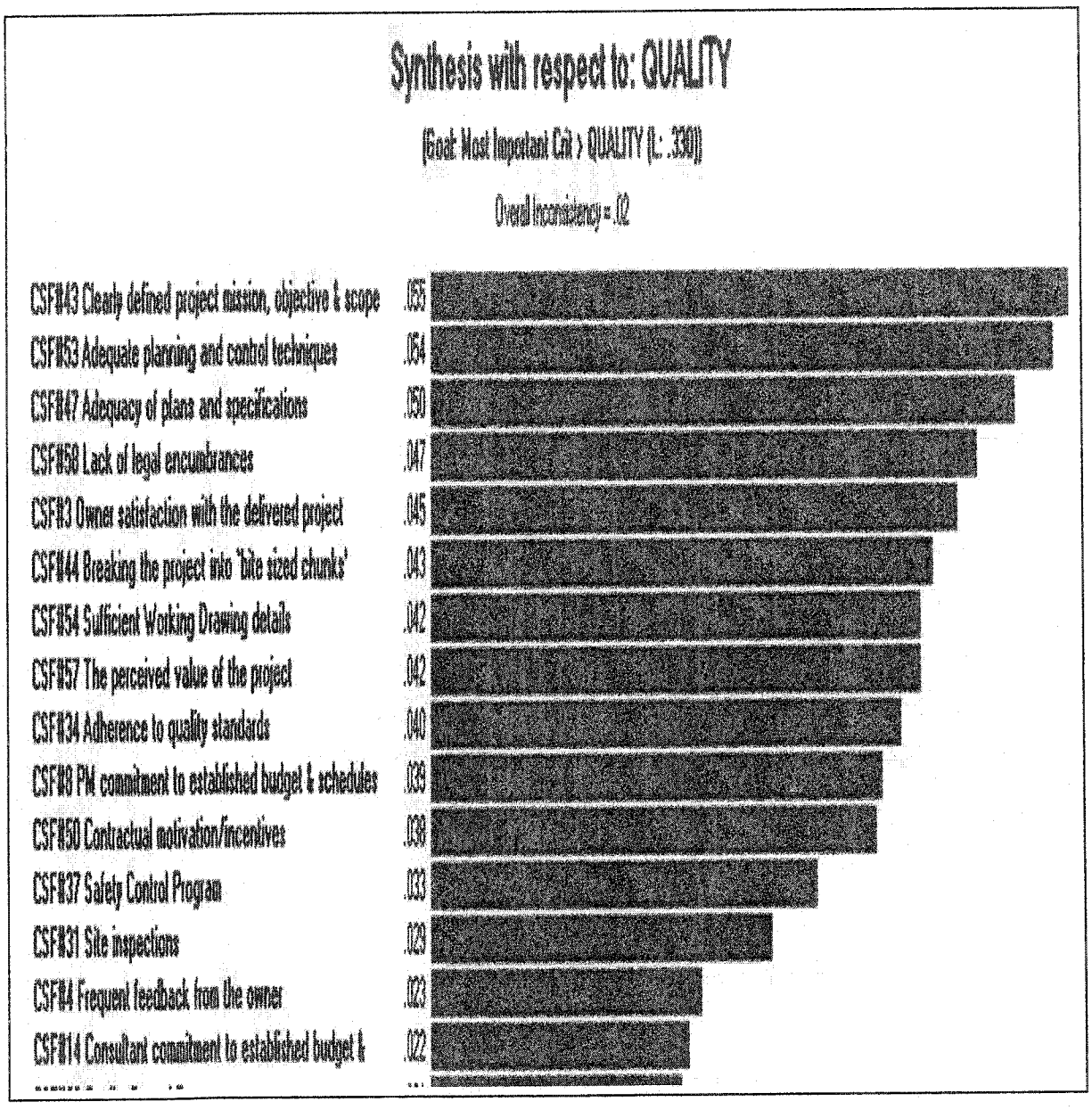

Figure 4.22: Ranking of success factors for quality done by all participants

4.7.6 SUCCESS FOR COST OBJECTIVE

The overall ranking of top fifteen success factors for the cost objective is presented in Figure 4.23. Top five (5) factors are discussed as follows:

1. Clearly defined project mission, objective and scope
2. Owner satisfaction with the delivered project
3. Budget management (profit and loss)
4. Adequate planning and controlling techniques
5. Adequacy of plans and specifications

4.7.6.1 Clearly defined project mission, objective and scope

Consultants have ranked this factor as forty fifth (45^{th}) most important, contractors have ranked this factor as top (1^{st}) most important factor while the owners have ranked it as fourth (4^{th}) most important factor for the achievement of cost objective in a project. All project participants are of firm opinion that clearly defined project mission, objectives and scope is very important in controlling the cost of a project.

4.7.6.2 Owner satisfaction with the delivered project

Consultants have ranked this factor as top (1^{st}) most important, contractors have ranked this factor as twenty seventh (27^{th}) most important factor while the owners have ranked it as seventh (7^{th}) most important factor for the achievement of cost objective in a project. All project participants agree that owner satisfaction at the end of a project is very vital to finish a project within the specified budget.

4.7.6.3 Budget management (profit and loss)

Consultants have ranked this factor as second (2^{nd}) most important, contractors have ranked this factor as thirtieth (30^{th}) most important factor while the owners have ranked it as forty first (41^{st}) most important factor for the achievement of cost objective in a project. All project participants are of the opinion that proper budget management is necessary to control the cost of a project.

4.7.6.4 Adequate planning and controlling techniques

Consultants have ranked this factor as fourth (4^{th}) most important, contractors have ranked this factor as twenty fourth (24^{th}) most important factor while the owners have ranked it as top (1^{st}) most important factor for the achievement of cost objective in a project. Utilization of sufficient project planning and controlling techniques, as agreed by all project participants is important for savings at the end of a project.

4.7.6.5 Adequacy of plans and specifications

Consultants have ranked this factor as fifteenth (15^{th}) most important, contractors have ranked this factor as third (3^{rd}) most important factor while the owners have ranked it as second (2^{nd}) most important factor for the achievement of cost objective in a project. All project participants agree that accurate plans and specifications may help accomplish the cost objective.

Table 4.2 shows summary of all the results obtained.

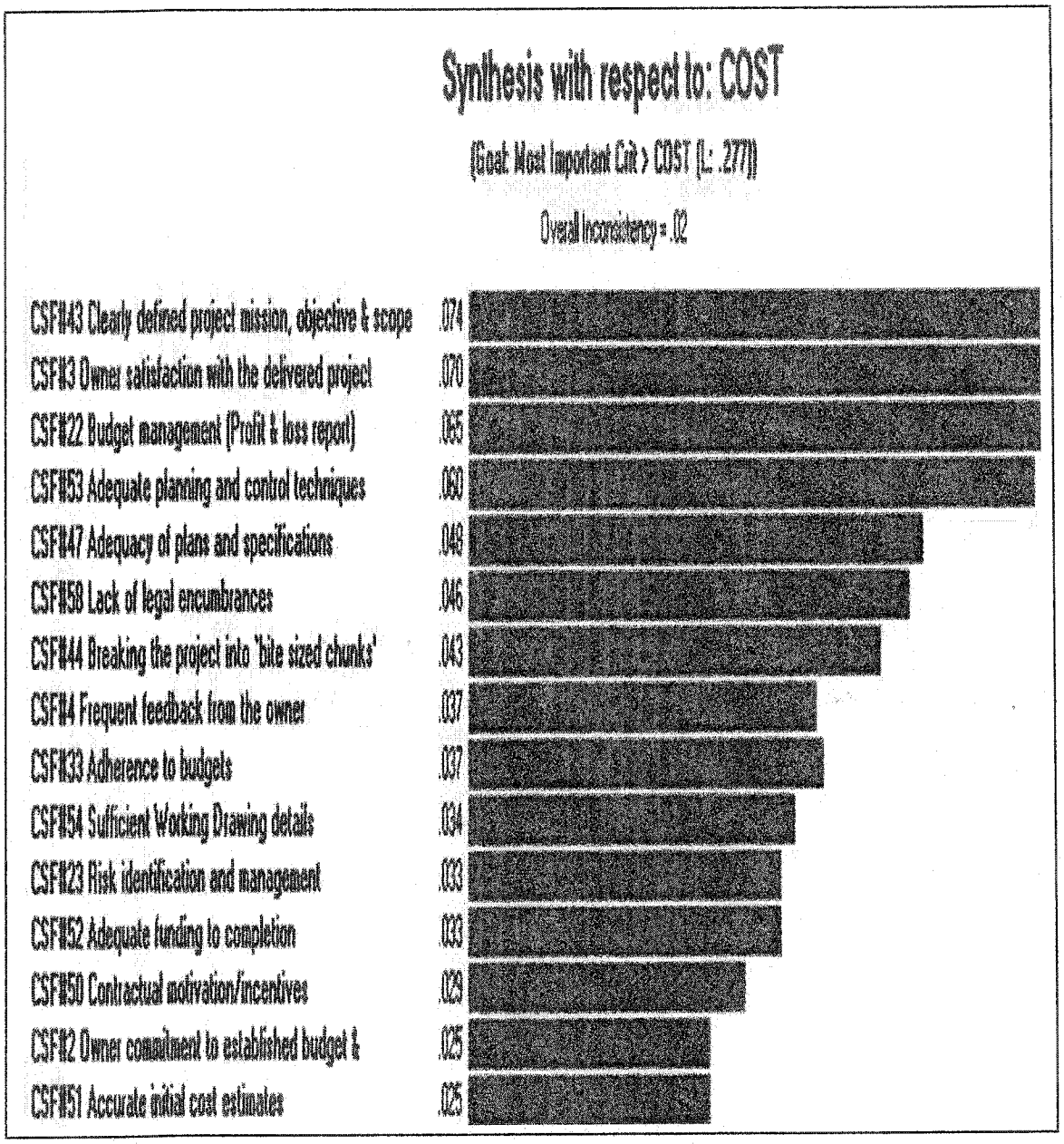

Figure 4.23: Ranking of success factors for cost done by all participants

Table 4.2: Summary of Results

(** = ranking below top 15)	PROJECT PARTICIPANTS															
	Consultant				Owner				Contractor				All Participants			
SUCCESS FACTORS	Cost	Time	Quality	All	Cost	Time	Quality	All	Cost	Time	Quality	All	Cost	Time	Quality	All
Clearly defined project mission, objective & scope	**	8	**	**	4	4	**	4	1	1	1	1	1	1	1	1
Adequate planning and control techniques	4	6	4	2	1	1	1	1	**	12	**	**	4	**	2	2
Owner satisfaction with the delivered project	1	1	1	1	7	8	14	9	**	**	**	**	2	3	5	3
Adequacy of plans and specifications	15	12	**	**	2	2	3	2	3	5	5	3	5	4	3	4
Lack of legal encumbrances	**	7	**	**	3	3	4	3	**		**	**	6	7	4	5
Breaking the project into `bite sized chunks'	**	**	**	**	6	7	5	8	2	2	2	2	7	8	6	6
Contractual motivation/incentives	**	**	**	**	**	**	**	**	11	13	**	14	13	10	11	7
Sufficient Working Drawing details	**	**	14	**	10	5	7	5	**	**	13	**	10	12	7	8
PM commitment to established budget & schedules	9	**	**	**	**	**	**	**	**	**	**	**	**	9	10	9
Adequate funding to completion	10	**	9	10	14	**	12	**	**	**	**	**	12	6	**	10
Frequent feedback from the owner	7	5	8	4	**	**	10	**	6	7	9	7	8	**	14	11
Budget management (Profit & loss report)	2	**	**	14	**	**	**	**	**	**	**	**	3	**	**	12
The perceived value of the project	**	**	**	**	**	**	15	**	**	**	**	**	**	**	8	13
Safety Control Program	**	**	**	**	**	**	**	**	**	**	**	**	**	**	12	14
Consultant commitment to established budget & schedules	**	**	15	**	**	***	**	**	**	**	**	**	**	11	15	15

4.8 OWNER VS CONTRACTOR

This section deals with hypotheses testing related to the level of agreement present between the owner and the contractor group. Test statistic is calculated using Spearmen's correlation (r_s) technique which is already discussed in chapter three. Spearmen's correlation (r_s) can be calculated using the following equation (Thondike, 1978):

$$r_s = 1 - \frac{6\sum d^2}{n(n^2 - 1)} \quad \text{..... (4A)}$$

where;

r_s = The Spearmen correlation

d = the difference between ranking for each group (2)

n = number of factors (60)

The procedure for testing r_s for significance depends on the sample size (n). If n is less than or equal to 30, critical values of r_s for various values of α can be consulted from tables which are present in various statistics books. For values of n greater than 30, statistic can be calculated using the following equation (Thondike, 1978):

$$z = r_s \sqrt{n - 1} \quad \text{..... (4B)}$$

Table 4.3 shows calculation of d^2 values for the owner vs. contractor group in a tabular form, which are used in calculating r_s.

Table 4.3 Level of agreement between owner and contractor

Spearman's data correlation	Ranking by		Rank Difference (d)	d^2
Critical success factors	**Owner**	**Contractor**	**Owner-Contractor**	**Owner-Contractor**
CSF#1 Owner enthusiasm	32	4	28	784
CSF#2 Owner commitment to established budget & schedules	5	29	24	576
CSF#3 Owner satisfaction with the delivered project	8	24	16	256
CSF#4 Frequent feedback from the owner	13	7	6	36
CSF#5 PM competency & authority	17	10	7	49
CSF#6 On-site project manager	25	35	10	100
CSF#7 Project team capability and commitment	33	36	3	9
CSF#8 PM commitment to established budget & schedules	18	46	28	784
CSF#9 Nature of the projects managers' authority	15	54	39	1521
CSF#10 Capability of contractor key person	34	44	10	100
CSF#11 Contractor commitment to established budget & schedules	35	56	21	441
CSF#12 Contractor team capability and commitment	26	57	31	961
CSF#13 Consultant team capability and commitment	46	58	12	144
CSF#14 Consultant commitment to established budget & schedules	53	59	6	36
CSF#15 Capability of Consultant key person	54	60	6	36
CSF#16 Absence of bureaucracy	59	13	46	2116
CSF#17 Flexible parent organization	60	25	35	1225
CSF#18 A good customer and client relationship	55	22	33	1089
CSF#19 Accomplishment of contract add-ons	56	26	30	900
CSF#20 Meeting design goals	47	15	32	1024
CSF#21 Pre-contract activities	57	28	29	841
CSF#22 Budget management (Profit & loss report)	48	23	25	625
CSF#23 Risk identification and	49	30	19	361

management				
CSF#24 Design-Construction interface management	51	5	46	2116
CSF#25 Frequent feedback from the parent organization	58	50	8	64
CSF#26 Monitoring and feedback from the project	27	47	20	400
CSF#27 Communication throughout the project	43	34	9	81
CSF#28 Beneficial coordination between professionals	45	31	14	196
CSF#29 Construction control meetings	28	48	20	400
CSF#30 Design control meetings	29	51	22	484
CSF#31 Site inspections	44	41	3	9
CSF#32 Adherence to schedules	24	32	8	64
CSF#33 Adherence to budgets	30	39	9	81
CSF#34 Adherence to quality standards	36	52	16	256
CSF#35 Adherence to change control processes	37	55	18	324
CSF#36 Quality Control Program	40	37	3	9
CSF#37 Safety Control Program	22	49	27	729
CSF#38 Site limitation and location	41	9	32	1024
CSF#39 Constructability	31	6	25	625
CSF#40 The size of the project (measured by total cost)	42	16	26	676
CSF#41 Pioneering status	52	12	40	1600
CSF#42 Economic risks	50	17	33	1089
CSF#43 Clearly defined project mission, objective & scope	14	1	13	169
CSF#44 Breaking the project into `bite sized chunks'	23	2	21	441
CSF#45 Using project plans as working documents	20	11	9	81
CSF#46 Design considerations	38	20	18	324
CSF#47 Adequacy of plans and specifications	1	3	2	4
CSF#48 Realistic obligations/clear objectives	3	8	5	25
CSF#49 Formal dispute resolution process	11	21	10	100
CSF#50 Contractual motivation/incentives	12	14	2	4
CSF#51 Accurate initial cost estimates	9	27	18	324
CSF#52 Adequate funding to completion	21	38	17	289
CSF#53 Adequate planning and control techniques	2	19	17	289
CSF#54 Sufficient Working Drawing	4	18	14	196

details				
CSF#55 Minimal start-up difficulties	6	42	36	1296
CSF#56 Availability of back-up strategies	10	40	30	900
CSF#57 The perceived value of the project	19	53	34	1156
CSF#58 Lack of legal encumbrances	39	33	6	36
CSF#59 Minimized number of public/government agencies involved	16	45	29	841
CSF#60 Constraints imposed by end-users	7	43	36	1296
			Total ∑	**32012**

4.8.1 Hypotheses

H_o: The owners and contractors are mutually independent in the ranking of major portion of the critical success factors.

H_1: The owners and contractors are not mutually independent in the ranking of major portion of the critical success factors.

4.8.2 Test statistic

The test statistic is calculated using equation 4A, values of Σd^2 are obtained from table 4.2. Test statistic is calculated as follows:

$$r_s = 1 - \frac{6X32012}{60(60^2 - 1)}$$

$r_s = 0.1105$

4.8.3 Decision rule

Significance statistic is calculated using equation 4B as follows:

$$z = 0.1105\sqrt{60 - 1}$$

$z = 0.8490$

Accept H_o if test statistic is less than the significance statistic; otherwise reject the null hypotheses.

Therefore accept the null hypotheses as $0.1105<0.8490$. At a significance level (α) of 0.05 or 95% confidence interval, it can be deduced that owners and contractors do not agree on the rankings of major portion of the critical success factors. One quite obvious reason is that each group is working towards their own objectives.

4.9 CONTRACTOR VS CONSULTANT

This section deals with hypotheses testing related to the level of agreement present between the contractor and the consultant group. Test statistic is calculated using equation 4A which is already discussed and tested for significance using equation 4B, also already discussed.

Table 4.4 shows calculation of d^2 values for the contractor vs. consultant group in a tabular form, which are used in calculating r_s.

Table 4.4 Level of agreement between contractor and consultant

Spearman's data correlation	**Ranking by**		**Rank Difference (d)**	**d^2**
Critical success factors	**Contractor**	**Consultant**	**Contractor-Consultant**	**Contractor -Consultant**
CSF#1 Owner enthusiasm	4	27	23	529
CSF#2 Owner commitment to established budget & schedules	29	12	17	289
CSF#3 Owner satisfaction with the delivered project	24	1	23	529
CSF#4 Frequent feedback from the owner	7	4	3	9
CSF#5 PM competency & authority	10	35	25	625
CSF#6 On-site project manager	35	59	24	576
CSF#7 Project team capability and commitment	36	28	8	64
CSF#8 PM commitment to established budget & schedules	46	29	17	289
CSF#9 Nature of the projects managers' authority	54	60	6	36
CSF#10 Capability of contractor key person	44	42	2	4
CSF#11 Contractor commitment to established budget & schedules	56	45	11	121
CSF#12 Contractor team capability and commitment	57	46	11	121
CSF#13 Consultant team capability	58	40	18	324

and commitment				
CSF#14 Consultant commitment to established budget & schedules	59	23	36	1296
CSF#15 Capability of Consultant key person	60	3	57	3249
CSF#16 Absence of bureaucracy	13	24	11	121
CSF#17 Flexible parent organization	25	50	25	625
CSF#18 A good customer and client relationship	22	51	29	841
CSF#19 Accomplishment of contract add-ons	26	47	21	441
CSF#20 Meeting design goals	15	17	2	4
CSF#21 Pre-contract activities	28	52	24	576
CSF#22 Budget management (Profit & loss report)	23	14	9	81
CSF#23 Risk identification and management	30	54	24	576
CSF#24 Design-Construction interface management	5	20	15	225
CSF#25 Frequent feedback from the parent organization	50	36	14	196
CSF#26 Monitoring and feedback from the project	47	37	10	100
CSF#27 Communication throughout the project	34	6	28	784
CSF#28 Beneficial coordination between professionals	31	11	20	400
CSF#29 Construction control meetings	48	25	23	529
CSF#30 Design control meetings	51	30	21	441
CSF#31 Site inspections	41	9	32	1024
CSF#32 Adherence to schedules	32	13	19	361
CSF#33 Adherence to budgets	39	21	18	324
CSF#34 Adherence to quality standards	52	31	21	441
CSF#35 Adherence to change control processes	55	55	0	0
CSF#36 Quality Control Program	37	8	29	841
CSF#37 Safety Control Program	49	43	6	36
CSF#38 Site limitation and location	9	48	39	1521
CSF#39 Constructability	6	22	16	256
CSF#40 The size of the project (measured by total cost)	16	44	28	784
CSF#41 Pioneering status	12	57	45	2025
CSF#42 Economic risks	17	58	41	1681

CSF#43 Clearly defined project mission, objective & scope	1	38	37	1369
CSF#44 Breaking the project into `bite sized chunks'	2	59	57	3249
CSF#45 Using project plans as working documents	11	39	28	784
CSF#46 Design considerations	20	32	12	144
CSF#47 Adequacy of plans and specifications	3	19	16	256
CSF#48 Realistic obligations/clear objectives	8	33	25	625
CSF#49 Formal dispute resolution process	21	56	35	1225
CSF#50 Contractual motivation/incentives	14	49	35	1225
CSF#51 Accurate initial cost estimates	27	5	22	484
CSF#52 Adequate funding to completion	38	10	28	784
CSF#53 Adequate planning and control techniques	19	2	17	289
CSF#54 Sufficient Working Drawing details	18	18	0	0
CSF#55 Minimal start-up difficulties	42	15	27	729
CSF#56 Availability of back-up strategies	40	7	33	1089
CSF#57 The perceived value of the project	53	26	27	729
CSF#58 Lack of legal encumbrances	33	16	17	289
CSF#59 Minimized number of public/government agencies involved	45	41	4	16
CSF#60 Constraints imposed by end-users	43	34	9	81
			Total ∑	**36662**

4.9.1 Hypotheses

H_o: The contractors and consultants are mutually independent in the ranking of major portion of the critical success factors.

H_1: The contractors and consultants are not mutually independent in the ranking of major portion of the critical success factors.

4.9.2 Test statistic

The test statistic is calculated using equation 4A, values of Σd^2 are obtained from table 4.3. Test statistic is calculated as follows:

$$r_s = 1 - \frac{6X36662}{60(60^2 - 1)}$$

$r_s = -0.01867$

4.9.3 Decision rule

Significance statistic is calculated using equation 4B as follows:

$$z = -0.01867\sqrt{60 - 1}$$

$z = -0.1434$

Accept H_o if test statistic is less than the significance statistic; otherwise reject the null hypotheses.

Therefore accept the null hypotheses as -0.01867<-0.1434. At a significance level (α) of 0.05 or 95% confidence interval, it can be deduced that contractors and consultants do not agree on the rankings of major portion of the critical success factors. One quite obvious reason is that each group is working towards their own objectives.

4.10 OWNER VS CONSULTANT

This section deals with hypotheses testing related to the level of agreement present between the owner and the consultant group. Test statistic is calculated using equation 4A which is already discussed and tested for significance using equation 4B, also already discussed.

Table 4.5 shows calculation of d^2 values for the owner vs. consultant group in a tabular form, which are used in calculating r_s.

Table 4.5 Level of agreement between owner and consultant

Spearman's data correlation	**Ranking by**		**Rank Difference (d)**	**d^2**
Critical success factors	**Owner**	**Consultant**	**Owner-Consultant**	**Owner-Consultant**
CSF#1 Owner enthusiasm	32	27	5	25
CSF#2 Owner commitment to established budget & schedules	5	12	7	49
CSF#3 Owner satisfaction with the delivered project	8	1	7	49
CSF#4 Frequent feedback from the owner	13	4	9	81
CSF#5 PM competency & authority	17	35	18	324
CSF#6 On-site project manager	25	59	34	1156
CSF#7 Project team capability and commitment	33	28	5	25
CSF#8 PM commitment to established budget & schedules	18	29	11	121
CSF#9 Nature of the projects managers' authority	15	60	45	2025
CSF#10 Capability of contractor key person	34	42	8	64
CSF#11 Contractor commitment to established budget & schedules	35	45	10	100
CSF#12 Contractor team capability and commitment	26	46	20	400
CSF#13 Consultant team capability and commitment	46	40	6	36
CSF#14 Consultant commitment to established budget & schedules	53	23	30	900

CSF#15 Capability of Consultant key person	54	3	51	2601
CSF#16 Absence of bureaucracy	59	24	35	1225
CSF#17 Flexible parent organization	60	50	10	100
CSF#18 A good customer and client relationship	55	51	4	16
CSF#19 Accomplishment of contract add-ons	56	47	9	81
CSF#20 Meeting design goals	47	17	30	900
CSF#21 Pre-contract activities	57	52	5	25
CSF#22 Budget management (Profit & loss report)	48	14	34	1156
CSF#23 Risk identification and management	49	54	5	25
CSF#24 Design-Construction interface management	51	20	31	961
CSF#25 Frequent feedback from the parent organization	58	36	22	484
CSF#26 Monitoring and feedback from the project	27	37	10	100
CSF#27 Communication throughout the project	43	6	37	1369
CSF#28 Beneficial coordination between professionals	45	11	34	1156
CSF#29 Construction control meetings	28	25	3	9
CSF#30 Design control meetings	29	30	1	1
CSF#31 Site inspections	44	9	35	1225
CSF#32 Adherence to schedules	24	13	11	121
CSF#33 Adherence to budgets	30	21	9	81
CSF#34 Adherence to quality standards	36	31	5	25
CSF#35 Adherence to change control processes	37	55	18	324
CSF#36 Quality Control Program	40	8	32	1024
CSF#37 Safety Control Program	22	43	21	441
CSF#38 Site limitation and location	41	48	7	49
CSF#39 Constructability	31	22	9	81
CSF#40 The size of the project (measured by total cost)	42	44	2	4
CSF#41 Pioneering status	52	57	5	25
CSF#42 Economic risks	50	58	8	64
CSF#43 Clearly defined project mission, objective & scope	14	38	24	576
CSF#44 Breaking the project into `bite sized chunks'	23	59	36	1296
CSF#45 Using project plans as working documents	20	39	19	361
CSF#46 Design considerations	38	32	6	36
CSF#47 Adequacy of plans and specifications	1	19	18	324

CSF#48 Realistic obligations/clear objectives	3	33	30	900
CSF#49 Formal dispute resolution process	11	56	45	2025
CSF#50 Contractual motivation/incentives	12	49	37	1369
CSF#51 Accurate initial cost estimates	9	5	4	16
CSF#52 Adequate funding to completion	21	10	11	121
CSF#53 Adequate planning and control techniques	2	2	0	0
CSF#54 Sufficient Working Drawing details	4	18	14	196
CSF#55 Minimal start-up difficulties	6	15	9	81
CSF#56 Availability of back-up strategies	10	7	3	9
CSF#57 The perceived value of the project	19	26	7	49
CSF#58 Lack of legal encumbrances	39	16	23	529
CSF#59 Minimized number of public/government agencies involved	16	41	25	625
CSF#60 Constraints imposed by end-users	7	34	27	729
			Total ∑	**28270**

4.10.1 Hypotheses

H_o: The owners and consultants are mutually independent in the ranking of major portion of the critical success factors.

H_1: The owners and consultants are not mutually independent in the ranking of major portion of the critical success factors.

4.10.2 Test statistic

The test statistic is calculated using equation 4A, values of Σd^2 are obtained from table 4.3. Test statistic is calculated as follows:

$$r_s = 1 - \frac{6X28270}{60(60^2 - 1)}$$

$r_s = 0.2145$

4.10.3 Decision rule

Significance statistic is calculated using equation 4B as follows:

$$z = 0.2145\sqrt{60-1}$$

$$z = 1.6476$$

Accept H_o if test statistic is less than the significance statistic; otherwise reject the null hypotheses.

Therefore accept the null hypotheses as 0.2145<1.6476. At a significance level (α) of 0.05 or 95% confidence interval, it can be deduced that owners and consultants do not agree on the rankings of major portion of the critical success factors. One quite obvious reason is that each group is working towards their own objectives.

4.11 LEVEL OF AGREEMENT BETWEEN ALL PARTICIPANTS

This section deals with hypotheses testing related to the level of agreement present between all the project participants i.e. owner, consultant and the contractors group. Test statistic is calculated using the Kendall coefficient of concordance (τ) which is a measure of degree of association or agreement among sets of rankings. It can be calculated by using the following equation (Thondike, 1978):

$$\tau = \frac{\sum_{i=1}^{k} (R_i - R)^2}{n(n^2 - 1)/12} \quad \text{.....(4C)}$$

where

R_i = average of the ranks assigned by an individual.

R = average of the ranks assigned to the nth variable factor (sum of R_i / n)

k = Number of judgments (3)

n = the number of aspects of a problem or factor being ranked (60)

n (n^2-1) /12 = the maximum possible squared deviations

Kendall coefficient of concordance (τ) also depends upon the sample size (n). For values of n greater than 10, standard error of τ is calculated using the following equation:

$$S_\tau = \sqrt{\frac{2(2n+5)}{9n(n-1)}} \quad \text{.....(4D)}$$

Test of statistical significance is calculated using the following equation:

$$Z = \frac{\tau}{S_\tau} \quad \text{.....(4E)}$$

Calculations are done in the table 4.6 for (R_i – R), which is used to calculate Kendall's coefficient of concordance:

Table 4.6 Level of agreement between all participants

Kendall's data correlation	Ranking by					
Critical success factors	**Owner**	**Contractor**	**Consultant**	**Mean R_i**	**R_i-R**	**$(R_i-R)^2$**
CSF#1 Owner enthusiasm	32	4	27	21.00	-9.53	90.88
CSF#2 Owner commitment to established budget & schedules	5	29	12	15.33	-15.20	231.03
CSF#3 Owner satisfaction with the delivered project	8	24	1	11.00	-19.53	381.54
CSF#4 Frequent feedback from the owner	13	7	4	8.00	-22.53	507.74
CSF#5 PM competency & authority	17	10	35	20.67	-9.87	97.34
CSF#6 On-site project manager	25	35	59	39.67	9.13	83.42
CSF#7 Project team capability and commitment	33	36	28	32.33	1.80	3.24
CSF#8 PM commitment to established budget & schedules	18	46	29	31.00	0.47	0.22
CSF#9 Nature of the projects managers' authority	15	54	60	43.00	12.47	155.43
CSF#10 Capability of contractor key person	34	44	42	40.00	9.47	89.62
CSF#11 Contractor commitment to established budget & schedules	35	56	45	45.33	14.80	219.05
CSF#12 Contractor team capability and commitment	26	57	46	43.00	12.47	155.43
CSF#13 Consultant team capability and commitment	46	58	40	48.00	17.47	305.10
CSF#14 Consultant commitment to established budget & schedules	53	59	23	45.00	14.47	209.29
CSF#15 Capability of Consultant key person	54	60	3	39.00	8.47	71.69
CSF#16 Absence of bureaucracy	59	13	24	32.00	1.47	2.15
CSF#17 Flexible parent organization	60	25	50	45.00	14.47	209.29
CSF#18 A good customer and client relationship	55	22	51	42.67	12.13	147.23
CSF#19 Accomplishment of contract add-ons	56	26	47	43.00	12.47	155.43
CSF#20 Meeting design goals	47	15	17	26.33	-4.20	17.64
CSF#21 Pre-contract activities	57	28	52	45.67	15.13	229.03
CSF#22 Budget management (Profit & loss report)	48	23	14	28.33	-2.20	4.84

CSF#23 Risk identification and management	49	30	54	44.33	13.80	190.45
CSF#24 Design-Construction interface management	51	5	20	25.33	-5.20	27.04
CSF#25 Frequent feedback from the parent organization	58	50	36	48.00	17.47	305.10
CSF#26 Monitoring and feedback from the project	27	47	37	37.00	6.47	41.82
CSF#27 Communication throughout the project	43	34	6	27.67	-2.87	8.22
CSF#28 Beneficial coordination between professionals	45	31	11	29.00	-1.53	2.35
CSF#29 Construction control meetings	28	48	25	33.67	3.13	9.82
CSF#30 Design control meetings	29	51	30	36.67	6.13	37.62
CSF#31 Site inspections	44	41	9	31.33	0.80	0.64
CSF#32 Adherence to schedules	24	32	13	23.00	-7.53	56.75
CSF#33 Adherence to budgets	30	39	21	30.00	-0.53	0.28
CSF#34 Adherence to quality standards	36	52	31	39.67	9.13	83.42
CSF#35 Adherence to change control processes	37	55	55	49.00	18.47	341.03
CSF#36 Quality Control Program	40	37	8	28.33	-2.20	4.84
CSF#37 Safety Control Program	22	49	43	38.00	7.47	55.76
CSF#38 Site limitation and location	41	9	48	32.67	2.13	4.55
CSF#39 Constructability	31	6	22	19.67	-10.87	118.08
CSF#40 The size of the project (measured by total cost)	42	16	44	34.00	3.47	12.02
CSF#41 Pioneering status	52	12	57	40.33	9.80	96.05
CSF#42 Economic risks	50	17	58	41.67	11.13	123.96
CSF#43 Clearly defined project mission, objective & scope	14	1	38	17.67	-12.87	165.54
CSF#44 Breaking the project into `bite sized chunks'	23	2	59	28.00	-2.53	6.42
CSF#45 Using project plans as working documents	20	11	39	23.33	-7.20	51.84
CSF#46 Design considerations	38	20	32	30.00	-0.53	0.28
CSF#47 Adequacy of plans and specifications	1	3	19	7.67	-22.87	522.87
CSF#48 Realistic obligations/clear objectives	3	8	33	14.67	-15.87	251.74
CSF#49 Formal dispute resolution process	11	21	56	29.33	-1.20	1.44

CSF#50 Contractual motivation/incentives	12	14	49	25.00	-5.53	30.61
CSF#51 Accurate initial cost estimates	9	27	5	13.67	-16.87	284.47
CSF#52 Adequate funding to completion	21	38	10	23.00	-7.53	56.75
CSF#53 Adequate planning and control techniques	2	19	2	7.67	-22.87	522.87
CSF#54 Sufficient Working Drawing details	4	18	18	13.33	-17.20	295.83
CSF#55 Minimal start-up difficulties	6	42	15	21.00	-9.53	90.88
CSF#56 Availability of back-up strategies	10	40	7	19.00	-11.53	133.01
CSF#57 The perceived value of the project	19	53	26	32.67	2.13	4.55
CSF#58 Lack of legal encumbrances	39	33	16	29.33	-1.20	1.44
CSF#59 Minimized number of public/government agencies involved	16	45	41	34.00	3.47	12.02
CSF#60 Constraints imposed by end-users	7	43	34	28.00	-2.53	6.42
			Total ∑	**1832.00**		**7325.38**
			Mean R	**30.53**		

4.11.1 Hypotheses

H_0: The owners, consultants and contractors are mutually independent in the ranking of major portion of the critical success factors.

H_1: The owners, consultants and contractors are not mutually independent in the ranking of major portion of the critical success factors.

4.11.2 Test statistic

The test statistic is calculated using equation 4C, values of $(R_i - R)$ are obtained from table 4.5. Test statistic is calculated as follows:

$$\tau = \frac{\sum_{i=1}^{3} (7325 \quad .38)}{60\,(60^{2} - 1)/12}$$

$\tau = 0.4071$

4.11.3 Decision rule

Significance statistic is calculated using equation 4D and 4E as follows:

$$S_{\tau} = \sqrt{\frac{2(2x60 + 5)}{9x60\,(60 - 1)}}$$

$S_\tau = 0.0886$

$$Z = \frac{0.4071}{0.0886}$$

$z = 4.5955$

Accept H_o if test statistic is less than the significance statistic; otherwise reject the null hypotheses.

Therefore accept the null hypotheses as $0.4071<4.5955$. At a significance level (α) of 0.05 or 95% confidence interval, it can be deduced that owners, consultants and contractors do not agree on the rankings of major portion of the critical success factors. One quite obvious reason is that each group is working towards their own objectives.

CHAPTER FIVE

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

In this chapter first the summary of the whole thesis is discussed, followed by some important conclusions derived from the research and recommendations for future studies.

5.2 SUMMARY

The main objective of this research was to determine the most important critical success factor for construction projects, based on accumulative knowledge and judgment of experts (owner/owner representative, consultant, and contractor) in the Saudi Arabian construction industry and also to define and identify the critical factors for the objectives of budget (cost), schedule (time) and quality that lead to project success.

The research encircled those project participants (experts) belonging to three major groups i.e. (owner/owner representative, consultant, contractor), who had a minimum of ten (10) years experience in the Saudi Arabian construction industry. Experts interviewed were experienced in industrial, commercial, and residential projects belonging to private sector, semi-government or government sectors.

First of all whole concentration of research was on acquiring the knowledge through extensive literature review about different project objectives, project participants

and critical success factors from the point of view of researchers and project participants throughout the world. A list of sixty success factors was developed from the literature searched. These factors were grouped under three main project aspects, namely, project participants, management communication & control and project characteristics, depending upon their similar nature.

After retrieving the most influential critical success factors through comprehensive analysis of data and the allegations of the participants, a questionnaire was developed for interviews of selected contractors, eminent consultants and project managers representing owner organizations, in the Eastern Province of Saudi Arabia. This questionnaire consisted of pair-wise comparison tables developed in Expert Choice software. A total of sixty interviews were conducted, twenty interview from each group. Only those experts were contacted who had about 10-15 years experience on projects greater than 5 Million Saudi Riyal, in order to preserve the quality of the opinions gathered in the survey and also depending on the nature of the questionnaire.

Data collected by means of interviews was separated and screened, for different project participants. A hierarchical model was developed in order to do a detailed analysis of the findings, using the software mentioned earlier. The analysis assisted to point out the most important critical success factors, according to each project participant as well as for the overall construction industry. Agreement between different project participants was also calculated using Spearman's and Kendall's technique. Results can be seen in the Conclusions section of this chapter.

Apart from the above mentioned major objectives, this research helped in achieving the following sub-objectives as well:

- Defining success from the projects participants' point of view. This enabled in comparing the view of project success between experts of the local construction industry and those experts present in different parts of the world.
- Investigation of the most important overall critical success factors (CSFs) as well as for different objectives. This helped in delineating those factors which were important for the project objectives of time, cost and quality.
- Investigation of the most important critical success factors according to different project participants and also for all project participants. Each participant gave a set of most important critical success factors based on their own objectives.
- Comparing the results of the present study with those conducted in the past in different parts of the globe. Again this enabled in getting a better idea of the definition of project success.

5.3 CONCLUSIONS

- Project success has been defined from both the literature review done as well as the interview survey conducted from different project participants. The definitions given by each participants reflect the objectives whose achievement mark success and that is why each participant defined success based on the achievement of their own objectives. The consultants laid great emphasis on the achievement of quality and owner satisfaction, the contractors relate success of a project to its timely completion and the owners apart from timely completion are also concerned with the lack of quality in government projects.

- Top five (5) success factors for overall project objective are as follows:
  - ❖ Clearly defined project mission, objective and scope.
  - ❖ Adequate planning and controlling techniques.
  - ❖ Owner satisfaction with the delivered project.
  - ❖ Adequacy of plans and specifications.
  - ❖ Lack of legal encumbrances.

- Top five (5) success factors for the time objective are as follows:
  - ❖ Clearly defined project mission, objective and scope.
  - ❖ Adequate planning and controlling techniques.
  - ❖ Owner satisfaction with the delivered project.
  - ❖ Adequacy of plans and specifications.
  - ❖ Adherence to schedules.

- Top five (5) success factors for the quality objective are as follows:
  - ❖ Clearly defined project mission, objective and scope.
  - ❖ Adequate planning and controlling techniques.
  - ❖ Adequacy of plans and specifications.
  - ❖ Lack of legal encumbrances.
  - ❖ Owner satisfaction with the delivered project.

- Top five (5) success factors for the cost objective are as follows:
  - ❖ Clearly defined project mission, objective and scope.
  - ❖ Owner satisfaction with the delivered project.
  - ❖ Budget management (profit and loss).
  - ❖ Adequate planning and controlling techniques.
  - ❖ Adequacy of plans and specifications.

- Top five (5) success factors from the consultants perspective are as follows:
  - ❖ Owner satisfaction with the delivered project.
  - ❖ Adequate planning and control techniques.
  - ❖ Capability of the consultant key person.
  - ❖ Frequent feedback from the owner.
  - ❖ Accurate initial cost estimates.

- Top five (5) success factors from the contractors perspective are as follows:

- ❖ Clearly defined project mission, objective & scope.
- ❖ Breaking the project into `bite sized chunks'.
- ❖ Adequacy of plans and specification.
- ❖ Owner enthusiasm.
- ❖ Design-Construction interface management.

- Top five (5) success factors from the owners perspective are as follows:
  - ❖ Adequate planning and controlling techniques.
  - ❖ Adequacy of plans and specifications.
  - ❖ Lack of legal encumbrances.
  - ❖ Clearly defined project mission, objective & scope.
  - ❖ Sufficient working drawing details.

- Percentage agreement of 11.05% was present between owners and contractors group on the ranking of factors and the hypotheses "The owners and contractors are mutually independent in the ranking of major portion of the critical success factors" was accepted.

- Percentage agreement of −1.867% was present between contractors and consultants group on the ranking of factors and the hypotheses "The contractors and consultants are mutually independent in the ranking of major portion of the critical success factors" was accepted.

- Percentage agreement of 21.45% was present between owners and consultants group on the ranking of factors and the hypotheses "The owners and consultants are mutually independent in the ranking of major portion of the critical success factors" was accepted.

5.4 RECOMMENDATIONS

1. Further research can be carried out with fewer success related factors being considered after discarding those factors identified as less important in the present study. This would increase the number of experts who are willing to participate in the survey as less time would be required of them to complete the questionnaire. With a greater number of respondents, more meaningful comparisons can be made by analysing the results according to organizational backgrounds of the respondents, types of project, etc. Further research could help provide a better understanding of the developing construction environment and the ability to consistently achieve outstanding project outcomes.
2. Further research can be carried out on different projects with a specific delivery system, e.g. success factors for design-build, B.O.T., construction management, design-manage, research and development projects.
3. Other multivariate techniques like regression can be used in further research using only the top few success factors, to further gain insight about success of projects.

CHAPTER SIX

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APPENDIX I

QUESTIONNAIRE

Critical Success Factors for different Project Objectives

This questionnaire consists of two parts. First part is regarding the respondents' general information, while the second part is for pairwise comparisons. The respondents are specifically reminded of the importance of observing consistency in their answers. Their responses should not be biased towards any particular project whether it was highly successful or disastrous. Any information obtained through this questionnaire will stringently be used for educational use.

PART I (General Information)

1) Respondent Information:

Name (Optional)	
Company Name. (Optional)	
Status (Title)	
Telephone no.	
Facsimile.	
E-Mail Address.	
Company Address.	

2) What best describes your organization type:

a) Project Management	b) Contractor.
c) Consultant.	d) Other, Specify:

3) If your organization type is "Contractor" then Specify the classification of your company according to Ministry of Public Works.

a) Grade 01.	b) Grade 02.
c) Grade 03 or Below.	

4) How many years of experience you have in large building projects context:

a) Less than 10 years	b) 10-15 years.
c) 15-20 years	d) Over 20 years.

5) Projects on which you have the most experience were:

a) Less than 5 Million S.R.	b) 5-10 Million S.R.
c) 10-15 Million S.R.	d) Greater than 15 Million S.R.

6) Projects on which you have the most experience were:

a) Government projects.	b) Private Sector projects.
c) Semi-Government Projects.	d) Other, Specify:

7) Projects on which you have the most experience can be categorized as:

a) Residential projects	b) Commercial projects.
c) Industrial projects.	d) Other, Specify:

PART II (Pairwise Comparison)

Considering your professional experience, in context of large building projects, as Project Manager, Consultant or Contractor, designate the appropriate intensity to the following factors. In each table you have to compare the factors with each other, considering the three Project Objectives i.e. Cost (C), Time (T) and Quality (Q).

Pair wise comparison scale

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**
Reciprocals	**For the inverse comparison**

Pair wise comparison of Objectives

	TIME (T)	QUALITY (Q)
COST (C)		
TIME (T)	1.0	
QUALITY (Q)		1.0

Example

Write 3 in the first cell if, **Cost** is **Moderately Preferred** over **Time** (Cost is _3_ times more important than Time.)

Or

Write 1/3 in first cell if, **Time** is **Moderately Preferred** over **Cost** (Time is 3 times more important than Cost.)

PAIRWISE COMPARISONS

Pair wise comparison of Sub-Objectives	Management Communication & Control			Project Characteristics		
	C	T	Q	C	T	Q
Project Participants						
Management Communication & Control	1	1	1			
Project Characteristics				1	1	1

Sub-Objective # 1

Pair wise comparison of Project Participants	Project Manager			Contractor & Consultant		
	C	T	Q	C	T	Q
Owner						
Project Manager	1	1	1			
Contractor & Consultant				1	1	1

Pairwise Comparison of Owner		CSF2			CSF3			CSF4		
		C	T	Q	C	T	Q	C	T	Q
(Owner enthusiasm)	CSF1									
(Owner commitment to established budget & schedules)	CSF2	1	1	1						
(Owner satisfaction with the delivered project)	CSF3				1	1	1			
(Frequent feedback from the owner)	CSF4							1	1	1

Pairwise Comparison of Project Manager		CSF6			CSF7			CSF8			CSF9		
		C	T	Q	C	T	Q	C	T	Q	C	T	Q
(PM competency & authority)	CSF5												
(On-site project manager)	CSF6	1	1	1									
(Project team capability and commitment)	CSF7				1	1	1						
(PM commitment to established budget & schedules)	CSF8							1	1	1			
(Nature of the projects managers' authority)	CSF9										1	1	1

Pairwise Comparison of Contractor & Consultant		CSF11			CSF12			CSF13			CSF14			CSF15		
		C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q
(Capability of contractor key person)	CSF10															
(Contractor commitment to established budget & schedules)	CSF11	1	1	1												
(Contractor team capability and commitment)	CSF12				1	1	1									
(Consultant team capability and commitment)	CSF13							1	1	1						
(Consultant commitment to established budget & schedules)	CSF14										1	1	1			
(Capability of Consultant key person)	CSF15													1	1	1

Sub-Objective #2

Pair wise comparison of Management Communication & Control

	Communication			Control		
	C	T	Q	C	T	Q
Management						
Communication	1	1	1			
Control				1	1	1

Pairwise Comparison of Management		CSF17			CSF18			CSF19			CSF20			CSF21			CSF22			CSF23			CSF24		
		C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q
(Absence of bureaucracy)	CSF16																								
(Flexible parent organization)	CSF17	1	1	1																					
(A good customer and client relationship)	CSF18				1	1	1																		
(Accomplishment of contract add-ons)	CSF19							1	1	1															
(Meeting design goals)	CSF20										1	1	1												
(Pre-contract activities)	CSF21													1	1	1									
(Budget management (Profit & loss report))	CSF22																1	1	1						
(Risk identification and management)	CSF23																			1	1	1			
(Design-interface management)	CSF24																						1	1	1

Pairwise Comparison of Communication

		CSF26			CSF27			CSF28		
		C	T	Q	C	T	Q	C	T	Q
(Frequent feedback from the parent organization)	CSF25									
(Monitoring and feedback from the project)	CSF26	1	1	1						
(Communication throughout the project)	CSF27				1	1	1			
(Beneficial coordination between professionals)	CSF28							1	1	1

Pairwise Comparison of Control

		CSF30			CSF31			CSF32			CSF33			CSF34			CSF35			CSF36			CSF37		
		C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q
(Construction control meetings)	CSF29																								
(Design control meetings)	CSF30	1	1	1																					
(Site inspections)	CSF31				1	1	1																		
(Adherence to schedules)	CSF32							1	1	1															
(Adherence to budgets)	CSF33										1	1	1												
(Adherence to quality standards)	CSF34													1	1	1									
(Adherence to change control processes)	CSF35																1	1	1						
(Quality Control Program)	CSF36																			1	1	1			
(Safety Control Program)	CSF37																						1	1	1

Sub-Objective #3

Pair wise comparison Project Characteristics	Contractual arrangement			Project planning			Constraints		
	C	T	Q	C	T	Q	C	T	Q
Internal Project Characteristics									
Contractual arrangement	1	1	1						
Project planning				1	1	1			
Constraints							1	1	1

Pairwise Comparison of Internal Project Characteristics		CSF39			CSF40			CSF41			CSF42			CSF43			CSF44			CSF45			CSF46		
		C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q
(Site limitation and location)	CSF38																								
(Constructability)	CSF39	1	1	1																					
(The size of the project (measured by total cost))	CSF40				1	1	1																		
(Pioneering status)	CSF41							1	1	1															
(Economic risks)	CSF42										1	1	1												
(Clearly defined project mission, objective & scope)	CSF43													1	1	1									
(Breaking the project into `bite sized chunks')	CSF44																1	1	1						
(Using project plans as working documents)	CSF45																			1	1	1			
(Design considerations (Quality, Reliability and Producibility))	CSF46																						1	1	1

Pairwise Comparison of Contractual Arrangement		CSF48			CSF49			CSF50		
		C	T	Q	C	T	Q	C	T	Q
(Adequacy of plans and specifications)	CSF47									
(Realistic obligations/clear objectives)	CSF48	1	1	1						
(Formal dispute resolution process)	CSF49				1	1	1			
(Contractual motivation/incentives)	CSF50							1	1	1

Pairwise Comparison of Project Planning		CSF52			CSF53			CSF54			CSF55			CSF56			CSF57		
		C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q	C	T	Q
(Accurate initial cost estimates)	CSF51																		
(Adequate funding to completion)	CSF52	1	1	1															
(Adequate planning and control techniques)	CSF53				1	1	1												
(Sufficient Working Drawing details)	CSF54							1	1	1									
(Minimal start-up difficulties)	CSF55										1	1	1						
(Availability of back-up strategies)	CSF56													1	1	1			
(The perceived value of the project)	CSF57																1	1	1

Pairwise Comparison of Constraints		CSF59			CSF60		
		C	T	Q	C	T	Q
(Lack of legal encumbrances)	CSF58						
(Minimized number of public/government agencies involved)	CSF59	1	1	1			
(Constraints imposed by end-users)	CSF60				1	1	1

Dear Respondent, based on your experience, how will you define a successful project?

APPENDIX II

بسم الله الرحمن الرحيم

A2-1

Ministry of Higher Education
King Fahd University of Petroleum & Minerals
COLLEGE OF ENVIRONMENTAL DESIGN
Dept. of Construction Engineering & Management

وزارة التعليم العالي
جامعة الملك فهد للبترول والمعادن
كلية تصاميم البيئة
قسم هندسة وإدارة التشييد

Ali Hussain Contracting Est.
Phone No. 8649524
Fax No. 8954673

Dear Sir,

SUBJECT: **Study of Factors Affecting the Success of Construction Projects in the Eastern Province**

Mr. Munib Asif is conducting a study of factors related to successful projects, which is a requirement for the completion of Masters Degree, in the Construction Engineering and Management Program at King Fahd University of Petroleum and Minerals. He would like to interview experts in professional organizations like yours to fill the questionnaire for this study.

Results of this study will inshallah benefit the construction industry of the Kingdom of Saudi Arabia. We hope that you will participate, in this study. If you agree you can check the box at the bottom of the page, fill the relevant information and fax it back to **8604453**, Mr. Munib will contact you and arrange a time for a meeting at your convenience so that everyone can benefit from your participation in this study.

Bubshait

Dr. Abdul Aziz A. Bubshait
Associate Professor,
Construction Engineering & Management Department.

☑ **We agree to participate in the study.**
Name of the person responding Mohammad Imtiaz Ahmed (Project's Manager)
Telephone 03-8644149 **Mobile:** 05 4805114

اللجنة الهندسية
فرع المنطقة الشرقية

ENGINEERING COMMITTEE
EASTERN PROVINCE BRANCH

المملكة العربية السعودية هاتف : ٨٤٣٩٢٨٨ (٠٣) فاكس : ٨٤٣٩٢٨٦ (٠٣) ص.ب ٢٦٩٨ – الدمام ٣١٤٦١
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السادة / الفنيون السعوديون المحترم

ت ٨٩٥٠٠٩٠ فاكس ٨٦٤٧٩٣٠

السلام عليكم ورحمة الله وبركاته

الموضوع: دراسة عن الأسباب التي تساهم في انجاح مشاريع التشييد بالمنطقة الشرقية

نفيدكم بإن السيد/ منيب عاصف يقوم بإعداد دراسة عن أسباب نجاح المشاريع، وهذه الدراسة إحدي متطلبات التخرج لدرجة الماجستير في هندسة وإدارة التشييد في جامعة الملك فهد للبترول والمعادن.

ويرغب السيد منيب مقابلة أحد المسئولين ذو الخبرة الطويلة في المشاريع، لنعبئة الإستبيان الخاص بالدراسة. وتستغرق المقابلة حوالي الساعة.

وحيث أن نتائج الدارسة ستكون أن شاء الله ذات فائدة عامه لإدارة المشاريع في المملكة لذى نرجو مشاركتكم في هذه الدراسة وذلك بالتأشير في الخانة اسفل، وارسال الفاكس إلي ٨٤٣٩٢٨٦، وسيقوم السيد منيب بالاتصال بكم في حالة موافقتكم بالإشتراك في الدارسة.

وتقبلوا فائق تحياتي

الدكتور/ عبد العزيز بن عبد الرحمن بوبشيت
مدير فرع اللجنة الهندسية
المشرف علي الدراسة

☐ **أرغب بالمشاركة في الدارسة**

APPENDIX III

CSF#1 Owner enthusiasm

The degree to which the owner is personally involved in the project will cause great variation in their support of the processes related to the project. Owner enthusiasm to new ideas will be a key factor in the success of a project.

CSF#2 Owner commitment to established budget & schedules

Owners commitment to the budget and schedule, established in the preliminary estimates will lead the project across a smooth road to success. The owner must not try to force the project participants to decrease or increase the established budget or schedules.

CSF#3 Owner satisfaction with the delivered project

Owner satisfaction refers to the final stage of the project. It is very important for the success or failure of a project. Owner participation in the early stages of the project will provide more likelihood of satisfaction in the end.

CSF#4 Frequent feedback from the owner

Owner has the ability to review the project status, make suggestions, and corrections through formal feedback channels or review meetings. Frequent feedback may ensure timely completion within specified limits of budget and accepted quality.

CSF#5 PM competency & authority

The person who is effectively in charge of the project and has sufficient authority, personality, and reputation to ensure that everything that needs to be done for the benefit of the project is done.

CSF#6 On-site project manager

Presence of a competent representative of the owner on the site throughout the duration of the project will avoid delays and help resolve petty issues which might lead to disputes incurring huge costs and delays. For a successful project, presence of onsite project manager is very important.

CSF#7 Project team capability and commitment

Key personnel in the project team for its entire duration, personnel with strong managerial qualifications, team members with operational experience.

CSF#8 PM commitment to established budget & schedules

Here project manger represents the Owner in the project. In order to put the project in the right path for success, he must act on the owner's behalf in order to synchronize all the project related processes. Project manager's commitment to the established budgets and schedules is a key ingredient in the projects success.

CSF#9 Nature of the projects managers' authority

This factor is also of significance importance, if the owner's representative does not enjoy sufficient authority then he cannot make the project a successful one. Huge losses in terms of delays will be incurred if the project manager has to seek approval from the owner for petty issues. Project manager must have sufficient authority to issue orders and take corrective measures.

CSF#10 Capability of contractor key person

A professionally experienced, technical leader with extensive managerial experience must be representing the contracting firm in order to complete the job within the limited budget and time.

CSF#11 Contractor commitment to established budget & schedules

Contractor is that party which is directly related with the construction process. In order to put the project in the right path for success, he must synchronize all the project related processes like procurement of material, construction equipment and other construction related resources. Contractor's commitment to the established budgets and schedules is a key ingredient in the projects success.

CSF#12 Contractor team capability and commitment

This factor has emphasis on contractor's capabilities and commitment on the management of various aspects including, project planning, resource allocation, procurement and all other construction related tasks.

CSF#13 Consultant team capability and commitment

Consultant team capability and commitment is very important for the success of a project. The consultant is responsible for correct drawings and initial estimates. These early estimates will provide a basis for updating and measuring the performance of the project. Only a capable and committed team will put all the effort into the preparation of these early estimates, in order to avoid costly delays and change orders.

CSF#14 Consultant commitment to established budget & schedules

Consultant is that party which is responsible for the preliminary designs and estimates. In order to put the project in the right path for success, he must synchronize all the project related processes like preparation of working drawings, updates, detailed cost estimates and schedules. Consultant's commitment to the established budgets and schedules is a key ingredient in the projects success.

CSF#15 Capability of Consultant key person

This considers the skill and ability of the upper management in the consultant office. Upper management is considered to be those people responsible for the overall success of projects. Their responsibility stretches beyond the contract to include long-term business and customer satisfaction objectives.

CSF#16 Absence of bureaucracy

In construction projects, there are many challenges faced due to factor of bureaucracy and corruption associated risks and uncertainties. Due to corruption tendencies and some time the way the issues are being tackled, it poses various risks and uncertainties as challenges to project management. Some people either deliberately create bureaucracy bottlenecks to attract bribe for themselves or create bureaucracy 'red tape' to protect themselves from

corruption allegations. Absence or less involvement usually means timely completion of a project within specified budget.

CSF#17 Flexible parent organization

This includes encouraging new ideas and willingness to consider changes and new approaches, from the owner/representative firm. A flexible parent organization may lead to a harmonious relationship between different project participants, thus ensuring a successful project.

CSF#18 A good customer and client relationship

This factor covers a broad category. It means harmonious relationship between the owner, contractor and the consultant. The performance of these participants is interdependent. Hence, in order to perform effectively, a reciprocal requirement exists, whereby each participant requires the other participants to perform their duties effectively and in harmony with the others.

CSF#19 Accomplishment of contract add-ons

These might come up as the project proceeds. These might either be change orders or new work orders. Accomplishment of these add-ons will ensure timely completion of project within the revised budget.

CSF#20 Meeting design goals

These include functional specifications, technical specifications, schedule goals and budget goals. It is the duty of both the consultant and the contractor to harmoniously work together towards achieving this goal.

CSF#21 Pre-contract activities

These include complete project plans, cost estimation for the entire project, negotiations with alternative contractors, detailed contract documents and detailed payment milestones, contractor involvement in system definition, proposal based on a feasibility study.

CSF#22 Budget management (Profit & loss report)

This will give a basis for updating and recording the status of the project. Any discrepancies will tell if the project is over or under budget.

CSF#23 Risk identification and management

Its main focus is on the assessment of risk all participants have to face in a project. Potential risk lies in the thoroughness of the assessment of prospective tenderers' qualification and proposals and change of client's requirements during construction.

CSF#24 Design-Construction interface management

Conflicts between the owner, consultants and contractors are more frequent in projects marked by poor management. Conflicts can be reduced by carefully adhering to procedures set forth in the contract, which may include authorization requests granting approvals, reporting procedures, inspections, regular meeting, etc. mutual lack of attention to procedures by the owner and several contractors caused management problems.

CSF#25 Frequent feedback from the parent organization

Frequent feedback is necessary for the completion of a project within the specified budget and schedule, with fulfillment of the owner expectations.

CSF#26 Monitoring and feedback from the project

Monitoring and feedback refer to the project communication mechanisms. Making allowances for adequate monitoring and feedback give the project manager the ability to anticipate problems and to oversee corrective measures.

CSF#27 Communication throughout the project

Used effectively, it can reduce non-productive effort, avoid duplication and help eliminate mistakes. It can help to manage uncertainty, may lead to problems being identified sooner or may generate ideas that lead to better solutions.

CSF#28 Beneficial coordination between professionals,

It will encourage team-work, increase motivation and ensure the involvement of all key players. The end result will be a project which is more likely to meet its objectives within the allocated time and resources.

CSF#29 Construction control meetings

These meeting are a basis for update and monitoring the status of the project and continue throughout the construction phase of the project. Quality requirements are checked and orders are issued for any corrective measures. Mutual coordination is very important between project participants.

CSF#30 Design control meetings

These meetings take place at the design stage and presence of all the participants will ensure project success. The owner must provide clear objectives, the consultant should make sure that he can give material form to the objectives set by the owner and the contractor should make sure that he can deliver the final project within the specified limits of budget, schedule and accepted quality.

CSF#31 Site inspections

Regular site inspections will ensure the satisfaction at the end of the project for all the parties involved. For quality control regular site visits are very important. These site inspections are a basis for update and monitoring the progress of the project. Timely corrective actions or rework orders may avoid disputes, ensuring a successful project.

CSF#32 Adherence to schedules

This factor deals with all the project participants and adherence to schedules established at the initiation of the project. All parties must coordinate between themselves in order to finish the project within specified limits of time to deliver a successful project.

CSF#33 Adherence to budgets

This factor deals with all the project participants and adherence to budgets established at the initiation of the project. All parties must coordinate between themselves in order to finish the project within specified budget to deliver a successful project.

CSF#34 Adherence to quality standards

This factor deals with all the project participants and adherence to quality standards established at the initiation of the project. All parties must coordinate between themselves in order to achieve the accepted quality standards, to deliver a successful project.

CSF#35 Adherence to change control processes

This process is concerned with the factors which create changes to ensure that changes are beneficial, determining that a change has occurred and managing the actual changes when and as they occur. Adherence to the proper procedures of a change control system, performance measurements, updates and corrective actions will lead to a successful project.

CSF#36 Quality Control Program

Quality is achieved if the intended use of a product is achieved, and this can be only done if the project participants strictly adhere to the quality control program. A project might not be successful if it is not completed with the required standards of quality.

CSF#37 Safety Control Program

The intent of this factor is to provide an effective methodology for managing the hazards inherent to construction work in a systematic manner that can be easily integrated with the management of other technical aspects of a construction project. The construction contractor should establish and maintain a program to protect the safety and health of all persons on the construction worksite visitors and the public.

CSF#38 Site limitation and location

This factor determines, among others, the viable construction methods and availability of resources that are closely linked to the quality of work on site. This category measures the limit of the actual project site. Some items considered are storage, access and staging for setup.

CSF#39 Constructability

A measure of the ease or expediency with which a facility can be constructed. It is often described as integrating construction knowledge, resources, technology and experience into the engineering and design of a project. A high level of constructability may reflect minimal start-up difficulties and amount of rework

CSF#40 The size of the project (measured by total cost)

Larger projects maybe more complex and more chances of problems like disputes, legal issues, safety etc. may occur. Even a large project can be successful if it is well planned and documented.

CSF#41 Pioneering status

A project is considered as a ''pioneering'' project if its technology is new to the project team. This kind of a project can be successful if complete information is obtained about the technology intended to be used in the project, before the initiation of the project. This kind of project can be made successful if a complete risk analysis is done.

CSF#42 Economic risks

These risks may be incurred in case of changes, disputes and other legal issues. Large sized projects generally have more economic risks. These risks can be overcome if the project is well planned and there is harmonious coordination between project participants.

CSF#43 Clearly defined project mission, objective & scope

Scope and objectives are the guiding principles that direct the efforts of the project team and they will determine a project's success or failure. If they are defined at the start of the

project, the project will stay within its intended boundaries and not expand to include more than originally planned.

CSF#44 Breaking the project into `bite sized chunks'

Breaking large projects down into sub-projects or work packages is regarded as one of the most important tasks in new or development projects. It ensures greater ownership by all those owning a `chunk' of the project, spreading responsibilities and accountability across a greater number of people.

CSF#45 Using project plans as working documents

In order to ensure that a project is completed successfully, project plans need to be simple enough to be used as working documents. Keeping the plans simple, with the right level of detail, can encourage a project to be reviewed regularly and easily. This makes them useful communication tools and effective monitoring devices for the project.

CSF#46 Design considerations

These have to be considered at the very early stage of the project. It is the duty of all the participants to fully understand their goals and objectives and how are they going to achieve it. Contractor must make plans to achieve the desired quality, the consultant must optimize design to cost ratio and also give suggestions on the producibility of the project.

CSF#47 Adequacy of plans and specifications

Adequacy of plans and specifications will significantly reduce the uncertainties during tender submissions or other contractual negotiations and hence minimize project risks.

CSF#48 Realistic obligations/clear objectives

The contract explains obligations such as quality of work, schedule and financial obligations. This factor judges whether these obligations are reasonable assignment of responsibility. Objectives are to be set even before the project is initiated, success is guaranteed if the objectives are clear right from the start.

CSF#49 Formal dispute resolution process

This factor considers how well the contract describes a dispute resolution process. Such processes include but are not limited to dispute resolution boards, mini trials, mediation and arbitration.

CSF#50 Contractual motivation/incentives

These incentives can be set in the contract to achieve timely completion, with specified cost and desired quality. These can be extra bonuses, percentages, more contracts etc. These incentives can be set with the mutual agreement between parties.

CSF#51 Accurate initial cost estimates

This will provides a basis for monitoring the status of the projects, as well as give an idea about the proposed expenditures necessary to accomplish the owners requirements. A project cannot be successful if the initial cost estimate is not correct. Initial estimates are considered the benchmark estimates and are continually, modified and improved as the project is better defined.

CSF#52 Adequate funding to completion

It is the duty of the owner to provide adequate funding to completion. The contractor may stop work if payments are stopped at the completion of project milestones. If payments to concerned parties are not made on time, huge costs may be incurred due to delays and conflicts.

CSF#53 Adequate planning and control techniques

Planning, scheduling, and control of the project using Critical Path Method (CPM) or Project Evaluation and Review Technique (PERT) should be adopted. Resource leveling; scheduling with limited resources; time-cost tradeoffs and other analysis may put the project on the road to success. Planning is a fundamental and challenging activity in the management and execution of construction projects. It involves the choice of technology, the definition of work tasks, the estimation of the required resources and durations for individual tasks, and the identification of any interactions among the different work tasks.

CSF#54 Sufficient Working Drawing details

Working drawing is the set of information through which the contractor gets line of action to pursue the entire project. In case of insufficient working drawing details, the contractor is in vulnerable state if he pursues the project with insufficient drawing details it can lead him in the wrong way which might ends up as not the required one or delayed one.

CSF#55 Minimal start-up difficulties

A project may have minimal startup difficulties if the owner of the project has clear objectives and realistic obligations, the contractor has sufficient resources, labor, equipment and the consultant has sufficient experience in similar projects, as well as competent staff in his project team.

CSF#56 Availability of back-up strategies

Back up strategies may be required due to unexpected site conditions or unavoidable circumstances including natural disasters. Back-up strategies may include alternate source for funding the project, new designs, reallocation of resources etc.

CSF#57 The perceived value of the project

Accurate conceptualisation of the project may help in assessing the perceived value of the project. Perceived benefits, perceived price, monetary price, psychological price, and behavioral price are all concepts that are associated with conceptualization of perceived value. Furthermore, perception of value is recommended to be affected by stimulus and personal response factors such as characteristics of project, interest in project, different needs, motives, expectations, personality and social status.

CSF#58 Lack of legal encumbrances

This involves permits and regulations. Encumbrances are legally binding rights of the government agency or previous owner to exploit natural resources of the property, e.g., minerals, timber, water, etc. lesser number of legal encumbrances will ensure smooth running of different processes to yield a successful project.

CSF#59 Minimized number of public/government agencies involved

These agencies usually put in a lot of constraints and hindrances in the progress of the project in form of permits, clearances and regulations. Lesser the involvement of these agencies, more the chances of success.

CSF#60 Constraints imposed by end-users

This factor examines whether end-users have a thorough understanding of their own needs. Design consultants work under numerous constraints, imposed by end users. Lesser number of constraints may lead the project to a timely completion with budget.

VITA

Munib Ahmad Asif was born in Maiduguri, Nigeria. After graduating from secondary school he enrolled for Bachelor of Science in Civil Engineering at **University of Engineering and Technology**, Lahore, Pakistan. In August 2000, he graduated and secured **Tenth Position** in University for **Bachelor of Science in Civil Engineering.** Then he joined an eminent engineering firm as a structural/design engineer. In June 2003, He secured **MS** degree in **Construction Engineering & Management**, from **King Fahd University of Petroleum & Minerals**, Dhahran Saudi Arabia.