Islamic University-Gaza
High Studies Deanery
Faculty of Engineering

Civil Engineering Department
Construction Management

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عمادة الدراسات العليا
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إدارة التشييد

A FEES ESTIMATING MODEL FOR CONSULTING ENGINEERING FIRMS IN GAZA STRIP

Eng. Ibrahim A. Raouf Radwan
B.Sc. Civil Engineering, Cairo University

Supervised by:

Dr. Kamalain Sha'at
Assistant Professor of Construction Engineering and Management

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بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

يقول الله تعالي جل جلاله :

"ولكلٍ وجهة هو موليها، فاستبقوا الخيرات"

صدق الله العظيم

Dedication

To my parents, wife and children, for their unlimited and generous support

Ibrahim Radwan

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ABSTRACT

The performance of the design process in a construction project has a great influence on the success and quality of the subsequent processes in the project life cycle. Despite its importance, relatively little attention has been given to the management of the design process.

This research is conducted to investigate the perception and practice of the design consultants in Gaza Strip in the design process management. Eventually, a computer based decision making tool, called "Fees Estimating Model" (FEM) is developed. This tool is based on Microsoft Excel spreadsheets. It is supposed to utilize the consultant's experience, available cost data, historical data regarding the total score of the consulting bids winners, and Monte Carlo simulation in order to estimate rationally the consulting fees.

The research has been conducted through literature review of the topics related to management and costing of design process, followed by a field survey of the local consultants perception and practice in the design management. Twenty two top consulting firms/offices are asked to fill a questionnaire that covers topics related to design management perception and practice. Archival data about the consulting tenders evaluation results of about forty consulting tenders are gathered as well. The field survey indicated that local consultants have, in general, a good perception of the design process, but more efforts are to be addressed to enhance their practice

A model representing the local design process is proposed. This model emphasizes planning and coordinating the design activities as well as the proactive involvement of the client in the design process. These elements, together with design staff training, has been found as the main factors that lead to successful design process and consequently contribute to developing the local construction industry.

FEM is tailored for the commonly used two envelop tendering procedure for soliciting consulting services. The model helps the user to decide his bidding strategy and prepare an estimate accordingly. The local consultants who evaluated FEM stated that it is useful as a decision support tool suitable for the two envelop consulting bids in Gaza Strip.

This study concludes that all the construction industry stakeholders should aim at achieving successful design process. Consultants are advised to use a computerized tool, such as FEM, in their fees estimating. Professional associations and academic institutions are invited to participate in activities that disseminate the awareness of the good design management practices. It is recommended that the Association of Engineers, together with governmental and academic institutions, contribute in design staff capacity building and enforce the compliance to the association scale of fees.

الملخص

جــودة الأداء أثــناء مــرحلة التصــميم لمشاريع التشييد تؤثر بدرجة كبيرة على نجاح وجودة المراحل اللاحقة من المشروع ، إلا أن الاهتمام الذي يُعطي لإدارة مرحلة التصميم قليل إذا قورن بأهميتها .

يهــدف هــذا البحــث استكشاف أداء الاستشاريين المحليين في قطاع غزة في إدارة التصميم من حيث المفاهــيم والممارســة ، كما يسعى في النهاية إلى تطوير أداة محوسبة للمساعدة في اتخاذ القرارات ، تسمى (FEM) " برنامج تقدير أتعاب الخدمات الاستشارية" ، حيث تعمل هذه الأداة من خلال برنامج "ميكروســوفت إكسل" و تعتمد على خبرة الاستشاري ، بالإضافة إلى المعلومات المتوفرة عن عناصر الكلفــة للخدمــات الاستشـــارية ، والنتائج السابقة لتقييم العطاءات الاستشارية ، مع تقنية "مونت كارلو" للمحاكاة ، للحصول علي تقدير منطقي لكلفة الخدمات الاستشارية .

اعــتمد البحــث علــى مــراجعة الدراسات السابقة في المواضيع ذات العلاقة بإدارة التصميم وتسعير الخدمــات الاستشارية ، تبع ذلك بحث ميداني لاستكشاف المفاهيم وتطبيق الاستشاريين المحليين لها في إدارة التصــميم، حيث تم التوجه إلى اثنين وعشرين مكتباً/شركة هندسية من المكاتب/الشركات الهندسية الكــبرى فــي قطـــاع غزة لتعبئة استبانة تشمل الموضوعات المتعلقة بمفاهيم وتطبيق عملية التصميم . بالإضافة إلى ذلك ، تم تجميع معلومات عن نتائج تقييم حوالي أربعين عطاءً سابقاً للخدمات الاستشارية. وقد اتضح من نتائج المسح الميداني أن الاستشاريين المحليين يتمتعون بفهم جيد للأساس النظري لإدارة التصميم إلا أنه يلزم المزيد من الجهد لتحسين ممارستهم الفعلية .

يشــمل البحــث نموذجــاً مقترحا يمثل عملية التصميم محلياً ، ويركز هذا النموذج على أهمية التخطيط والتنســيق بيــن الفعاليات المختلفة في التصميم بالإضافة إلى الدور الإيجابي المبادر من المالك . وتمثل هذه العناصر ، مع تدريب طواقم التصميم ، العوامل الرئيسية في تحقيق تصميم ناجح وبالتالي المساهمة في تطوير صناعة التشييد المحلية.

الثمرة الرئيسية لهذا البحث هي برنامج تقدير الأتعاب الاستشارية المعد خصيصاً للعطاءات الاستشارية المبنــية علــى التقيــيم الفني والمالي لاختيار الاستشاريين ، وبمساعدة هذا البرنامج يختار الاستشاري اســتراتيجية العطـــاء التي يرغب بها ووفقاً لذلك يُعدّ تقديراً لأتعابه الاستشارية . وقد أفاد الاستشاريون المحلــيون الذين قيموا البرنامج أنه مفيد كأداة مساعدة في اتخاذ القرارات في العطاءات الاستشارية التي تعتمد على التقييم الفني والمالي ويصلح للاستخدام في قطاع غزة.

يخلــص هــذا البحــث إلى أنّ جميع الأطراف المشاركة في صناعة التشييد المحلية يجب أن تسعى إلى إنجــاح مــرحلة التصــميم ، كمـــا يخلص إلى توصية للاستشاريين المحليين بضرورة استخدام برنامج محوسب ، مثل البرنامج المقترح ، عند تقدير أسعار الخدمات الاستشارية. كذلك يوصي النقابات المهنية والمؤسســات الأكاديمية بالمساهمة في نشر الوعي بالممارسات الصحيحة في إدارة التصميم. و ينصح بأن تقوم نقابة المهندسين بالمساهمة في فرض الالتزام بأسعار الخدمات الاستشارية التي تحددها .

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List of Abbreviations

A/E	Architect/Engineer
AAL	Average Agreement Level
AIL	Average Implementing Level
AL	Average Level
CET	Continuous Education and Training
CPM	Critical Path Method
DSS	Design Support System
f	Amount of Financial Proposal
F	Weight given to financial proposal
FEM	Fees Estimating Model
F_m	Lowest Financial Proposal
GOH	General Overhead
ISO	International Organization of Standards*
MOEHE	Ministry of Education & Higher Education
MOH	Ministry of Health
PA	Palestinian Authority
PECDAR	Palestinian Economic Council for Development and Reconstruction
PWA	Palestinian Water Authority
RFP	Request for Proposal
S	Total Score
S_f	Financial Score
SPSS	Statistical Package for Social Sciences
St	Technical Score
T	Weight given to technical proposal
UK	United Kingdom
UL	Uncertainty Level
US	United States
Z	Normal distribution value corresponding to the certain expected cost.

* *ISO is a prefix assigned to the standards of the* International Organization of Standards*. It comes from the Greek word* isos *which means equal*

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CHAPTER 1

Introduction

1.1 Background

1.1.1 The engineering consulting profession

The engineering consulting profession is expected to play a crucial role in planning, designing, and implementing of building and infrastructure projects in Palestine. In developed countries, the consulting profession grew in stages during more than 200 years. It evolved with the growth of the education system, the emergence of engineering as an applied science, and the formation of professional societies and associations. Before its establishment as an independent profession, projects were designed and constructed primarily by government departments. As their capacity proved inadequate to meet the demands of rapid industrialization, opportunities opened for private enterprises to begin construction and consulting services on a major scale. Professional societies and association of consulting firms played a key role in disseminating knowledge and promoting high technical and professional standards.

1.1.2 Local consulting firms

Before 1993, the number of domestic consulting offices in Gaza strip was very limited, around five offices. These offices provided consultancy services mainly to the private sector and the work mostly included the design of small residential buildings.

On the eve of establishing the Palestinian Authority (PA) in the year 1994, the number of local consulting firms in the Gaza Strip grew phenomenally; the number rose to about 40 offices/firms. These firms were established to provide consultancy services to Palestinian institutions in the public and private sectors as well as to international and donor organizations operating in Palestine. The firms' activities include regional and town planning, building systems, road and traffic engineering, water supply and distribution for domestic and irrigation uses, wastewater collection and treatment, housing and industrial development. The consulting activities also cover all stages of the construction project life cycle, namely:

- Projects appraisal and feasibility studies.
- Projects design and preparations of tender and construction documents.

- Site supervision and construction management.
- Monitoring and technical auditing during the projects implementation.
- Evaluation of programs and projects at completion.

Recently, local consulting firms have formed joint ventures with international and regional consultants to compete for projects requiring several fields of specialization. These joint ventures enabled local consulting firms to provide all the professional services required for designing and preparing large scale projects; multipurpose projects that need specialization in computer modeling, economic and financial analysis, and human resources development. On the other hand, these joint ventures created a channel to transfer the international knowledge and expertise to the local construction industry.

1.1.3 Tendering for consulting engineering services

Two-envelop tendering method is commonly used in construction industries as a mechanism for allocating consultancy work to design consultants such as architects, surveyors and engineers. The consultancy contracts are awarded on the basis of price (i.e. fee) and quality (i.e. technical score). In many cases, each consultant's technical score and fee is converted to a percentage or ratio relative to the competition's highest technical score and lowest fee before being weighted and aggregated according to a given formula. Usually, the contract is then awarded to the consultant with the best overall score.

Local consultants get most of their work through the two-envelop tenders. Frequently they submit two proposals; technical and financial. The client first evaluates the technical proposals and each consultant is assigned a "technical score". The financial proposals are then opened and each consultant is assigned a "financial score". By using a certain formula, the technical and financial scores are aggregated to get the total score. The consultant with the maximum total score is usually awarded the work.

1.2 Research problem

Design process is an important component in the success of construction projects. It contains several consecutive activities, and multi- relations between interrelated parties. A survey of the literature suggests that researchers have focused on addressing the management of the construction phase more than the management of the design phase of projects.

Successful management of the design process demands personal skills to enable one to motivate and control people as well as to organize communications between them, coupled with engineering experience to comprehend the needs of construction and foresee problems (Rutter and Martin, 1990).

The local consulting firms in Palestine as a whole, and particularly in Gaza strip, suffer from myriad problems. The absence of organized procedures in the design process in addition to the severe competition may be considered as the main causes of these problems. This makes it necessary to propose a model that organizes the design and consulting service procedures. Also, it is necessary to propose a decision making tool for pricing consulting services which enables the local consultants calculate rationally the cost of the design and consulting services. By using this tool, consultants are supposed to prepare price quotations, which are low enough to get the work, but high enough to achieve reasonable profit.

1.3 Objectives

The aim of this research is to introduce a decision making tool in the form of a computer based fees estimation model for engineering consulting services. To achieve this goal, it is broken down into the following objectives:

1. To study the process of design management through literature review of the different aspects of the research.
2. To investigate how the local consultants perceive and practice the design and consulting services management.
3. To determine the local design and consulting services procedures and the elements that significantly contribute to the cost of consulting services.
4. To introduce a model that fits the local practice in the design and consulting services process.
5. To develop a computer based Fees Estimation Model (FEM) which is a decision making tool for pricing the local consulting services.
6. To evaluate the Fees Estimation Model (FEM) by asking local consultants to run it and report their comments and suggestions.

1.4 Scope

This research aims at serving local consultants in Gaza Strip. The scope of the study covers the design and consulting services procedures in the top local consulting offices and firms. Design stages, management practices, resources needed and the cost of design services will be investigated.

A pricing tool for the consulting services is developed. This tool utilizes the available cost data, probability distribution of different cost elements, history of the evaluation results of local consulting tenders and Microsoft Excel spreadsheets to prepare competitive price quotations for the design and consulting services.

It is important to state that this research is neither about the design codes nor about the planning requirements. This research is about how to manage the design process and how to estimate its cost.

1.5 Methodology

The goal of the research is achieved through the following stages:

1.5.1 Stage 1: Literature review

Review of relevant Literature in order to identify the major topics related to design and consulting services process management. This stage includes also review of the programming techniques in the Microsoft Excel spreadsheets. The output of this stage is the basis for preparing the questionnaire used in the next stage

1.5.2 Stage 2: Field Survey

In this stage, a survey of the local practice of design and consulting services management is made. A structured questionnaire is conducted and analyzed. Together with the questionnaire, the managers of the local consulting offices are interviewed.

1.5.3 Stage 3: Collection of archival data

In this stage, archival data related to the evaluation of two envelope consulting tenders is collected. A project survey card is used to collect tender information such as: the project type, evaluation criteria, total score formula, and the price and total score of the winning consultant. The data gathered is used as an input in the Fees Estimation Model (FEM).

1.5.4 Stage 4: Models' formulation and verification

In this stage, using the information collected in the previous stages, a model for the design and consulting services process in Gaza Strip is developed. The cost significant elements in this design process are identified and formulated, using MS Excel, in a fees estimating computer based model. This fees estimating model is verified by asking some local consultants to run it and report their comments and suggestions.

1.6 Organization of the research

Together with this chapter, there are seven more chapters:

Chapter 2 and chapter 3 present a literature review for different topics related to design and consulting services management and costing.

Chapter 2 presents definitions and components of the design and consulting services process , and introduces the management of design and consulting services in action.

In chapter 3 the cost of design and consulting services and their fees estimating is introduced.

The questionnaire design, method of analysis, and the survey results are presented and analyzed in chapter 4 and chapter 5.

Chapter 6 presents the proposed model that fits the design and consulting services process in the local market.

The fees estimating model for the design and consulting services (FEM) is discussed in detail in chapter 7. This include: concepts on which the model is based, overall structure of the model and how the model is used to establish a reliable and competitive price quotation.

Chapter 8 presents conclusions and recommendations for further studies.

CHAPTER 2
Design Definition, Procedure and Management

2.1 Introduction

One of the main objectives of this research is to investigate the local perception and practice in the design management. The term "design management" entails two parts; design and management. In this chapter, concepts and definitions of both "design" and "management" are introduced. The components of the design process are then described in brief. Management functions applied in the design process together with the design quality control are described as well.

2.2 Historical preview

The need of people to have buildings to accommodate them for residential and public uses was identified in the early stages of the mankind history. Consequently, the need for professional persons who are responsible for the design and construction of buildings emerged. These professionals were known by several names throughout the history periods. Some of the old names mentioned in the architectural literature are: Architecton, Mechanikos, and Master Builder (Samy, 1977) Recently the terms "Architect/Engineer", "Design Consultants" and "Design Professionals" are commonly used.

Not only did the name of architectural/engineering professionals change at different stages of the history, but also the way they render their services and their approach to these services changed as well. In the nineteenth century the architects introduced themselves as artists and worked in an individual basis. In the earlier part of the twentieth century, both in Britain and North America, architects established themselves in a good position within the expanding middle classes in the society. In this period architecture became a profession: architects needed to obtain their diplomas or degrees from specialized schools. They had to belong to professional institutions by law (Symes et al, 1996).

Since the Second World War the (Architects-entrepreneurs) and the (Design teams) emerged. The design professionals have come to see themselves as business organizations and needed to establish a product line, to assemble capitals either material or financial, to promote their output, and to evaluate their profitability.

The approach to the design and construction of new projects has changed rapidly over the last years. Nowadays, design is a complex process which involves many contributors. This demands thorough coordination of the continual exchange and refinement of information and knowledge. In other words, the design process has now become an integral part of a complex industrial process and there is a need to identify the management task and manage it well (Gray & Hughes, 2001).

2.3 Design Definitions and characteristics

Literature review suggests several definitions for design and the design process. The followings are some of these definitions:

Landis (2000) states that engineering design process is a step by step method to produce a device, a structure or a system that satisfies a need. The need is generally described by a set of specifications.

Oberlender (1993) defines design as a creative process that involves diverse areas of expertise and numerous decisions that have major impacts on the project. The problem in design is not finding design people who know how to do the work, it is interfacing the work of all the designers. A difficult task in design coordination is interfacing related work to ensure compatibility of the whole project.

Design is defined by Ballard and Koskela (1998) as "*Careful identification of customer needs and meticulous translation of these needs into engineering specifications*". They advise: "*Design process can be conceived in at least three different ways:(1) as a process of converting inputs to outputs, (2) as a flow of materials and information through time and space, and (3) as a process of generating value for customers*."

From the above mentioned definitions we can figure out the following characteristics of the design process:

1- Design is a process carried out by individuals and/or organizations that consists of inputs, procedure, and outputs. It aims at satisfying a need of a client or a customer.

2- Design process is a logical, thorough problem-solving process. The following schematic illustrates the complete steps which reflect the logic of problem-solving (Source: Landis, 2000)

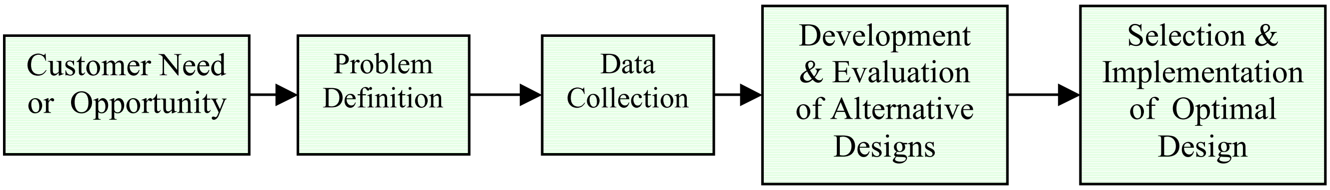

FIGURE 2.1: THE ENGINEERING DESIGN PROCESS

3- Design process is an iterative process. Many iterations through the design process may be required before a final design is selected.

4- Design process is a form of art and it needs special engineering skills in order to produce innovative and creative solutions that satisfy the customers' needs.

5- Design is a complex process that has diverse disciplines and comprises contributions from many specialists. This necessitates effective communications to ensure that the whole process is well run and to coordinate all the design activities.

6- Design process has constraints and limitations related to the availability of information and materials and to the nature of the design problem.

2.4 Stages and steps of the design process

Design is a dynamic process and generally contains many phases. It is divided into three major stages that may be considered as common to all projects (Gray & Hughes, 2001). These are:

1- Brief

The initial statement of need expressed by the client .

2- Concept and scheme (Preliminary design)

The designer development of the client statement into concept and outline design for the project. After the approval of the concept by the client, the scheme design is developed including basic systems study, feasibility study and value engineering

3- Engineering (Detailed design)

Development of full construction information including drawings, specifications and any other documents needed for the proper construction of the project.

Rutter & Martin (1991) bring in detail the steps of the design process. It is noticed that these steps are consistent with the previous definitions while giving them more details. These steps are:

1. Obtain client's brief and budget.
2. Arrange site investigation.
3. Make feasibility study.
4. Draft program.
5. Survey site.
6. Conceive alternatives, including estimations of cost.
7. Preliminary design.
8. Select preferred scheme.
9. Detailed design.
10. Seek statutory approvals.
11. Prepare contract documents

2.5 Design stages in the local practice

In the local practice, stages of design projects vary among the design offices according to the nature, volume and client of the project. However, every design project passes through the three main stages mentioned by Gray and Hughes. The client initiates the project and briefs the designer who prepares preliminary design to be approved by the client. Finally, the designer prepares the final detailed design of the project.

In big projects, mainly public buildings and infrastructure projects, the design process is commonly divided into the following stages or tasks:

1- Request for proposal

This stage may be considered as the " Client Brief". The client issues a request for proposal including a part explaining his needs and requirements (usually called Terms of Reference "TOR"). The design consultants are asked to submit proposals, frequently in two separate envelops: one is for the technical proposal and the other is for the financial proposal. The technical proposal illustrates the technical capabilities of the consultant and his work methodology, whilst the financial proposal indicates the fees to be paid to the consultant in return to performing the design works. The output of this stage is the design agreement between the client and the designer.

2- **Staff mobilization and data collection**

   In this stage, the designer starts the work. He mobilizes the design staff and collects the pertinent data. Site surveys and soil investigation, if needed, are included in this stage .

3- **Preparation of design criteria according to the client's need.**

   In this stage, design criteria and guidelines are prepared by the designer relying on the clients requirements stated in the TOR.

4- **Client's review and approval of the design criteria.**

5- **Preparation of preliminary design plans.**

After the client's approval of the design criteria, the designer starts preparing the preliminary design plans. The design gives broad lines of the project.

6- **Client's comments and approval of preliminary design plans.**

7- **Preparation of final design plans.**

After the client's approval of the preliminary design, the designer starts the detailed design stage. The detailed design stage is considered as the core of the design process. In this stage the detailed information for the construction stage is generated. The output is the detailed drawings, specifications and tender documents which are used for soliciting construction contractors

2.6 Approaches to Detailed Design

Literature review elucidates that the designers' approaches to design stages is almost the same. However, there are two different approaches to deal with the detailed design regarding the level of detailing and accordingly the number of drawings produced. Gray and Hughes (2001) state that these approaches are: Design-Led approach or (design for quality) and the Low-cost approach.

2.6.1 Design-Led Approach

This approach is adopted mainly in the United Kingdom (UK). Designers are involved in the detailed description of every aspect of the project. The average number of drawings produced for a building project is one drawing for $9m^2$ of building (Gray & Hughes, 2001). In this approach, the involvement of construction contractor in the project detailing is limited to utilizing their manufacturing and technical knowledge to achieve perfection in the execution of the work according to the prepared designs.

The design according to this approach does not involve standardization and repetition of work. Every part of the project is considered as unique one having its own details. This makes the design process more complex, but it enables the designers to present high quality products.

2.6.2 The low Cost Approach

This approach is adopted in US and Japan. Designers try to achieve the low-cost products through simple and standard designs. They allow the construction contractors to utilize their skills and knowledge to interpret their intentions.

In this approach the total number of drawings produced is a tenth of the drawings for an equivalent building in UK (Design-led approach) (Gray & Hughes, 2001). The construction contractors use their knowledge in manufacturing within a broader framework. They prepare workshop or manufacturing drawings to be approved by the designer. They are responsible for optimizing the designs to achieve cost effective construction. This approach has significant impact on the design complexity and gives overall simplification of the design management task.

2.7 Management Concepts

Literature review elucidates different approaches in the definition of management concepts. However, there is much agreement among these approaches. The following are definitions of the main management concepts quoted mainly from (Burton & Thakur, 1995)

2.7.1 The Organization

Design is frequently performed by "a group of people" or in other words a design organization; the organization is defined as "a group of two or more people who work together in a structured setting to achieve common goals".

2.7.2 The Management Functions

Management is the process of planning, organizing, leading, and controlling the resources of an organization in the efficient and effective pursuit of specified organizational goals. Management is seen as a process of activities that can be divided into four distinct but interrelated activities or management functions These are:

- Planning (deciding what is to be done),

- Organizing (deciding how it will be done and who will do it)
- Leading (influencing behaving), and
- Controlling (being certain that plans are carried out).

2.7.3 The manager's challenge

The manager, the person in charge of the management functions, faces many problems in handling the dynamic management functions in his organization. The basic challenge is getting the job done. This challenge can best be examined in three parts:

- Management of work.
- Management of people.
- Management of operations.

These challenges are explained as follows:

Management of work

It must be decided what need is to be served, what goals must be established, and what means will be used for the conduct of work. Problems must be solved, decisions must be made, plans must be established, budgets must be prepared, responsibilities must be assigned, and authority must be delegated. All of these tasks are involved in the management of work.

Management of people

The manager must lead the people working with him in order to accomplish the work of the organization. "Getting work done through people" is the major task for the manager.

Management of operations

Every organization has an operations' process by which a product or service is produced and/or provided for the customer. The management of this production operation entails the flow of input materials and the technology of transforming those inputs into the desired outputs for consumption.

It is noteworthy to state that the three management challenges are interrelated and can not stand alone. One can not deal with any of these challenges without involving the other two. Furthermore, these challenges fall within the context of the four management functions previously mentioned (planning, organizing, leading and controlling

2.8 Planning the Design Process

Planning is defined generally as the first management function that includes predicting future activities and preparing the organization to deal with expected problems. Planning also involves setting the organizational goals and means of achieving them most efficiently and effectively. Moreover, planning demands creative decision making in order to maximize the selection of appropriate courses of actions (Burton & Thakur, 1995). This definition implies that planning the design process comprises the followings:

1- Setting the objectives of the design process
2- Identifying what to be done and the required resources to achieve the objectives of the design process
3- Stating the anticipated outputs of the design process

2.8.1 Objectives of design Process

Planning the design process starts with setting the objectives or goals of the design organization. Rutter and Martin (1990), state that the main objectives include:

1- To aspire as an enterprise to attain high standards of integrity and quality.
2- To provide efficient and effective consultancy services in construction to all clients at all times.
3- To provide sufficient funds annually for growth and development of individuals and the enterprise.
4- To provide a secure working environment for all employees.

2.8.2 Planning Requirements

For all design projects, the essential requirement is a brief from the client defining the purpose of the design and the objectives to be met in both specific and qualitative terms (Rutter & Martin, 1990).

For proper planning, it is needed, in addition to defining clear objectives, to know what is to be done and what are the anticipated outputs of the design process. After the job is defined, it is divided into different tasks to be assigned to the staff members of the design team. A detailed list of tasks should be prepared and grouped into phases that show the sequencing of tasks and their interdependences.

The design plan is then prepared based upon the estimated times for each of these tasks. The completion date should be determined in consultation with the client.

To ensure effective planning it is important to establish and agree the roles and relationships of all team members including the client's representative.

The client's involvement should be considered in planning the design process. Actually, the design process is divided into stages based on key sign-off points needed from the client. Signing-off is a discipline whereby the designers present to the client at the end of each stage a complete set of information. If it is accepted after review and the decision made to proceed, then the client and designers will sign the drawings as the agreed set (Gray & Hughes, 2001)

2.8.3 Desired Results of Planning

Oberlender (1993) suggests that planning the design process has the following results:

- Planning provides the central communication that coordinates the work of all parties involved in the design works.
- Planning establishes the benchmark for the control system to track the amount, cost, and timing of the work required to successfully complete the design works.
- Planning should clearly identify the work that is required by each individual and the interface of work between individuals. It should also include a reasonable amount of time for the exchange of information between project participants, including the delay time for reviews and approvals.
- Project planning and scheduling can serve as an effective means of preventing problems. It can prevent delays in work. It can also prevent low worker morale and decline in productivity that is caused by lack of direction.

2.8.4 Techniques for Planning

As per Oberlender (1993), there are two general methods that are commonly used in planning: the bar chart (the Gantt chart) and the Critical Path Method (CPM) or network analysis. The bar chart, developed by Henry L. Gantt during World War I, is a graphical time-scale of the schedule. It is easy to interpret; but it is difficult to update, does not show interdependences of activities, does not integrate costs with the schedule, nor does it provide resources, such as man-hours, which are important for management of design.

The CPM provides interrelationship of activities and scheduling of costs and resources. It is also an effective technique for overall project scheduling and detailed scheduling. However, it does have some limitations when applied to detailed engineering design work during the early stages of a project because it requires an extensive description of the interrelationship of activities.

Several software programs are available for use in programming based on critical path analysis and resource management. Example of these programs is Microsoft Project, which is widely used in programming.

2.9 Organizing the design process

Organizing is the second management function. Once the plan has been established, the organizing function examines the activities and resources needed to implement the plan. It involves the grouping of the required tasks into manageable departments or work units and the establishment of authority and reporting relationships within the corporate hierarchy (Burton & Thakur, 1995). Accordingly, the design process should be organized to achieve the following:

1- to ensure that all the technical and other information is available for each stage;
2- to provide the right blend of professional skills to resolve all the problems which can be anticipated;
3- to make sure that everyone concerned in the project understands the extent and nature of his responsibilities;
4- to see that good communication links exist between all those concerned and that they are properly used; and
5- to ensure that all decisions are timely and are made known to those whom they affect.

2.9.1 Design organizations

The design organizations or design offices are two main types (Rutter & Martine, 1990)

1- In house offices, which provide their services to the whole organization. This type may be recognized in big contracting companies and public authorities.
2- Consulting Engineers who are commissioned to provide design and consulting services to interested clients either one-off for a specific project or working with regular clients in a manner similar to in-house offices.

The number of employees working within the design organization varies according to work volume and services rendered.

2.9.2 Forming the design Team

The design team consists of members from the various discipline departments (architectural, civil, structural, mechanical, electrical, etc.) led by the team leader or the Design Manager. The client's representative is considered as an integral part of the design team.

The project manager must organize, co-ordinate and monitor the progress of the work to ensure completion in time with the required quality. He should maintain frequent contact with the client's representative (Oberlender, 1993).

The design Manager needs to combine successfully two different functions, which may be defined as:

1- The management function: to ensure that the project as a whole is well run, and to co-ordinate the process of design.
2- The design or technical function: to contribute his own design skills in the solution of the problems and in the making of judgments.

It is important that each team member clearly understands the project objectives and realizes his/her importance in contributing to the overall success of the project. A cooperative working relationship is necessary between all team members.

2.10 Leading the design process

The leadership function in design management involves the management of human resources through activities such as: selection, employment and training. In addition, leading deals with interpersonal tasks such as motivating and communication process.

Leadership has to focus on accomplishing the design management plan in the best way. Outstanding leadership has the capacity to achieve success in spite of poor plans and/or poor organizations, whilst the best plans and/or organizations will fall under poor leadership. (Burton & Thakur, 1995)

The first step in leading is making the firms objectives clear to the employees. The most successful firms are those in which the objectives of the firm and its employees most nearly correspond. (Cappell & Willis, 1992)

2.10.1 Design team meetings

An effective means of communicating design objectives is the regularly scheduled team meetings. The kick-off meeting is one of the most important meetings in design management and is held prior to starting any work. There are three important purposes of the kick-off meeting: to orient team members regarding project objectives and needs, to distribute the overall project plan, and to assign to each team member the responsibility of preparing work packages for the work required in his or her area of expertise.

Throughout the duration of the design, weekly team meetings are held. These meetings are necessary to keep the team acting as a unit and to insure a continuous exchange of information. The agenda of the meetings should include a list of the items to be discussed including; work progress and special problems.

The design project manager is the leader of all team meetings; however, he should not dominate the discussions. Every team member should be allowed to lead the discussions related to his or her particular field of expertise (Oberlender, 1993).

2.10.2 Design reports

Reports are issued, frequently to the top management and to the client, on a regular basis and should include information that is beneficial to the receiver. Two routine reports are regularly prepared: weekly and monthly reports. Much of the weekly report can be obtained from the minutes of the weekly meetings and it includes information about the work progress and problems encountered. The weekly reports are beneficiary in the design coordination.

The monthly report is used by upper management and the owner's representative. It contains milestones that have been achieved and cost components in addition to overall work progress. It is preferred to have formats for both weekly and monthly reports in order to maintain consistency of the reports, to allow comparisons of project status and to evaluate the performance of the team.

2.10.3 Motivation in the design process

In design offices, mangers should motivate their employees to achieve job satisfaction. The employee may be motivated through: recognition of achievement, delegating authority and responsibility, and advancement. Other motivation factors that lead to

healthy work environment include: company policy, supervision, salary, inter-personal relations and working conditions. These factors serve to prevent job dissatisfaction.
The organization's form should not be static, but should vary over time to create an environment in which people can produce work of a high standard in a reasonable time. People who enjoy job satisfaction do not necessarily produce more, but the quality of their work is likely to be good, and they are less likely to seek to move to another organization (Rutter & Martine, 1990).

2.10.4 Communication

Good communications are required to ensure that information (messages and instructions) is distributed to those who need it. Distribution is not sufficient in itself, messages are not completed until they are received and understood. As stated earlier, the project team meetings and regular reports are the main channels of communication among the design team. However, much of communication on design problems will be by discussion between senior and junior engineers. The senior staff should maintain good communication with the junior staff. As per Chappell and Willis (1992) good communication involves: clarity, certainty, brevity and comprehensiveness.

2.10.5 Training

Training is necessary to develop the capabilities of the design staff. Self-development should be encouraged through working in multi-disciplinary design groups. Moving between different specialist groups widens the experience of the designer and makes him or her more capable to contribute to teamwork and eventually leading the design team.
Training may be conducted through a formal system of Continuing Education and Training (CET) sponsored by profession associations. Training schemes should include the acquisition of management and business skills. Computer skills and having a foreign language should not be forgotten (Rutter & Martine, 1990).

2.11 Controlling the design process

The controlling function of design process entails the establishment of the performance standards, the measurement of performance against these standards and taking the required corrective actions. It is essential to coordinate the communication system in the design process with the control function in order to secure timely information to those responsible for the controlling function.

For effective controlling, progress needs to be monitored regularly by group leaders. The results are to be discussed with the staff. Progress towards milestones needs to be examined with particular care. If delays are noticed, the program should be adjusted, or more resources should be allocated to the project (Rutter & Martine, 1990).

2.11.1 Drawings

The final product of design work is a set of contract documents (drawings and specifications). Drawings should be prepared in accordance with approved standards. Rutter and Martine (1990) suggest the British Standard BS 1192 as an example of drawings standards.

The design manager can develop a drawing index by assembling the list of drawings from all team members. This drawing index is used as a checklist of how many drawings to expect, and when to expect them.

2.11.2 Design checking and reviews

All designs should be checked to ensure that they are free from errors. It is preferred to do this check through an independent engineer or team who was not involved in the design. The checking procedure should be clearly defined. Engineers who are more senior and more experienced than the designers should undertake design reviews and checking.

Review of the design process can be of an effective means of avoiding problems to not occur in future. Reviews are time consuming. Time spent in a review should result in better solutions with improved quality and lower costs of both design and construction.

2.11.3 Project records and libraries

Records of completed projects should be kept on computer disks for ready access. Each project should have its own file that contains not only record drawings of the projects, but also the structural calculations and copies of the site investigation reports, together with all other relevant papers. The existence of standard drawings should be known to staff to avoid duplication of effort.

Most design offices keep a collection of information that they hope will be useful in their work. It consists of books, tables of data, standards of various fields, and specifications. All design offices should therefore have access to a library or information source containing all the materials needed on a day-to-day basis.

2.11.4 Standard Forms and manuals

Paper work is essential for monitoring and controlling the design process. It is recommended to use standard forms and manuals for follow up and monitoring of the design process in every stage. Examples of these forms are:

- Drawing Index.
- Formats of weekly and monthly reports.
- Distribution of documents form.
- Authority/Responsibility check list.
- Check list of duties for every design team member.

Another benefit of standardization of documents is that if similar events occur from time to time, preparing a written note or a procedure manual to be used on its next occurrence will make it possible to do the job without its having to be thought out again from scratch.

2.11.5 Post design review

After completion of the design for each project, the project manager and the design team should conduct a complete and candid evaluation of the design effort and the management of the design process. This evaluation should include each member of the project team as well as other key participants that were involved in design.

Oberlender (1993) advises that a checklist should be prepared to evaluate all aspects of the project including scope growth, match of quality and scope, owner's expectations and satisfaction, conflicts within the team or other parties, excessive changes in schedules, comparison of final costs with the original budget, and a list of precautions for managing future projects.

2.12 Design quality

Tilly et. al. (1997) state that when considering design quality, we can quote McGeorge (1988), who stated that:

> "*A good design will be effective (i.e. serve the purpose for which it was intended) and constructible with the best possible economy and safety*."

They further explain that whilst the design itself needs to be "effective", it also needs to be communicated effectively through the documentation (i.e. drawings, specifications, etc.). When documentation quality is considered, a number of criteria determine the level of quality:

- Timeliness: being supplied when required, so as to avoid delays;
- Accuracy : free of errors, conflicts and inconsistencies;
- Completeness : providing all the information required;
- Coordination: through coordination between design disciplines; and
- Conformance: meeting the requirements of performance standards and statutory regulations.

They conclude that the quality of the design and documentation process can simply be defined as:

> "The ability to provide the contactor with all the information needed to enable construction to be carried out as required, efficiently and without hindrance."

2.13 Design quality management system

ISO 9001 introduces guidelines for quality management in design process. Figure 3.6 depicts the quality management requirements. It consists of the followings:

2.13.1 Design and development planning

Document plans shall be prepared for each activity related to design and development. The plan shall describe each activity and assign responsibility, authority, and adequate resources for implementation. The plan shall be updated as the design progresses.

2.13.2 Organizational and technical interface

ISO standards require organizational and technical interface between the different groups involved in the design process. All relevant information will be documented, transmitted, and regularly reviewed.

2.13.3 Design input

ISO standards require that design input requirements related to the product be identified, documented, and reviewed by the organization. These include applicable statutory and regulatory requirements. Incomplete, ambiguous, or conflicting requirements must be resolved with those responsible for imposing them.

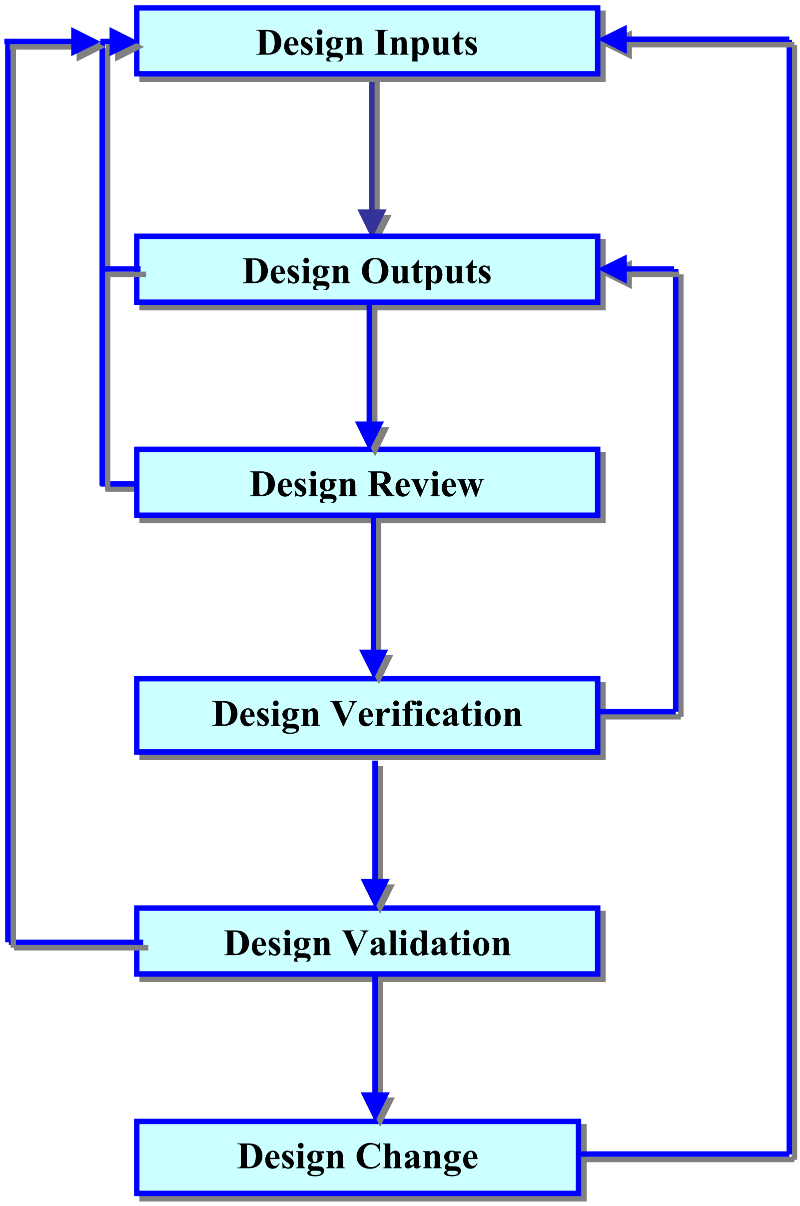

FIGURE 2.2: DESIGN PROCESS QUALITY MANAGEMENT (SOURCE: NEE, 1996)

2.13.4 Design output

ISO standards require design outputs to be documented in terms that can be verified against the design inputs. The outputs shall:

- Meet input requirements.
- Define acceptance criteria.
- Identify crucial characteristics of the product design such as operation, storage, handling, maintenance, and disposal.

Design output documents shall be reviewed and accepted prior to release.

2.13.5 Design review

ISO standards require that design results be reviewed at appropriate stages. These reviews are to be planned and documented. Representatives of all functions concerned with the design are to participate. Records of these reviews are to be maintained.

2.13.6 Design verification

ISO standards require that a verification plan be employed to ensure that the design stage outputs meet the design stage input requirements. That design verification may include the following:

- Performing alternative calculations.
- Comparing new designs with similar proven designs.
- Undertaking tests and demonstrations.
- Reviewing the design stage documents prior to release.

2.13.7 Design validation

ISO standards require that design validation shall be performed to ensure that the product meets the defined needs and requirements of the customer. It is noted that design validation follows design verification. Validation is to be performed under defined operating conditions. It is normally performed on the final product but it may be done in earlier stages prior to product completion. Multiple validations may be performed for different intended uses.

2.13.8 Design changes

All design changes or modifications are to be identified, documented, reviewed, and approved. These activities must be done only by authorized personal assigned by the design organization.

CHAPTER 3
Cost of Design Process

3.1 Introduction

This research aims at developing a decision support tool that helps local consultants determine their fees. In other words, this tool is intended to estimate the cost of the design process considering its main components. In this chapter, the design fees, cost components, and bidding procedure for design assignments are discussed. Some cost and accounting concepts are presented in the beginning of the chapter in order to cast light on these topics related to the design cost.

3.2 Cost concepts and terminology

3.2.1 What is cost?

Cost means different things to different people. Sha'at (1993) states that the cost of any thing to a consumer is what he or she is willing to sacrifice in money, time and effort to get it. He further explains that cost to maker is the sum of the various demands on resources, skills and organization that must be met before he or she can offer his or her product to the public.

3.2.2 What is estimating?

Cost estimating is defined by the Guide to the Project Management Body of Knowledge (2000) as: "Developing an approximation (estimate) of the cost of the resources needed to complete project activities".

El-Samadony et. al. (1998) state that according to the dictionary, to estimate is "to judge tentatively or approximately the value, or to produce a statement of the approximate cost". They further explain that a project cost estimate is prepared by evaluating the various components and elements that make up the project. Theoretically, the finer the detail, or the larger the number of elements used in estimating a project, the more accurate the total estimate should be.

3.2.3 Direct, indirect and overhead costs

In general, direct costs are defined as those costs that can easily be determined and charged to a specific operation, product, or project. Indirect costs are those costs that can not easily be determined and allocated to a specific operation, product, or project. Examples of indirect costs are; general and administrative expenses, pensions, and professional services. On the other hand, overhead (or burden) costs are defined as all costs other than direct costs. So, it is noted that indirect costs may be included in the overhead costs (Gonen, 1990). However, to avoid confusion between indirect costs and overhead costs in construction projects, indirect costs for a certain project are defined as the overhead costs related to this project, whilst the general overhead costs are the company costs that cant not be directly contributed to any specific project.

3.2.4 Fixed and variable Costs

Fixed costs are those costs that remain constant regardless of the output or activity level. Examples of fixed costs include capital costs, general expenses, management salaries, property taxes and insurance, rent, and building depreciation. Variable costs are those costs that vary directly with output or activity level. Examples of variable costs include the costs of direct material and direct labor (Gonen, 1990)

3.2.5 The Capital

The capital is the fund needed to start a business. It is necessary to purchase furniture and stationery, pay rents and other expenses, as well as be able to draw something to live on. Furthermore, a part of the capital is needed to cover the staff salaries paid somewhat ahead of receiving the fees for work completed (Chappell & Willis, 1992)

3.2.6 Cash forecasting and budgeting

It is needed to have some expectations of how well the design firm will do in financial terms. This implies that design firms will need to prepare some sort of budget based upon projected income and expenditure. A budget should be established for the period under consideration (normally one year). In this budget, the main expenditures should be identified. Literature review concludes that the major expenditure in the design organization is the staff salaries, which is typically two-thirds of the total cost (Rutter & Martine, 1992). The researcher experience, in a local consulting firm, confirms this conclusion. Review of the firms' monthly expenditures shows that the staff salaries range between 70% and 80% of the total expenditures.

3.2.7 Depreciation

Depreciation is the loss of value in an asset resulting from usage or age. This value decrease is caused by wear, deterioration or obsolescence. In estimating the cost of design process, a percentage is added to compensate the depreciation of the firm's assets. The amount to be included for depreciation can be calculated in several ways (straight-line method, reducing balance method, valuation method), all of which will provide a different set of figures from the same data (Gonen, 1990).

3.3 Design fees estimating

It should be noted that the task of estimating the cost of providing consulting services for design works is a difficult task. For many projects the magnitude of work that is required by the designer can not be fully anticipated (Oberlender, 1993). Furthermore, it is difficult to assess with some degree of certainty, the likely duration of the stages of the work or indeed the efforts required of the design team.

Oberlender (1993) and Chappell & Willis (1992) state that the design fees are usually calculated by one of the following methods:

1. A lump sum.
2. Time charge (or salary cost times a multiplier).
3. Cost plus a fixed payment.
4. Percentage of the total construction cost.

Lump sum fees are used when the project has a well-defined scope and similar to projects that the consultant has handled in the past. The salary cost times a multiplier method is used for projects when it is difficult to accurately define the scope of work at the time designer is retained for the project. A multiplier, usually within the range from 2 to 3 is applied to direct salary cost in order to compensate the design organization for overhead plus a reasonable margin for contingencies and profit.

The cost plus fixed payment method is used for projects that have a general description or statement of the scope of contemplated work. The design cost is determined by calculating the actual cost of all salaries, services and supplies, and then adding a fixed fee that is agreed on between the designer and the owner. This fixed fee usually varies from 10% for large projects to 25% for small projects that are short in duration.

Calculation of design fees based on a percentage of the construction cost is an old method which is not common today as it was in the past. The percentage generally ranges from 5% to 12% of the anticipated construction cost.

3.4 Design fees in the local practice

In the local practice, calculating the design fees varies according to the project nature and work volume. The client of the project and the method of obtaining the design projects have some effect as well.

The fees of local small projects, frequently owned by private sector, are agreed upon as a lump sum amount. The Association of Engineers has a guide scale of rates indicating the minimum building design fees proportional to the building type and area. However, the severe competition urges the designers to do the job with fees much lower than the fees specified in the Association of Engineers scale of rates.

For local infrastructure and public building projects, the design fees are calculated by breaking down the costs into main components. A commonly used example of this method is the World Bank form for breakdown of consulting rates which is depicted in Figure 3.1 (World Bank, 1997). It is noted, in this form, that the consulting fees are calculated according to the rates of the consulting staff. The agreed upon staff fixed rate of each staff member is multiplied by the duration of his involvement (time effort) in the work in order to get the total consulting fees. Also it is noted that the staff basic salary or rate, which is a direct cost, is considered as a basis of calculating other types of cost. The social charges and overhead costs are calculated as a percentage of this basic salary. Then, the basic salary, social charges and overhead costs are aggregated to calculate the total cost. The profit is eventually added as a percentage of the total cost.

The above described methodology of calculating the design fees is common. Frequently, the basis of fees calculating is the staff basic salaries, then indirect costs and overheads are added as a percentage of the staff basic salaries. The total cost is calculated by aggregating the direct and indirect costs and a profit is added as a percentage of the total cost. More details are introduced in the coming part of this chapter and in the coming chapters.

Consultants		1	2	3	4	5	6	7	8
Name	Position	Basic Rate[1]	Social Charge (__% of 1)	Overhead (__% of 1)	Subtotal	Fee (__% of 4)	Away from Headquarters Allowance (__ % of 1)	Total Agreed Fixed Rate	Agreed Fixed Rate (__ % of 1)
Country Assignment									
Home Office									

Signature of Consultant:________________________ Date:___________________

Authorized Representative:_____________________ Name:___________________

Title:______________________

Figure 3.1: World Bank Breakdown Of Consulting Rates Form (World Bank, 1997)

3.5 Design cost components

In preparing cost estimates for the design process, all the cost components should be considered. Rutter & Martin (1990) state that the principal objective of design organization is to make surplus of income over expenditure i.e. to achieve profit. So, if we want to identify the components that contribute to the design cost we have to recognize all the demands and resources needed to accomplish the design process and finally add a reasonable margin of profit.

Much literature has been written about the cost components of construction works. Figure 3.2 depicts the structure of costs and additions in the contractor's tender sum for construction works.

<table>
<tr><td>Direct cost</td><td rowspan="2">Construction cost</td><td rowspan="3">Net costs</td><td rowspan="4">Tender price</td></tr>
<tr><td>Site overheads</td></tr>
<tr><td colspan="2">General overheads</td></tr>
<tr><td colspan="3">Profit and risk</td></tr>
</table>

FIGURE 3.2: CONSTRUCTION COST COMPONENTS (SOURCE: MACCAFFER & BALDWIN,1991)

The design cost components may be arranged in a way similar to the construction costs depicted in the following Figure 3.3.

<table>
<tr><td>Direct cost</td><td rowspan="2">Production cost</td><td rowspan="3">Net costs</td><td rowspan="4">Total design fees</td></tr>
<tr><td>Project overheads</td></tr>
<tr><td colspan="2">General overheads</td></tr>
<tr><td colspan="3">Profit and risk</td></tr>
</table>

FIGURE 3.3: DESIGN COST COMPONENTS

The various components of the design cost are explained in the following paragraphs.

3.5.1 Direct cost

The direct cost of design consists of:

- ◊ Cost of the staff or the salaries of the staff directly involved in the project.

  It is frequently calculated by multiplying the monthly rate of each employee by the duration of his involvement in the project. The monthly rates are obtained by adding social allowances to the basic salaries of the employees
- ◊ Cost of equipment and stationary directly involved in the project, including printing of the project documents.
- ◊ Cost of sub-consultants directly involved in the project, such as soil investigation and land surveying consultants.

3.5.2 Project overheads

This portion of the design cost is related mainly to the salaries or part of it of the supporting administrative and managerial staff involved in the project such as the secretaries and accountants, etc. It may be included in the staff monthly rates as a percentage of the basic salary.

3.5.3 Production cost

Production cost is the sum of the direct cost and the project overheads. It represents the cost of a particular project to the design firm. Other cost elements are frequently calculated as a percentage of this production cost.

3.5.4 General overheads

It is a percentage added to the production cost to cover general expenditures of the design firm including rent costs, insurance premiums, equipment depreciation, staff training, etc.

MacCaffer & Baldwin (1991) state that the general overhead is to be estimated within the forecasted annually turnover of the design firm. They further explain that the firms expenditures have to be monitored monthly in order to get guidance of the amount of the allowance that should be made for the general overheads.

3.5.5 Risk and profit

The risk allowance is added when there is a possibility that the actual cost will be more than the estimated cost. It is often estimated as a percentage of the production cost depending on the estimator’s experience and judgment.

Profit allowance is a percentage added to the production cost. It is usually assessed at what is considered to be possible in the prevailing market conditions (Gonen, 1990).

3.6 Cost and Schedule increase for design projects

An important element in estimating the design cost is the risk factor. Risk is defined as the possibility of cost overruns. A survey reveals that about one third of Architectural/Engineering (A/E) projects miss cost and schedule target. Cost increased on an average of 24.8% and schedule increased on an average of 69% based on four sample completed projects (Chang, 2002).

Locally, time/cost overruns are frequently faced. Reasons for cost and time overruns can be categorized according to responsibility:

- Reasons within the owner's control.
- Reasons within the consultant's control.
- Reasons beyond either the owner's or the consultant's control.
- Joint responsibility of owner, consultant, and other stakeholders.

It is to be noted that in most cases, cost and time increases are contributed by reasons beyond either the owner's or the consultant's control. In construction the reasons for cost/time increases may be classified in a way that helps to identify and trace the responsibility. They can be grouped as: compensible, non-excusable, and excusable delays (Barrie and Paulson, 1992). In design works, the grouping may be as follows (Chang, 2002).

A. **Compensible** (within the owner's control).

1- Owner's Request
   - Additional work.
   - Optimistic schedule.
   - Omissions.

2- Owner's failure
   - Failure to provide information.
   - Incomplete or incorrect information.

B. **Non-excusable** (within consultants control)

- Consultant inability.
- Underestimation of cost and time.

C. **Excusable**

- Growing and new project needs.
- Other stakeholders
  - Agencies and local authorities.
  - Public.
- Others (Social and political conditions).

3.7 Tendering for design works

Drew et. al., (2002) state that two-envelop fee tendering is commonly used in some construction industries as a mechanism for allocating consultancy work to design consultants such as architects, surveyors and engineers. They further explain that consultancy contracts are awarded on the basis of price (i.e. fee) and quality (i.e. technical score). In many cases, each consultant's technical score and fee is converted to a percentage or ratio relative to the competition's highest technical score and lowest fee before being weighted and aggregated according to a given formula. Usually, the contract is then awarded to the consultant with the best overall score. In such situations consultants are faced with the problem in deciding whether to aim for a high technical score (which usually requires a higher fee) or submit a low fee (which is more likely to result in a lower technical score) or somewhere in between these two extremes.

Locally, in West Bank and Gaza Strip, the World Bank procedures for selecting consultants are widely used, either completely or partially. These procedures are explained in the World Bank Booklet (Standard request for proposals, selection of consultants, 1997). The following is a summary of these procedures:

1- The client issues a Request For Proposals (RFP) inviting the design consultants to submit their proposals for consulting services. The RFP includes the following:

   Section 1 - Letter of Invitation.

   Section 2 - Information to Consultants.

   Section 3 - Technical Proposal - Standard Forms

Section 4 - Financial Proposal - Standard Forms

Section 5 - Terms of Reference

Section 6 - Standard Forms of Contract.

2- Each invited consultant submits two separate proposals: a technical proposal and a financial proposal. The proposals will be the basis for contract negotiations and ultimately for a signed contract with the selected consultant.

3- The client assigns a committee to evaluate the proposals. First, the technical proposals are evaluated. Each technical proposal is given a technical score (St).

4- The technical score is calculated according to the evaluation criteria stated in the RFP. For example, the following are some of the evaluation criteria:

Criteria	Points
Specific experience of the consultants related to the assignment	5- 10
Adequacy of the proposed work plan and methodology in responding to the Terms of Reference	20-50
Qualifications and competence of the key staff for the Assignment	30-60
Suitability of the transfer of knowledge program (training)	0-10
Total Points	**100**

A minimum technical score is required in order to pass the technical evaluation. The financial proposals of the consultants, who pass the technical evaluation, are opened, whilst the financial proposals of the consultants, who did not pass the technical evaluation, are returned unopened to these consultants.

5- The financial proposals are opened publicly in the presence of the consultants' representatives who choose to attend. The lowest financial proposal (Fm) is given a financial score (Sf) of 100 points. The financial scores for other financial proposals are calculated by the formula: **Sf = (Fm / f) * 100**, where f is the amount of the financial proposal

6- Proposals are ranked according to their combined technical (St) and financial (Sf) scores using the weights T and F, where:

- T = the weight given to the Technical Proposal (Ranging between 70% & 80%);
- F = the weight given to the Financial Proposal (Ranging between 30% & 20%) ;
- T + F = 100%.

Total score (S) is then calculated using the formula:

Total score S = St * T % + Sf * F % .

The firm achieving the highest combined technical and financial score is invited for contract negotiations with the client.

Some institutions tend to use a modified procedure for selecting consultants. The technical evaluation is used to determine those consultants who pass the minimum required score (usually 70 to 75%). The financial proposals of the passing consultants are opened and the assignment is awarded to the consultant with the lowest financial proposal.

CHAPTER 4
Research Methodology

4.1 Introduction

In this chapter, methods of field survey, data gathering and analysis are introduced. A questionnaire is used to investigate the local perception and practice in managing the design process and how the design fees are estimated. Full questionnaire form is attached in Annex A. Tender evaluation results of previous consulting tenders are gathered from several institutions, authorities and municipalities using a "Projects Survey Card" prepared by the researcher.

4.2 Aim of the field survey

The field survey aims at collecting the data required to accomplish the research objectives. This includes investigating the local practice in design management in order to determine the local design and consulting services procedures. Elements significantly contribute to the cost of the consulting services are identified as well. Data collected is the basis for forming the design management model which is supposed to represent the local design and consulting services process.

The cost elements in the questionnaire results and the historical data from previous tenders survey are utilized as an input for the fees estimating computer based model (FEM). This computer based model is intended to serve the local consultants as "a decision making tool" for pricing the local consulting services.

The following Figure 4.1 summarizes the methodology flowchart and how it leads to achieve the research objectives.

4.3 Research population

The studied population is the top consulting offices and firms in Gaza Strip. This population is identified from the Association of Engineers records. The body responsible for these records is "The Engineering Offices and Consulting Firms Agency" which classifies and accredits the consulting and engineering offices/firms

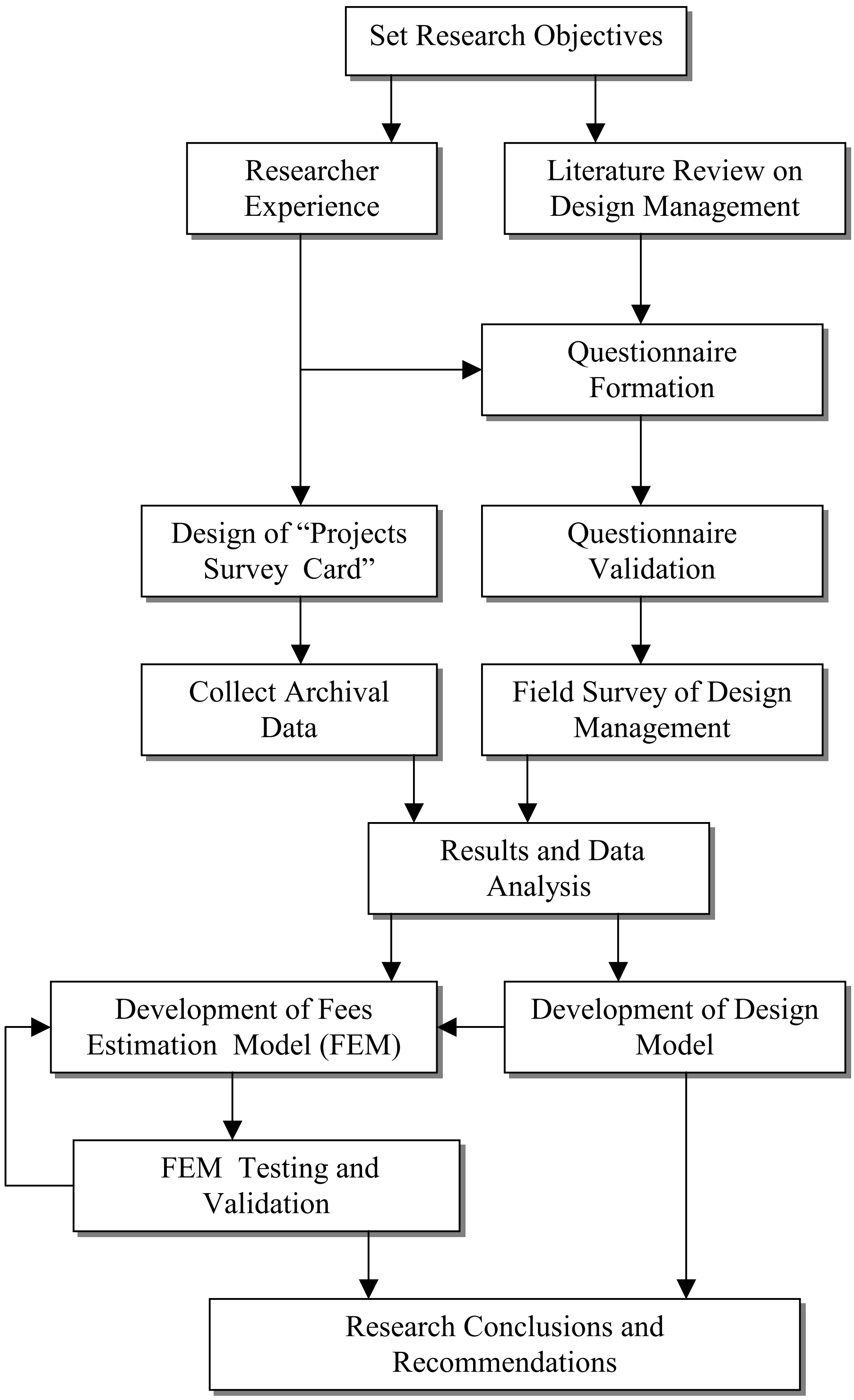

FIGURE 4.1: RESEARCH METHODOLOGY FLOW CHART FOR DESIGN FEES ESTIMATING

based on the Regulations of the Engineering Offices and Firms in Palestine (first approved in 1994, amended in 2000 and in 2003). According to these regulations, the engineering offices/firms can practice the work under one of the following categories:

1- **Engineer's office**: Individual engineer specialized in one discipline. The engineer should have three years of experience at least.
2- **Engineering office**: Minimum two engineers in two different disciplines. Each engineer must have five years of experience at least.
3- **Consulting office/firm**: In this category the office/firm must have two engineering disciplines at least. In each discipline, two engineers are needed; senior engineer with minimum eleven years of experience, and a junior engineer assisting the senior one. The consulting offices are often with a sole proprietorship, whilst the consulting firms are always registered as partnership companies.

The research population is the top category, i.e. the consulting offices/firms as per the list issued in September 2003. The total number of the consulting offices/firms is 35 offices/firms. As depicted in Table 4.1, It is oblivious that more than 60% of the local consulting engineers are working in this category. Furthermore, these engineers have rich experience and are involved in the major consulting works in Gaza Strip. Consequently, the design and management teams in this category of consulting offices/firms, might represent to a great extent the attitudes of design management in the top local engineering practice.

Table 4.1 Engineering offices/firms in Gaza strip and their number of engineers *

Category	Engineer's office	Engineering office	Consulting office/firm	Total
Number of offices/firms	6	48	35	89
	7%	54%	39%	100%
Number of employed engineers	8	180	310	498
	2%	36%	62%	100%

* Source: The Engineering Offices and Consulting Firms Agency (2003)

4.4 The research sample

The sample size is calculated using the techniques proposed by Professor Hossein Arsham (http://ubmail.ubalt.edu , 2003) It is found that, for acceptable confidence level (95%) with acceptable absolute error (0.5), the required sample size is 19 consulting offices/firms. So, the surveyed consulting offices/firms are 22 consultants out of the total 35 consultants registered in the records of the Association of Engineers in Gaza Strip. Table 4.2 depicts the number and distribution of the surveyed consultants compared to the total registered consultants in the top category (consulting offices/firms).

Table 4.2 : The survey sample

	Survey sample			Registered Consultants		
	Gaza City	Khanyounis & Rafah	Total	Gaza City	Khanyounis & Rafah	Total
Consulting offices (Sole proprietorships)	8	6	14	15	10	25
Consulting Firms (Partnership companies)	8	0	8	10	0	10
Total	**16**	**6**	**22**	**25**	**10**	**35**

From Table 4.2, it is clear that the survey sample includes 63% of the total consulting offices/firms in Gaza Strip. The sample considers the geographical distribution of the offices/firms. It covers 64% of the offices/firms in Gaza city and about 60% of the offices/firms in Southern Gaza (Khanyounis & Rafah). Regarding the organization type, the survey covers 56% of the consulting offices (sole proprietorship) and 80% of the consulting firms (partnership companies).

4.5 The research questionnaire

The questionnaire is prepared based on the researcher experience and ideas extracted from the literature review. Of course, the questionnaire is designed to cover the requirements of the research objectives. Issues, topics and ideas are identified and then translated into specific questions. The questionnaire is discussed deeply with the supervisor until a final agreed upon version is reached.

4.5.1 Questionnaire contents

The questionnaire includes the following topics

Part A: **Information about the consulting office/firm.**

Part B: **Management of design offices:**

1- The design process nature
2- Planning and scheduling the design process
3- Leading in the design process
4- The aim of the engineering design practice.
5- Design quality definition.
6- Estimating the design fees

It is to be noted that the questionnaire is prepared in “Arabic Language” in order to avoid any misunderstanding of its topics. A copy of the questionnaire and an English version of it are attached in Annex A and Annex B respectively.

4.5.2 Questionnaire design

The questionnaire is based mainly on exploratory questions that aim at diagnosing the local practice in design management. The respondents are asked to address their opinion on the questionnaire topics. For most of the topics, they have to express their level of agreement as well as the degree to which they are implementing the concept included in each topic. The agreement is indicated in an ordinal scale of five degrees: (strongly agree – agree – intermediately agree – weakly agree – very weakly agree). The agreement scale is assigned the following levels (5, 4, 3, 2 and 1) respectively. Also, the implementation is indicated in an ordinal scale of five degrees: (always – often – sometimes –

rarely – never). The implementation scale is assigned the following levels (5, 4, 3, 2 and 1) respectively.

An interval scale is used in the topics related to the amount of cost allowances and delay in projects.

As earlier explained in this chapter, the questionnaire is dispatched to 22 consulting offices/firms. The questionnaire is supplemented with personal interviews with some managers of the consulting offices/firms. These interviews contribute to better understanding of the respondents' view points.

4.5.3 Questionnaire Validity

A panel consisting of five experts is asked to verify the validity of the questionnaire topics and its relevance to the research objectives. Based on the comments of the experts some modifications in the text of the questionnaire are performed. The modifications are discussed with the supervisor and then the questionnaire is finalized.

4.5.4 Questionnaire method of analysis

Descriptive statistical techniques are used in the questionnaire analysis. Frequencies of the respondents' answers for each topic are calculated as well as the average level of each topic. The association between the agreement level and implementation level for each topic is tested using chi-square (X^2) test. Cross tabulation is used and Cramer's V association factor is calculated. The Statistical Package for Social Sciences (SPSS 11) is used in the data analysis.

4.6 Collection of secondary (archival) data

A project survey card is used to gather archival data about the evaluation results of tenders for consulting services (Figure 4.2).

Survey Of Projects			
Serial Number		Institution	
Project Date		No of Consultants	
Project Type		Estimated Man Months	
No of consultants who passed tech. Evaluation			
Technical Weight		Financial Weight	
Evaluation Results			

Company	Technical score	Price	Financial Score
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

FIGURE 4.2: PROJECTS SURVEY CARD

The researcher addresses the institutions that adopt the World Bank guidelines in soliciting consulting services. These institutions include:

- The World Bank Office in Gaza Strip.
- Palestinian Economical Council for Development and Reconstruction (PECDAR)
- Palestinian Water Authority (PWA).
- Ministry of Health (MOH).
- Ministry of Education & Higher Education (MOEHE).
- Municipalities (mainly in the middle area of Gaza Strip).

Tender evaluation results for about 40 projects (starting from 1997 till 2003) are collected. The data in the project cards is analyzed in order to determine the frequency of winning the tender for a certain total score. This frequency table is used as an input in the Fees Estimating Model (FEM). More details will be presented in the coming chapters.

CHAPTER 5

Field Survey Results

5.1 Introduction

The field survey questionnaire results are introduced and analyzed in this chapter. Descriptive statistical analysis is used to identify the local practice in design management and attitudes of the top design consultants in Gaza Strip. The relation between the local consultants perception of the design management elements and the actual implementation of these elements is tested. When possible, the local practice is compared with the concepts and practices introduced in the literature review.

The archival data collected using the project survey cards is tabulated and analyzed to explore the distribution of the total scores achieved by the consultants who won the tenders. Man-month rates of the lowest bidders are calculated and their trend is identified.

5.2 Questionnaire results

Part A: Information about the surveyed consulting offices/firms

1. **The survey sample**

As previously stated in Chapter 4, the surveyed consulting offices/firms are 22 consultants out of 35 consultants registered in the records of the Association of Engineers in Gaza Strip.

2. **Foundation date**

The foundation date of the surveyed consulting offices/firms is depicted in Table 5.1.

Table 5.1 : Foundation date of the offices/firms

Foundation Year	Number	Percentage
Before 1990	5	23%
1990 to 1994	9	41%
1995 to 2000	3	14%
After 2000	1	4%
Missing data	4	18%
Total	**22**	**100%**

It is noted that 23% of the surveyed offices/firms were founded before 1990. One of the interviewed firms started the work in 1972, i.e. it has been working for more than thirty years, which is quite long and rich experience. Majority of the surveyed offices/firms (about 77%) were established after 1990 where the establishment of the Palestinian Authority (PA) encouraged the foundation of new consulting offices/firms. This time period witnessed a leap of development and reconstruction works in Gaza Strip and the need to consulting services remarkably increased.

3. **Engineering disciplines**

The engineering disciplines carried out by the surveyed offices/firms are depicted in Table 5.2 and Table 5.3. These disciplines are categorized according to the classification of the Association of Engineers in Gaza Strip.

Table 5.2 : Disciplines carried out by the offices/firms

Discipline	No. of Consultants	Discipline	No. of Consultants
Architectural	22 (100%)	Roads	6 (27%)
Structural	22 (100%)	Construction Management	7 (33%)
Electrical	21 (95%)	Soil & foundations	0 (0%)
Mechanical	21 (95%)	Topographic survey	0 (0%)
Water & wastewater	10 (45%)	Others (Town planning)	1 (5%)

Table 5.3 : Number of disciplines carried out by the offices/firms

Disciplines Number	4	5	6	7
Offices/Firms Number	9 (41%)	7 (33%)	3 (13%)	4 (13%)

The above tables show that almost all the surveyed offices/firms are specialized in at least four disciplines namely : architectural, structural, electrical and mechanical engineering. Approximately 10% of the offices/firms are specialized in the other three main disciplines: water and wastewater, roads and construction management. None of the offices is specialized in the two disciplines: topographical survey and soil and foundation engineering. Services of these two disciplines are provided by specialized sub-consulting firms and laboratories.

4. **Number of Employees**

The average annual number of employees in the surveyed offices/firms during the last five years is depicted Table 5.4. The figures in brackets indicate the number of employees with post graduate qualifications.

Table 5.4 : Employees Number in the consulting offices/firms

SN	Average Annual Number of Employees (Post Graduate Employees)				
	1998	1999	2000	2001	2002
1	8 (0)	8 (0)	9 (0)	9 (0)	10 (0)
2	9 (0)	9 (0)	9 (0)	11 (0)	9 (0)
3	14 (1)	14 (1)	15 (1)	18 (1)	19 (1)
4	-	11 (0)	12 (2)	10 (2)	10 (2)
5	10 (0)	10 (0)	10 (0)	11 (0)	13 (0)
6	9 (0)	9 (0)	9 (0)	9 (0)	9 (0)
7	20 (0)	20 (0)	20 (0)	20 (0)	20 (0)
8	11 (0)	11 (0)	9 (0)	9 (0)	11 (0)
9	18 (1)	20 (1)	22 (0)	12 (0)	13 (0)
10	-	6 (0)	7 (0)	7 (0)	9 (0)
11	13 (0)	13 (0)	14 (0)	14 (0)	16 (0)
12	9 (0)	9 (0)	9 (0)	9 (0)	9 (0)
13	24 (0)	35 (0)	28 (0)	17 (0)	12 (0)
14	24 (3)	24 (4)	25 (4)	27 (4)	25 (4)
15	-	-	-	13 (0)	13 (0)
16	11 (0)	11 (0)	10 (0)	8 (0)	10 (0)
17	9 (1)	10 (1)	10 (1)	10 (1)	10 (1)
18	19 (2)	19 (2)	14 (2)	11 (2)	11 (2)
19	-	-	-	-	10 (1)
20	12 (3)	13 (3)	11 (3)	13 (3)	13 (3)
21	Missing	Missing	Missing	Missing	Missing
22	15 (1)	15 (1)	15 (1)	15 (1)	15 (1)
Total	**235 (12)**	**267 (13)**	**258 (14)**	**253 (14)**	**267 (15)**

The above table indicates that the minimum number of employees in the consulting offices/firms is 7 employees, the average number is around 15 employees, and the maximum number mounts up to 35 employees.

It is noted that along the last five years, in most of the surveyed offices/firms, the number of the employees is nearly fixed. However, in some firms there is a decrease in the employees number within the last two years. This decrease is justified since the available work decreased due to the prevailing unstable conditions.

About 30% of the surveyed offices/firms have employees with post graduate qualifications. The number of these employees ranges between 1 and 4 employees.

5. Work type and volume

In this part of the questionnaire, the work fields are categorized into 7 project types, namely: "small buildings, high rise buildings, public buildings, water and wastewater works, road works, supervision works and other works". The type of works performed by the surveyed consulting offices/firms and its percentage to the consultant's total works are depicted in Tables 5.5 a and Table 5.5 b

Table 5.5 a : Work diversity of the surveyed offices/firms

Number of Project Types (Work Fields)	Number of Offices/Firms	Percentage	Cumulative Percentage
7	3	14%	14%
6	1	5%	19%
5	3	14%	33%
4	10	43%	76%
3	3	14%	90%
2	2	10%	100%
Total	**22**	**100%**	

Table 5.5 b : Type and volume of work performed by the surveyed Offices/Firms

Work Volume Related to Total Work	Types of Work and Number of Consultants Working in Each						
	Small Buildings	High Rise Buildings	Public Buildings	Water & Wastewater	Road Works	Supervision Works	Others
0 % -	6	9	5	1	2	4	2
10% -	1	6	8	2	3	3	1
20% -	2	2	6	2	1	5	0
30% -	1	1	1	1	0	2	0
40% -	1	0	1	0	0	2	0
50% -	1	0	0	0	0	3	0
60% -	3	0	0	0	0	0	0
70% -	0	0	0	0	0	0	0
80% -	2	0	0	0	0	0	0
90%- 100%	3	0	0	0	0	0	0
Total Working Consultants	**22 (100%)**	**18 (82%)**	**21 (95%)**	**6 (28%)**	**6 (28%)**	**19 (86%)**	**3 (14%)**
Not Working Consultants	0	4	1	16	16	3	19
Total Consultants	22	22	22	22	22	22	22

The above tables indicate that all of the surveyed offices/firms are working in more than one work field or type of work (at least two fields). Almost all of them work in traditional building design (small residential buildings, high rise buildings and public buildings). More than 80% of the work volume of five offices is in small buildings.

About 25% of the surveyed offices/firms work in the infrastructure projects (water and wastewater, and road works). This is because the infrastructure projects usually need specialized staff, high technical capability, and ample resources. It is also noted that consultants involved in the infrastructure projects have a relatively small work volume in the traditional building design.

Majority of the surveyed consultants (86%) are involved in the supervision and construction management works. More than 50% of the work volume of three consulting firms is in supervision. Supervision works need additional staff members to those who work in the design works. This explicates the relatively big staff in some of the surveyed offices where the total staff members mount to 35 employees. Some of the surveyed firms (14%) are involved in other types of work mainly capacity building studies, feasibility studies and training. The amount of these other works may constitute up to 20% of the total work volume of these firms. It is to be noted that the consulting firms working in training and capacity building studies usually have staff members with post graduate qualifications (M.Sc. & Ph. D degrees)

6. Annual consulting fees

Table 5.6 indicates the average annual consulting fees of the surveyed offices/firms.

Table 5.6: Average annual consulting fees

Average Annual Fees (1000 $)	**Number of Consultants**	**Percentage**
Less than 50	11	50%
50 to 99	6	27%
100 to 149	1	5%
150 to 199	2	9%
200 and more	2	9%
Total	**22**	**100%**

The above table shows that half of the surveyed consultants earn in average less than $50,000 yearly. Furthermore, about 77% of the surveyed consultants earn less than $100,000 yearly. Only two consultants (9%) earn more than $200,000 yearly. It is noted that these annual fees are rather low. Taking into consideration that firms of high income have a relatively big staff, these fees hardly cover the running costs of the consulting offices/firms. This low income may be referred to the severe competition in the local market. Most of the consulting projects are contracted with prices much lower than the budget allocated. The recession in the consulting works in the last two years has contributed to such low consulting fees.

7. **Joint ventures with expatriate consultants**

Many regional and international consultants were involved in the consulting works in Gaza Strip, mainly in big infrastructure projects. Some local consultants worked with these expatriate consultants, in joint ventures, as local counterpart. Out of 22 surveyed offices/firms, 9 consultants (40%) has worked in joint ventures with expatriate consultants. The volume of the joint venture works ranges between 5% to 15% of these offices/firms total work.

Working in joint venture with regional and international consultants contributed to expertise and knowledge transfer to the local consulting offices/firms. This has paid real dividends through the improvement of the local practice in design management.

To conclude, results of the previous "Part A" of the questionnaire indicate that the surveyed offices/firms reflects, to a great extent, the local engineering consulting services. These offices/firms has been working in the local market for more than five years. They employ the majority of local design specialists. It is obvious also that they are involved in all work fields, and their experience is supplemented by working with regional and international consultants.

Part B: Management of design offices

In this part of the questionnaire, the consultants are asked to express their agreement to several concepts related to the design management and to state to what extent they implement these concepts. It is divided into groups of topics including: " The design process, planning and scheduling the design process, leading in the design process, design quality, tendering for the consulting projects, design fees estimation and cost and time overruns in local design projects".

Nominal scales are used to measure the level of agreement and implementation ranging from 1 to 5. (As we previously stated in chapter 4). For each topic, the average agreement level (AAL) and the average implementation level (AIL) are calculated.

1- The design process

Figure 5.1 depicts AAL and AIL for the concepts introduced in this part of the questionnaire. It is noted that the AAL ranges between 3.05 (for Q 1.4) and 4.55 (for Q 1.1). The AIL ranges between 2.55 (for Q 1.11) and 4.18 (for Q 1.1). The results show that the local consultants agree upon and implement the concepts introduced in this part of the questionnaire. In general, the AIL is consistently a little bit lower than the AAL.

Association test

The statistical X^2 (chi-square) test is used to measure the association between the degrees of agreement and implementation of the above mentioned concepts related to the nature of the design process. For all the questions, the Cramer's V association factor is around the value of 0.5. This value means intermediate association between the agreement and the implementation levels.

Overall evaluation of this part of the questionnaire, regarding the design process, points out that the local consultants have a good theoretical perception of the design process. However their actual practice in design management is not up to this level. Efforts and resources are needed to bridge the gap between the local consultants beliefs and practice. In addition, the results of this part of the questionnaire indicate that coordination is a key issue in the design management and the local consultants give considerable efforts in coordinating the design activities. This is coincident with the nature of design, which is a complex process that has diverse disciplines and comprises contributions from many specialists

	1. The design process
Q 1.1	Successful design process needs affective co-ordination of design activities in addition to the existence of competent technical design staff.
Q 1.2	Owner of the project has an important role in the success of the design process.
Q 1.3	Good design provides detailed drawings as much as possible.
Q 1.4	Good design allows for the use of the contractors experience in details preparation.
Q 1.5	The manager of the design process needs to have managerial skills in addition to the technical skills.
Q 1.6	Design drawings and tender documents have to comply with a fixed standard.
Q 1.7	A “Drawing Index” is prepared in the beginning of the design process in order to follow up the design progress.
Q 1.8	It is important to have a clear and known methodology in the design checking and review.
Q 1.9	It is important to keep copies of the previous design documents within a well arranged Library.
Q 1.10	An evaluation meeting is necessary in the end of every design project.
Q 1.11	The design office/company needs to adopt a formal quantity system (such as ISO 9001).

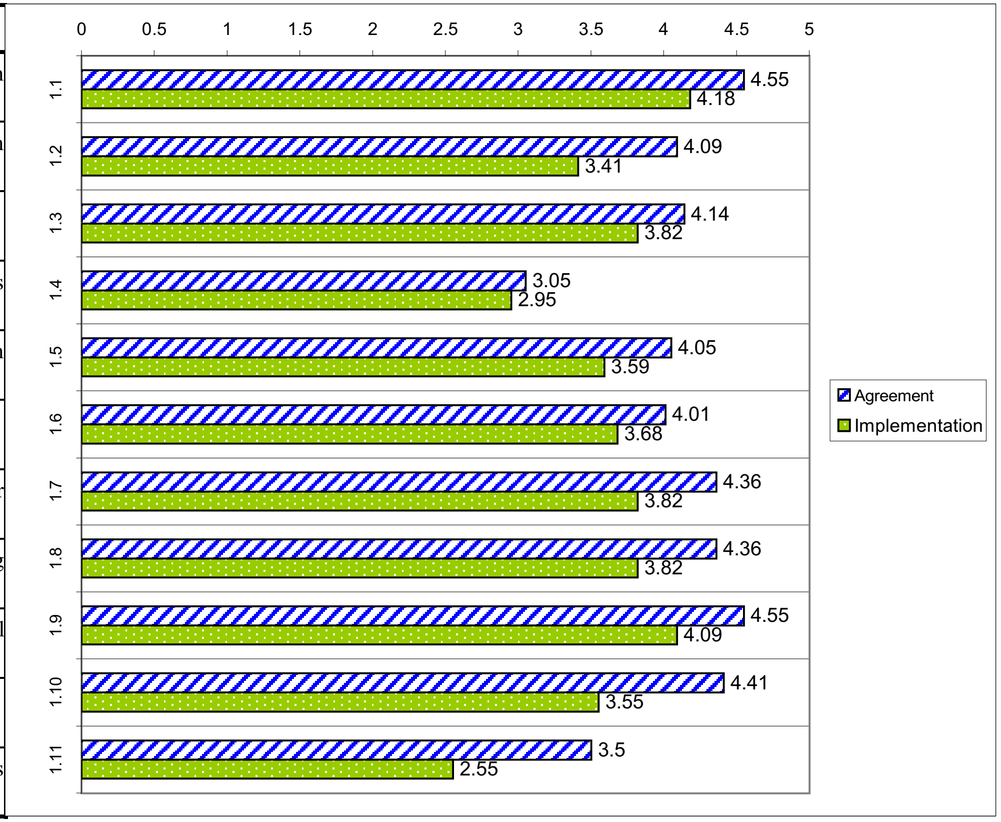

Figure 5.1:AAL and AIL for the design process concepts

2. Planning and scheduling the design process

Figure 5.2 depicts AAL and AIL for the concepts introduced in this part of the questionnaire. It is noted that the AAL ranges between 3.14 (for Q 2.12) and 4.55 (for Q 2.4). The AIL ranges between 2.77 (for Q 2.12) and 4.09 (for Q 2.4) which are the same concepts that achieved the minimum and maximum AAL. The results show that the local consultants agree upon and implement the concepts introduced in this part of the questionnaire. In general, the AIL is consistently a little bit lower than the AAL.

Association test

The statistical X^2 (chi square) test is used to measure the association between the levels of agreement and implementation of the above mentioned concepts related to the planning function in design management. The Crammer's V association factor is around the value of 0.5 for most of the questions. This value means intermediate association between the agreement and the implementation levels. Only for question number 2.4, related to the dividing of works into tasks allocated to team members, the association factor is 0.8. This indicates strong association between the agreement and implementation of this concept.

Similar to the previous part related to the design process concepts, overall evaluation of this part related to the design planning, points out that the local consultants have a good theoretical understanding of the planning function in design management. However, there is a gap between their beliefs and actions. This gap needs to be bridged by allocating more efforts and resources.

The results reflect also a good understanding of the local consultants regarding the importance of the clear clients brief. This reflects good perception of the design process. Worldwide, the unclear client brief, or "Lack of scope definition" is a main cause of cost and time overruns in design process. A survey done in the United States in 1991, showed that at 40% of the over-budgeted projects, the cause of the increase was due to changes of work scope (Knight, et al 2002).

2. Planning and schedueling the design process	
Q 2.1	Clear client brief contributes to the successful planning of the design process.
Q 2.2	It is needed to identify the outputs of the design prior to staring the design process.
Q 2.3	It is important to agree the design time plan with the client.
Q 2.4	Prior to starting the design process, the work is divided into specific tasks. Each task is allocated to a person/group to perform it.
Q 2.5	It is necessary that the client approves each design stage before starting the next one.
Q 2.6	Sufficient time must be given for clients review and approval of each design stage.
Q 2.7	Design work plan is the basis of coordinating the work of the design team.
Q 2.8	Design work plan is the basis to control the design progress.
Q 2.9	Design work plan identifies the role of every member in the design team and when to deliver the work.
Q 2.10	Design work plan helps to finish the work on time.
Q 2.11	Design work plan is a motivation tool to increase the output of every member in the design team.
Q 2.12	The Bar chart or Gantt chart is used to show the plan of design process.

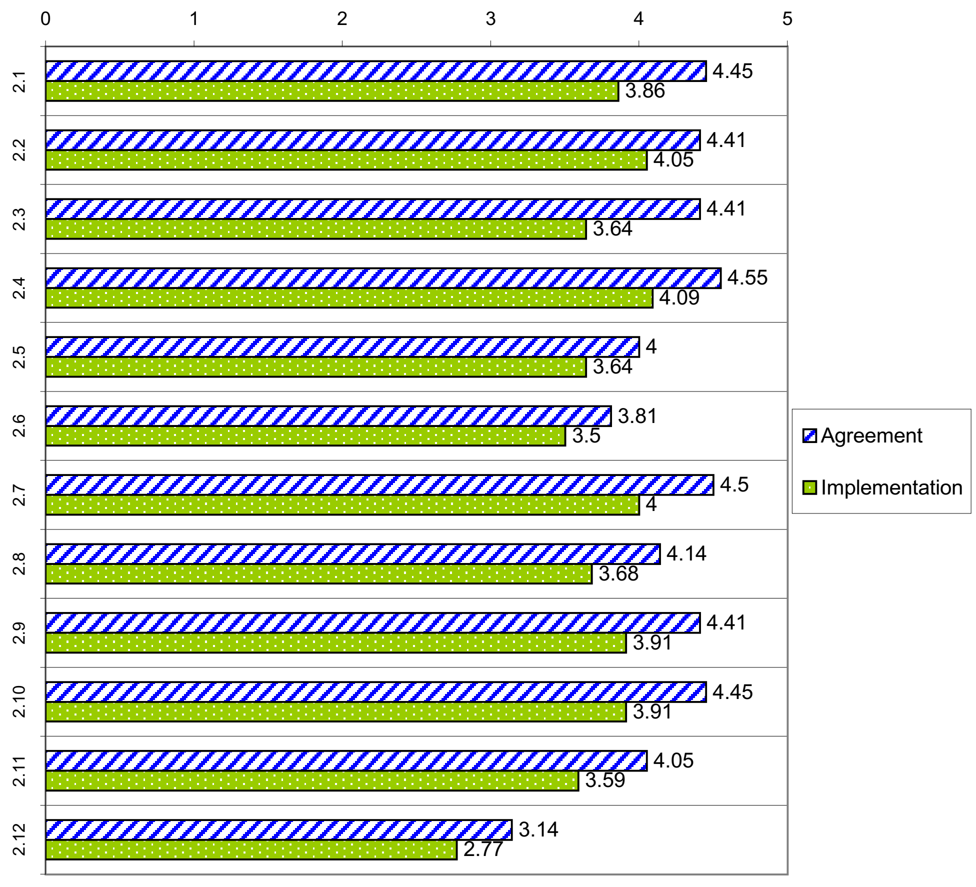

Figure 5.2: AAL and AIL for the design planning concepts

It is also obvious that the local consultants highly agree that the design plan should be coordinated with the client. However, their implementation degree in this point is lower than expected. This seems strange since the local clients frequently impose the time schedule of the design assignments. It is possible that those consultants who stated that they are not used to coordinate the design time plan with clients, it is possible that either they work mainly with private sector clients, or they deliver the work late.

3 leading in the design process

Figure 5.3 depicts AAL and AIL for the concepts introduced in this part of the questionnaire. It is noted that the AAL ranges between 3.50 (for Q 3.8) and 4.55 (for Q 3.10). The AIL ranges between 3.18 (for Q 3.9) and 4.09 (for Q 3.1). The results show that the local consultants agree upon and implement the concepts introduced in this part of the questionnaire. In general, the AIL is consistently a little bit lower than the AAL.

Association test

The statistical X^2 (chi-square) test is used to measure the association between the degree of agreement and implementation of the concepts related to the leading function in the design process. The crammer's V association factor is around 0.5 in most of the questions. This means intermediate association between the beliefs and actions of the local consultants in most of the leading function concepts.

The association factors of Questions 3.1 and 3.2 (related to periodic meetings) are low, about 0.2, which reflects weak association between the beliefs and actions of local consultants regarding the periodic meetings. It seems that they do not hold periodic meetings despite that they recognize its importance to the design success.

Also for question 3.8 and 3.9, regarding the training in technical and administrative fields, the association factors are about 0.3. This again reflects weak association between the beliefs and actions of the local consultants in these fields.

Overall evaluation of this part, related to the leading function in design process, points out that the local consultants have a good theoretical understanding of the leading function in design management. However, there is a gap between their beliefs and actions. This gap needs to be bridged by allocating more efforts and resources.

3. Leading in the design process	
Q 3.1	Regular meetings are necessary for successful design process.
Q 3.2	Regular meetings contributes to common understanding among. the design team
Q 3.3	The first meeting (kick-off meeting) is necessary for successful design.
Q 3.4	The design team may be motivated when the firm adopts policies that offer comfortable work environment.
Q 3.5	The design team may be motivated when the firm adopts policies that improve the employees salaries.
Q 3.6	The employees' job satisfaction leads to finish the work in short time.
Q 3.7	The employees' job satisfaction leads to produce high quality work.
Q 3.8	The employees in the design firm need training in the technical field.
Q 3.9	The employees' in the design firm need training in the administrative field.
Q 3.10	The employees in the design firm needs training in computer skills.
Q 3.11	The employees in the design firm needs training in using the English language.

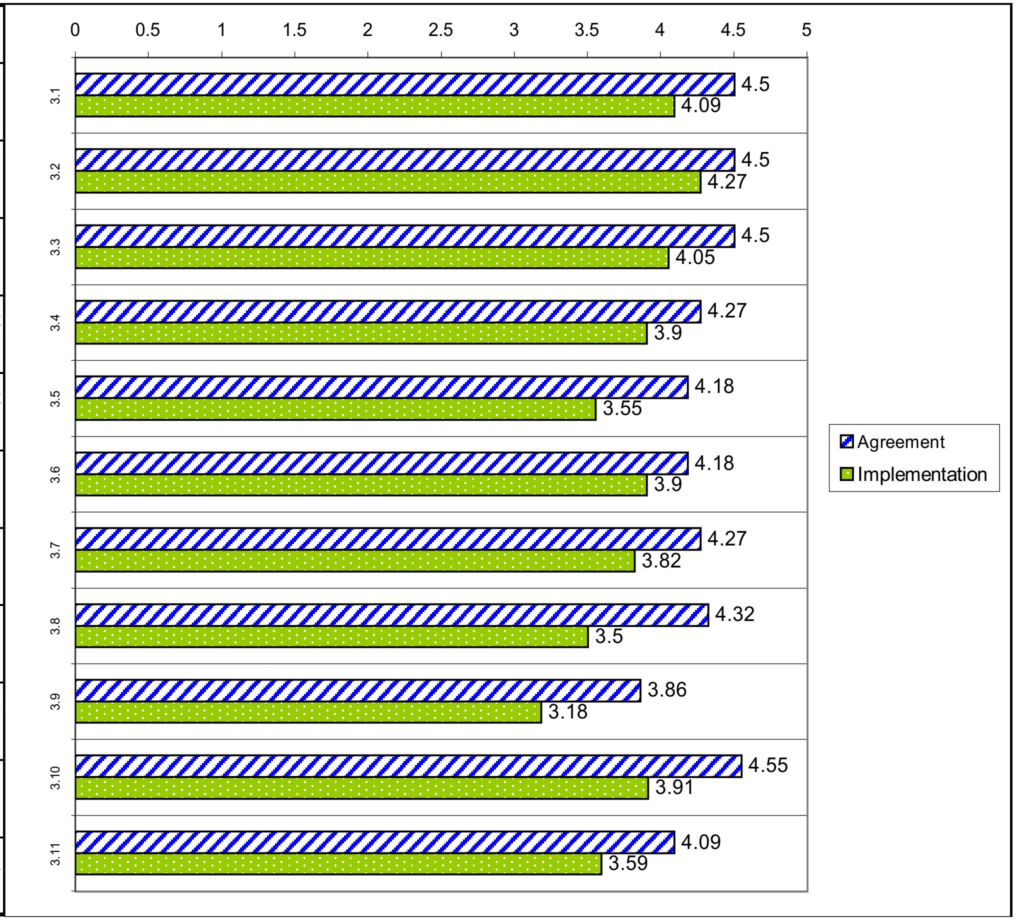

Figure 5.3: AAL and AIL for design leading concepts

Results also indicate that the local consultants highly agree, in average, that the kick-off meeting and periodic meetings have an important role in the design process success. This reflects good understanding of the nature of the design process. Furthermore, this emphasizes the role of periodic meetings as a tool of communication and forming a common basis of understanding among the design team members.

As for motivating as part of the leading function in design management, the local consultants are asked to express their opinion about two methods of motivation:

- Improving the work environment.
- Improving the employees' salaries.

The results indicate that local consultants agree with and implement both methods to motivate their employees. The salary improvement has a lower AIL (3.55) than the improvement of the work environment AIL (3.9).

The local consultants agree that job satisfaction may lead to finishing the work on time and/or to producing a high quality work. Regarding implementation, the job satisfaction of the employees in the local consulting offices/firms often leads to early finish and/or high design quality.

Regarding staff training, local consultants think that the most important training need is the training in computer skills, then comes the need of technical training. The training in English Language skills comes third and the need of administrative training is ranked as the last one. Actually, the local consultants offer training opportunities mainly in computer skills, then comes the English Language skills training, the technical training and finally the administrative training. It is also noted that the AAL and AIL of the above mentioned training needs are nearly close. This is consistent with the requirements of the design process which needs all these types of training. Nowadays, the computer is an essential tool for design calculations and drawings production. The English language is commonly used in engineering and scientific fields, so training in the English language skills is necessary for the design activities. Technical training is important to update the knowledge of the design team in the technical issues. The administrative training is needed, as well, since the design management requires supplementing the technical skills of the design manager with administrative skills.

4. The objectives of the engineering design practice

The objectives of Practicing consulting services in the engineering design may be one or more of the followings:

- To achieve income and profit.
- To produce high quality work.
- To get a bigger market share.
- To acquire new knowledge and expertise.

In this part of the questionnaire, the local consultants are asked about their aims of practicing the engineering design. Figure 5.4 depicts the AAL and AIL for every expected objective of practicing the job in engineering design.

The objectives of practice, according to the opinion of he local consultants are ranked as follows:

1- To produce high quality work (AAL is 4.6).
2- To get bigger market share, to acquire new knowledge (both with AAL of 4.3) and;
3- To achieve income and profit (AAL is 3.7).

The same order is noted regarding the level of implementation. The local consultants mainly aim at producing high quality works (AIL is 4.2). Then comes getting bigger market share and acquiring new knowledge (AIL in both is 4). The last target is the achievement of income and profit (AIL is 3.5).

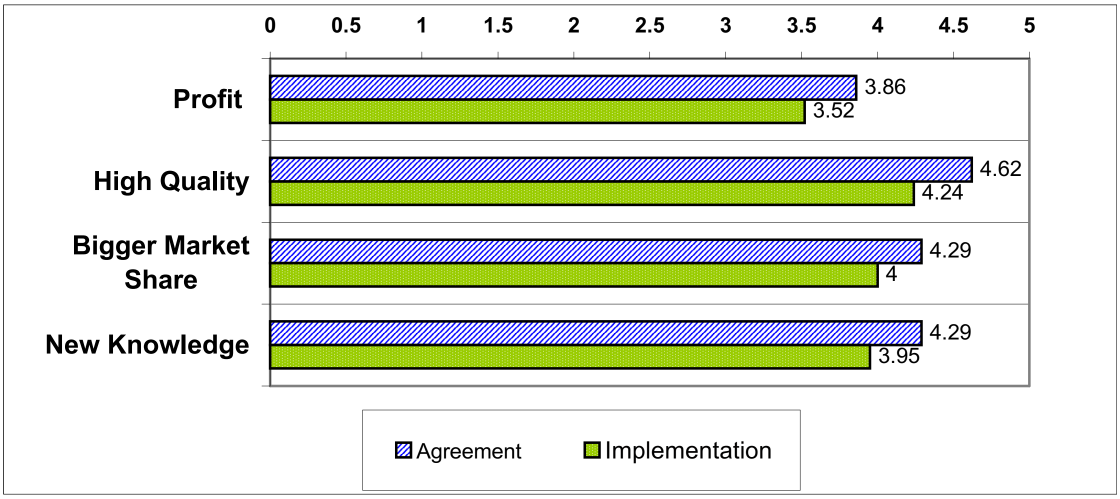

FIGURE 5.4: AAL & AIL FOR THE AIMS OF PRACTICE

Association test

The Crammer's V association factor is computed for each of the above mentioned practice objectives. The level of association is quite strong in the "achievement of profit" and the "acquiring of new knowledge" (the factor is about 0.8). This means that the actions of the local consultants, in these objectives, are consistent to their beliefs. Whilst, the association factor of both the "high quality work" and "getting bigger market share" is about 0.5. This reflects intermediate association between beliefs and actions of the local consultants in these two fields.

5- Design quality

In this part of the questionnaire, the local consultants are asked to state their opinions regarding the design quality indicators and how they achieve good designs.

As depicted in Figure 5.5 the local consultants agree that the good design is that design which.

1- Provides all information for construction (AAL 4.8).
2- Has no contradictions (AAL 4.6)
3- Has no errors (AAL 4.2).
4- Finished on time (AAL 3.5).

Actually, the local consultants achieve good design by:

1- Providing all information required to construction (AIL 4.3).
2- Eliminating all contradictions (AIL 4.2).
3- Eliminating errors (AIL 3.9).
4- Finishing the work on time (AIL 3.55).

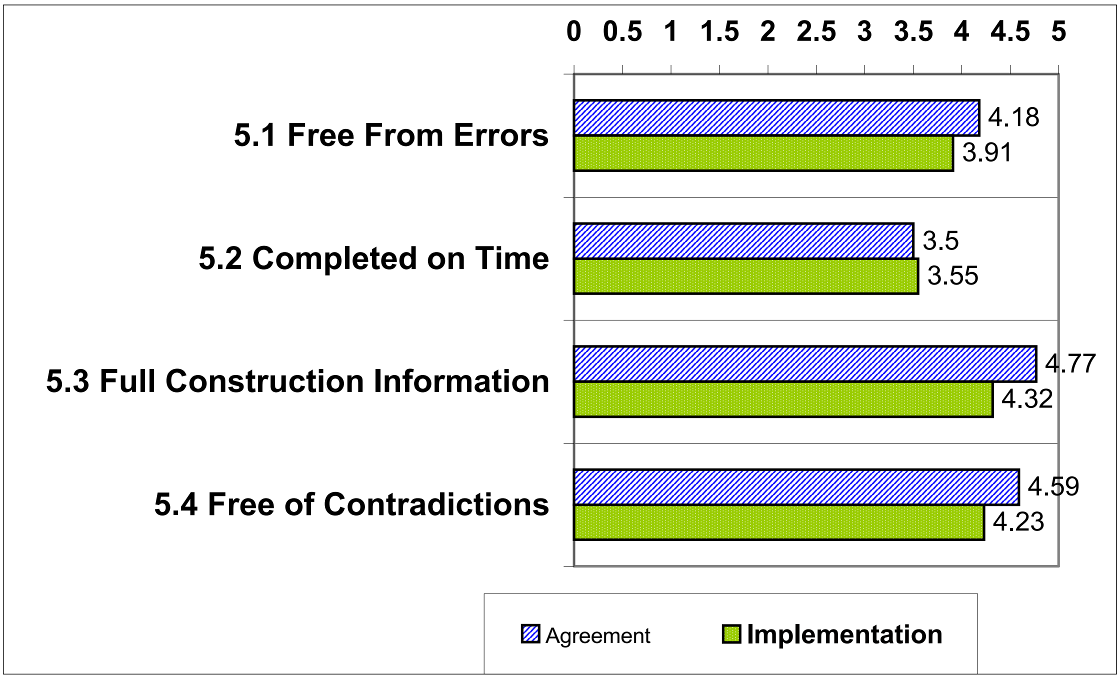

FIGURE 5.5 : AAL & AIL FOR DESIGN QUALITY

It is noted that the above mentioned opinions of the local consultants coincide with the worldwide trends where the presentation of all the information required to construction is the main aim of the design process (Tilly et. al., 1997). The design quality is mainly measured by the degree of success in fulfilling this aim.

It is noteworthy, in question 5.2, that the implementation average level is more than agreement average level. It is possible that the local consultants do their best to finish the work on time to satisfy the client despite that they think it is not the most important factor in the design quality.

Association test

The association factors for question 5.1 “free from errors” and question 5.4 “free of contradictions” are around 0.8. This reflects strong association between the beliefs and practice of the local consultants regarding these two points. On the other hand, the association factors for question 5.3 “provides all information for construction” and question 5.2 “completed on time” are around 0.5. This shows an intermediate association between the beliefs and practice of the local consultants regarding these two points. The most important design quality factor, which is in question 5.3 “provides all information for constructions”, has an intermediate association between beliefs and practice. Consequently, it is recommended to exert more efforts and allocate more resources to bridge this gap between the local consultants beliefs and practice regarding this important concept.

6. Tendering for consulting services and fees estimation

In this part of the questionnaire, issues related to tendering for consulting services and the estimation of consulting fees are investigated. The following is a summary of the responses of the surveyed local consultants:

- **Method of getting the design assignments (Q 6.1)**

  As depicted in Figure 5.6, almost two thirds of the local consultants always/often get the design assignments through two envelop competitive tenders, where the selection is based on both technical and financial (fees) evaluation. This method is common worldwide and the World Bank and other donors stipulate this method in the projects they fund in Palestine.

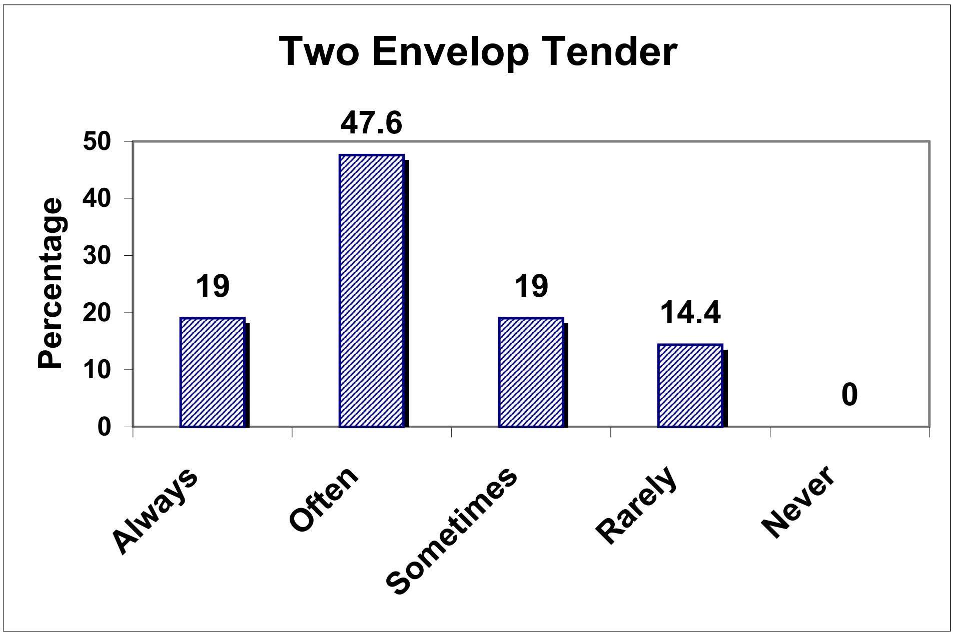

FIGURE 5.6: FREQUENCIES OF TWO ENVELOP COMPETITIVE TENDER

- **Using computer in fees estimating (Q 6.2)**

  Figure 5.7 indicates that about one third of the surveyed local consultants always/often use computer in fees estimating. About half of them rarely/sometimes use it and about 10% do not use it at all.

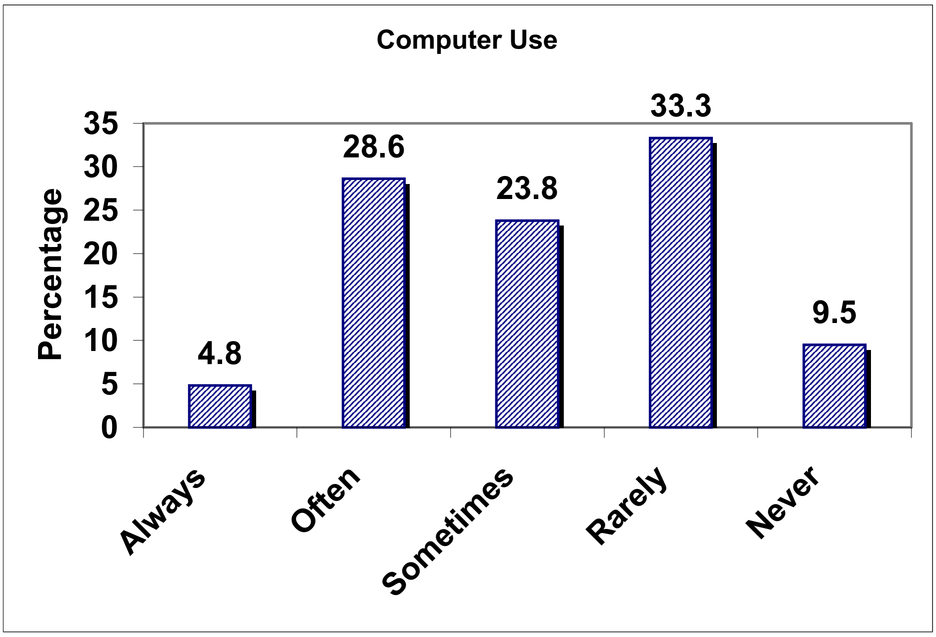

FIGURE 5.7: FREQUENCIES OF THE USE OF COMPUTER IN FEES ESTIMATING

Interviewed consultants state that they expect an increase in using computer in fees estimating in case that computer based decision making tools become more available.

- **Bidding strategies (Q 6.3a and b)**

  Figure 5.8 depicts the responses of the surveyed local consultants regarding the strategy they adopt in bidding for design assignments. They are asked to state how often they aim at getting high technical scores (which usually requires high fees), and on the opposite, how often they aim at lowering the price in order to get the work. It is noted that about two thirds of the surveyed consultants always/often aim at getting high technical score, whilst about one third of them often aim at lowering the price.

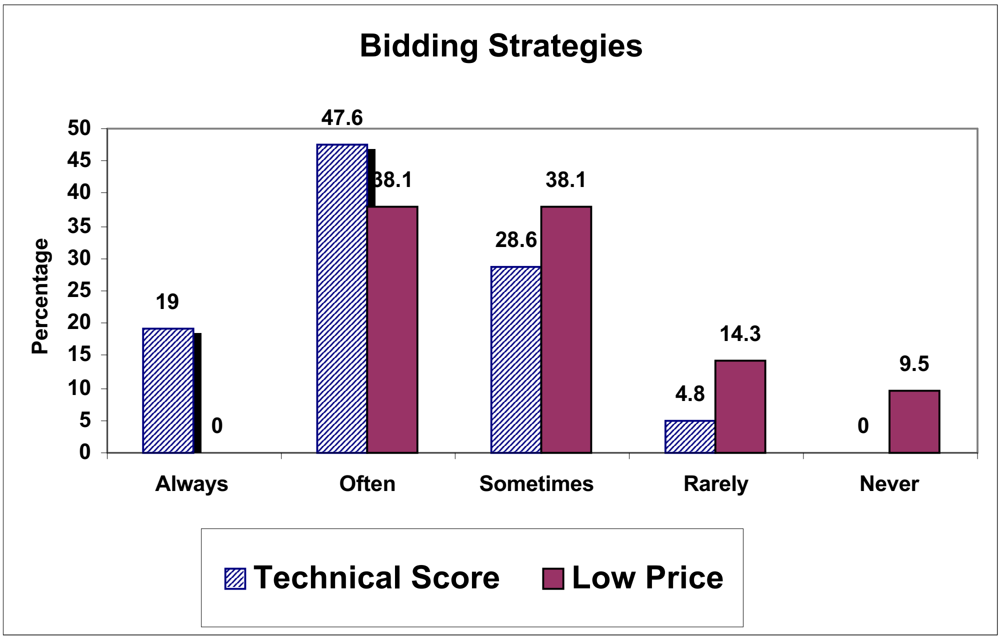

FIGURE 5.8: FREQUENCIES OF THE BIDDING STRATEGIES

- **Cost record keeping (Q 6.4)**

  As depicted in Figure 5.9, about 70% of the surveyed consultants always/often keep records of the actual cost of design assignments. This "cost history" is supposed to form a basis for cost estimation of new projects. Furthermore, it is a supportive tool that helps to prepare reasonable estimates with acceptable accuracy for additional works.

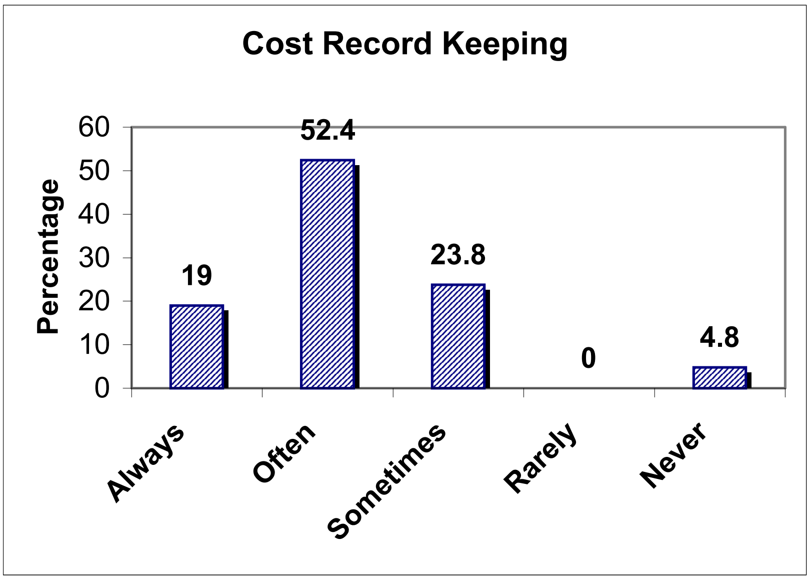

FIGURE 5.9: FREQUENCIES OF COST RECORD KEEPING

- **Effect of the client on fees estimating (Q 6.5)**

  As indicated in the Figure 5.10 most of the surveyed local consultants (about 70%) always/often consider the client behavior and attitude when estimating the fees of design assignments. The researcher believes that the type of the client has a great effect on adopting a bidding strategy, whether to aim for high technical score or to submit a lower price.

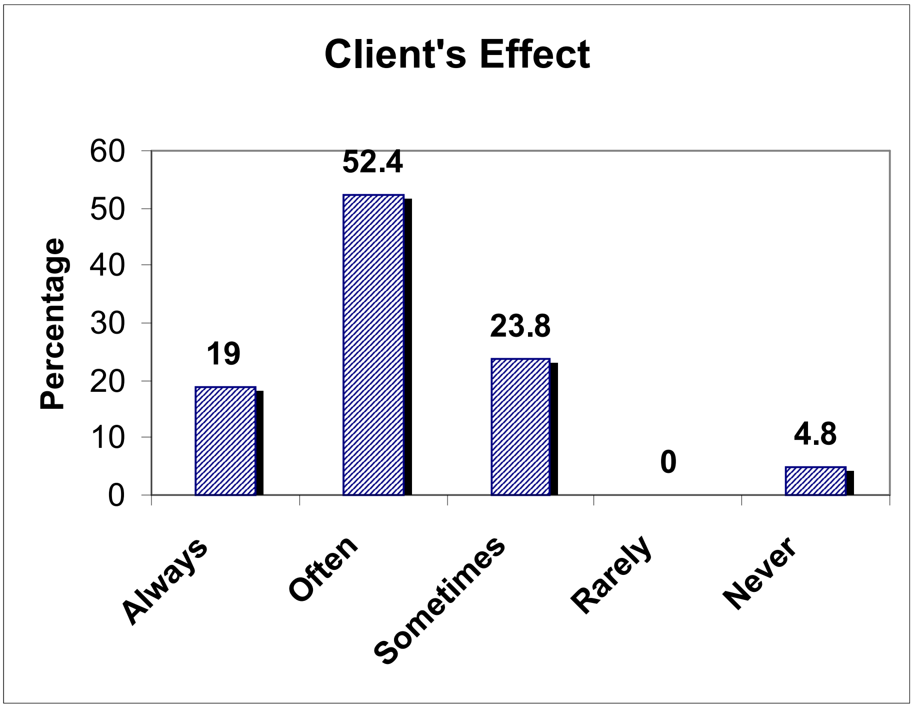

FIGURE 5.10: CLIENT'S EFFECT FREQUENCIES

- **Effect of the volume of work in hand on fees estimating (Q 6.6)**

  About half of the surveyed consultants always/often consider the works in hand when estimating the fees of a new project (Figure 5.11). About 30% of them sometimes do that.

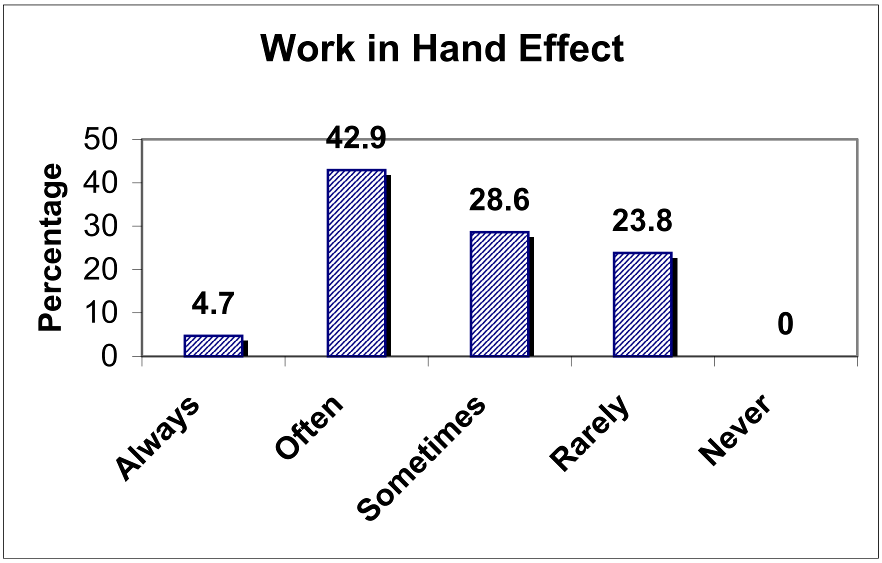

FIGURE 5.11: WORK IN HAND EFFECT FREQUENCIES

Work in hand and the availability of work has a great effect on fees estimating. In general, if there are few work opportunities, the consultants tend to lower the design fees, Drew et. al., (2002) quoted the comment of Seeley (1997) that in 1990-1995 UK recession many consultants were charging fees at 50% or less of the scale fee in cut throat competition in order to secure work.

- **Percentage of the employees salaries to the total expenses (Q 6.7)**

  In the consulting works, the main cost item is the employees salaries. Table 5.7 shows the frequencies of each percentage according to the responses of the local consultants.

Table 5.7: Share of the employees' salaries frequencies

Percentage	Frequency	Cumulative percent
< 40%	3 (14.3%)	14.3%
40% -	6 (28.6%)	42.9%
60% -	11 (52.4%)	95.2%
> 80%	1 (4.8%)	100%
Total	**21* (100%)**	

* one consultant didn't answer this question.

It is noted that about 60% of the surveyed consultants state that the employees salaries constitute at least 60% of the total expenses. This percentage is consistent with worldwide trends where employees' salaries may reach two thirds of the total expenses (Rutter and Martin, 1990).

- **Method of fees estimating (Q 6.8)**

In this part of the questionnaire the consultants are asked to state how often they use a certain method in fees estimating. The answers are given a five level scale (always (5), often (4), sometimes (3), rarely (2) and never (1)). The average levels (AL) of the methods indicated in the questionnaire are as follows

- Percentage of the total construction cost (AL 2.7)
- A lump sum (AL 4)
- The Association of Engineers scale of rates (AL 2.7)
- Salary cost times a multiplier (AL 2.4)
- Detailed cost calculations (AL 2.9)

From the above mentioned AL and from Figure 5.15 the most frequently used method of calculating the design fees is an agreed lump sum according to the project nature. About 80% of the surveyed consultants always/often use the lump sum method, and all of them use it at least sometimes. About 25% of the surveyed consultants always/often use the detailed method of fees calculation, while 14% never use this method. Also, 14% never use the Association of Engineers scale of rates, whilst about 23% of the consultants never use the cost multiplier method.

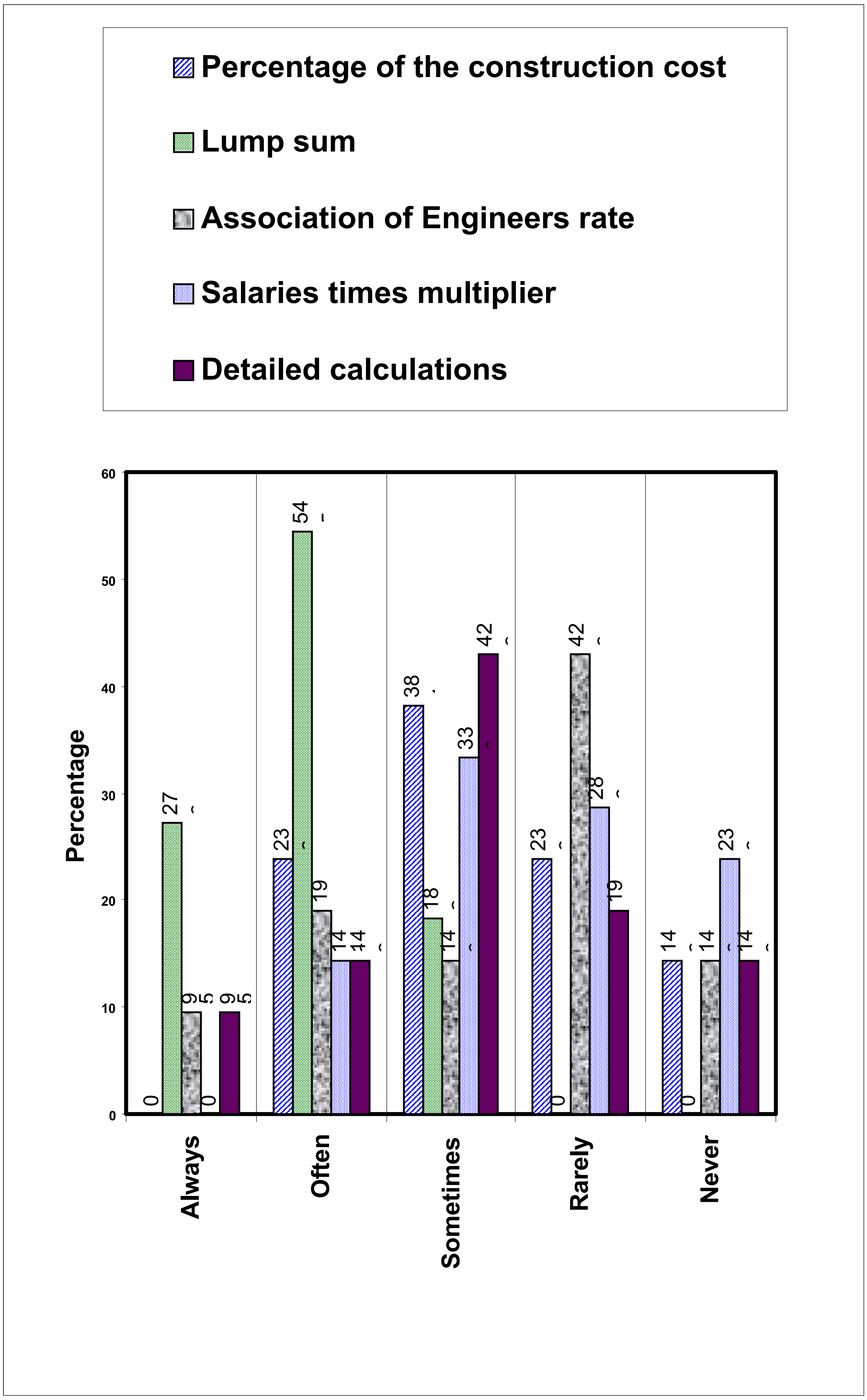

FIGURE 5.12: FREQUENCIES OF THE METHODS OF FEES CALCULATION

- **Amount of social allowances and project overheads (Q 6.9)**

  Table 5.8 depicts frequencies of the social allowances and project overheads expressed as a percentage to the basic employee's salary.

Table 5.8: Frequencies of social allowances and project overhead

Percentage	Social allowances		Project overhead	
	Frequency	Cumulative	Frequency	Cumulative
< 10%	8(40%)	40%	6(27.3%)	27.3%
10% -	8(40%)	80%	11(50%)	77.3%
20% -	3(15%)	95%	3(13.6%)	90.9%
30%-	1(5%)	100%	1(4.5%)	95.5%
40%-	0		0	95.5%
50%-	0		1(4.5%)	100%
60%-	0		0	
> 60%				
Total	**20*(100%)**		**22 (100%)**	

* Two consultants didn't answer.

It is noted that 80% of the surveyed consultants add to the basic salary less than 20% as social allowances. This figure seems a little bit small when compared to the practice in US and Europe, where the social allowances may reach about 50% of the basic salary and even more. It is possible that the local consultants, driven by the sever competition, underestimate the actual salary costs of their employees

As for the project overhead, also about 80% of the surveyed consultants add to the basic salary less than 20% of the staff salaries as project overhead costs. These costs, as explained in Chapter 3, account for the parts of salaries of the administrative and supportive staff who are involved in more than one project. The figures stated by the surveyed consultants for the project overhead costs seem to be reasonable. The supportive staff is frequently less than 20% of the main staff involved in the design projects.

- **Company overhead, risk and profit (Q 6.10)**

In this question, the consultants are asked to state the amount of the company overhead, risk, and profit as a percentage of the direct costs. Table 5.9 depicts the frequencies of the above mentioned items.

Table 5.9: Frequencies of general overhead, risk, & profit

%	General Overhead		Risk		Profit	
	Freq.	**Cum. %**	**Freq.**	**Cum. %**	**Freq.**	**Cum%**
< 5%	1(4.8%)	4.8%	9(42.9%)	42.9%	1(4.8%)	4.8%
5% -	5(23.8%)	28.6%	5(23.8%)	66.7%	7(33.3%)	38.1%
10% -	8(38.1%)	66.7%	3(14.3%)	81%	6(27.3%)	66.7%
15%-	2(9.5%)	76.2%	3(14.3%)	95.2%	4(19%)	85.7%
20%-	2(9.5%)	85.7%	1(4.8%)	100%	3(14.3%)	100%
25%-	0	85.7%				
> 30%	3(14.3%)	100%				
Total	**21*(100%)**		**21*(100%)**		**21*(100%)**	

* Note : "one consultant didn't answer this question"

In general, the figures stated by the surveyed consultants are reasonable. About two thirds of the surveyed consultants add the following as a percentage of the direct cost:

- General overhead: 10 to 15%.
- Risk: 5 to 10%.
- Profit: 10 to 15%.

- **Amounts and reasons of time overruns : (Q 6.11 a and b)**

In this part of the questionnaire, the consultants are asked to state the amount of the delays (time overruns) in the design projects and the party who is responsible for these delays. The frequency of each delay amount is measured in a nominal scale of five levels (Always (5), often (4), sometimes (3) rarely (2), never (1)). The average level (AL) of delay amounts as a percentages to the original design period are depicted in Table 5.9.

Table 5.10: AL and frequencies of time overruns

Delay Percentage	% Always	% Often	% Sometimes	% Rarely	% Never	AL
< 25%	25	25	35	5	10	3.5
25%-	0	5	42	37	16	2.4
50%-	0	0	16	47	36	1.8
75%-	0	0	0	47	52	1.5
100%-	0	0	0	21	79	1.2
125%-	0	0	0	16	84	1.2
150%-	0	0	0	16	84	1.2
175%-	0	0	0	16	84	1.2
> 200%	0	0	0	21	79	1.2

It is noted that the delay is often/sometimes occurs with a value less than 25% of the original design period. A delay of 25% to 49% sometimes/rarely occurs. Delays more than 50% rarely occur.

As for the causes of delay, the consultants are asked to choose a party who is responsible for the delay according to a nominal scale of five levels (similar to the scale described in the delays amount). The average (AL) of responsibility for each delay cause is depicted in Table 5.10.

Table 5.11: AL and frequencies of overruns responsibility

Delay Percentage	% Always	% often	% Sometimes	% Rarely	% Never	AL
Consultant's responsibility	0	0	59	32	9	2.5
Owner's responsibility	18	32	50	0	0	3.68
Other causes	5	50	23	22	0	3.37
Joint, consultant more	0	5	32	45	18	2.23
Joint, owner more.	18	42	18	13	9	3.45
Joint, others more	18	27	32	18	5	3.36

It is noted that the surveyed consultants think that the owner is often/sometimes responsible for time overruns. Even if the responsibility is joint, they think that the owner's responsibility is often/sometimes more than the other parties' responsibility.
Chang (2002) state that actual observations of four completed design projects in US, showed that the owner is responsible for about 44% of the time overruns whilst about 50% of the time overruns are contributed by reasons beyond the control of both the owner and the consultant. These figures provided by Chang are somehow similar to the results of this survey. It is to be noted that this survey introduces the viewpoint of the consultants only.

5.3 Analysis of archival data

The bid evaluation results of 44 consulting tenders are collected using the previously mentioned "project survey card" (Chapter 4, Figure 4.2) . The survey covers tenders for consulting services in the last six years, starting from 1997 until 2003. The surveyed projects include different consulting works such as: building and infrastructure design, construction supervision, and technical auditing.
The total scores of the winning consultants are calculated and their frequency distribution is identified. When possible, the minimum man-month rates are calculated and their trend along the time is identified.
Study of the survey cards shows that in all the surveyed projects the selection of consultants is made according to the World Bank guidelines previously stated in Chapter 3 of this thesis. First the technical proposals are evaluated and each consultant is given a technical score (St). The consultants have to get a minimum technical score in order to pass the technical evaluation. In most of the surveyed projects the minimum passing technical score is 70%. After finishing the technical evaluation, the financial proposals, of the consultants who have passed the technical evaluation, are opened and their financial scores (Sf) are calculated. The total score is then calculated using the following formula:

Total score S = St * T % + Sf * F % .

Where T and F are technical and financial weights respectively. (T+ F = 100%)

The consultant who achieves the highest total score is considered as the winner of the tender and is invited for contract negotiations with the client.

In the surveyed projects T has the following values 70%, 75%, and 80% with more tendency to the value of 80%. Consequently, F has the values of 30%, 25%, and 20% with more tendency to the value of 20%.

The calculated total winning scores ranged between 79.2% and 96.5%. The frequencies of the total winning scores are depicted in Table 5.11 .

The cumulative frequencies are used as an input in the Fees Estimation Model (FEM). It indicates the probability of winning the tender when getting a certain total score. For example, if the total score reaches 85% the probability of winning the tender is about 43%, while if the total score reaches 90% the probability of winning the tender is about 77%.

Table 5.12: Total scores frequencies

Total Score %	Frequency	Cumulative	Cumulative Percent
79 -	2	2	4.55%
80 -	0	2	4.55%
81 -	2	4	9.09%
82 -	1	5	11.36%
83 -	7	12	27.27%
84 -	4	16	36.36%
85 -	3	19	43.18%
86 -	3	22	50.00%
87 -	3	25	56.82%
88 -	2	27	61.36%
89 -	6	33	75.00%
90 -	1	34	77.27%
91 -	1	35	79.55%
92 -	3	38	86.36%
93 -	4	42	95.45%
94 -	0	42	95.45%
95 -	1	43	97.73%
96 -	1	44	100.00%
97 -	0	44	100.00%
Total	**44**		

In most the surveyed projects the total staff man-months are indicated in the tender documents. The minimum man-month rate is calculated by dividing the minimum price by the total man-months. Figure 5.13 indicates the trend of the man month rates in the surveyed projects for the years 1997 to 2003.

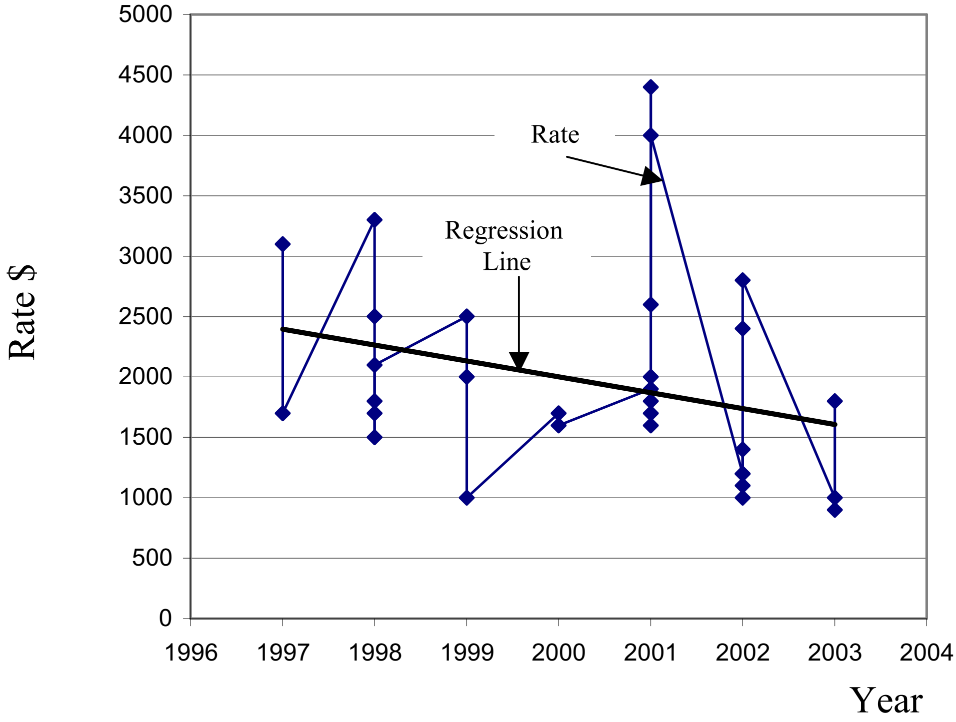

FIGURE 5.13: MAN/MONTH RATES TREND.

As depicted in Figure 5.13 the man-month rates range between \$900 and \$4500. The regression line is descending which means that the consultants are tending to lower their prices in the recent years. This may be justified by the current unstable situation and the sever competition to get the few available works.

CHAPTER 6
Modeling The Local Design Process

6.1 Introduction

This chapter introduces a model that fits the local practice in the design management. This model is derived mainly from the field survey questionnaire results and the researcher's experience, in addition to the literature review. Researches of particular help in this context are the researches of Formoso and Tzortzopoulos (1998 and 2002)

The model is intended to cover all the aspects of the design process management. It includes the following:

1- The main parties involved in the design process, namely the client, the funding agency (the donor) and the design consultant.
2- Organizational set up of the design team.
3- The stages of the design process.
4- The inputs and outputs of the design process.
5- Key issues in the design management.

6.2 Methodology of modeling the design process

Three main tools are used in the model presentation. The first is "organizational charts" which indicate the parties involved in the design process and the organizational structure of the design team. The second is a flow chart which represents graphically the process, including dividing it into sub processes (stages) and making explicit precedence relationships. The third tool is the input-output table. It describes the stages presented in the flow chart by explaining the inputs and outputs of each stage

6.3 Parties involved in the design process

The main parties involved in the design process are the client (the owner of the project), the design consultant and the funding agency if any. These parties are often supported by other parties such as: the local authorities' engineers, professional associations such as the Association of Engineers, and sub consultants who offer special types of work, as surveying and soil investigation services.

In the last years, the funding agencies and donors play a major role in the local design process. These funding agencies, such as the World Bank, The Islamic Development Bank and others, have their own rules and guidelines regarding the procurement and execution of consulting services. These rules and guidelines include standard documents for each stage of the consulting services starting from guidelines for selection and evaluation of consulting offers until the standard form of contract between the client and the consultant. Figure 6.1 depicts the main parties involved in the design process in the local practice.

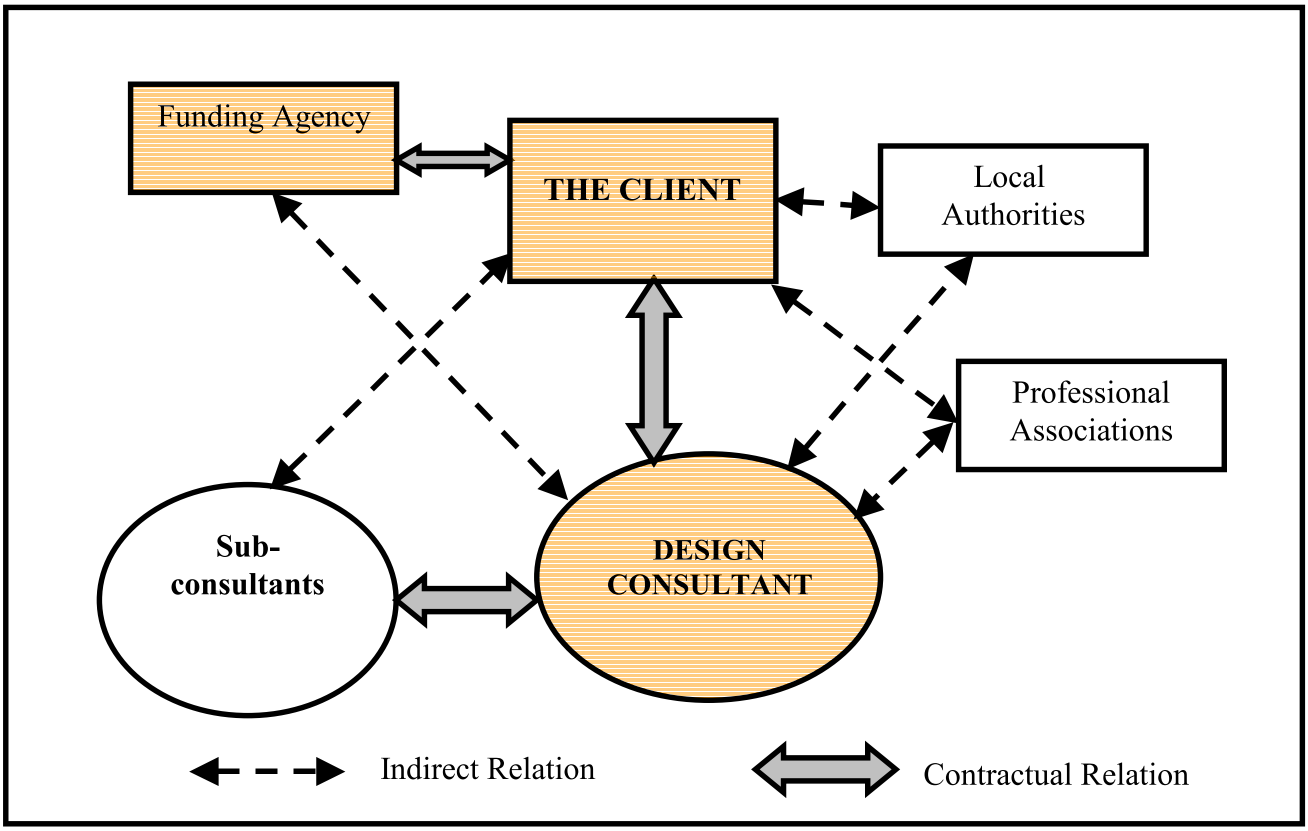

FIGURE 6.1: PARTIES INVOLVED IN THE DESIGN PROCESS

6.4 Design team organization

Every design office/firm usually has a permanent staff who carries out the different design assignments. The design staff is frequently composed of the project manager or "team leader", engineers from the different disciplines, technicians and supporting administrative staff. The proposed organizational structure for the design offices/firms is the matrix organizational structure where emphasis is on the project. As depicted in Figure 6.2, a horizontal line on the matrix defines each project. Issues related to technical expertise are addressed vertically while issues related to the project are addressed horizontally. The project manger is responsible for overall project coordination, interfacing of disciplines, relations with the client, and monitoring of overall project costs and schedules. The various design departments are responsible for providing technical expertise, quality performance, and the cost and schedule for their particular part of the project.

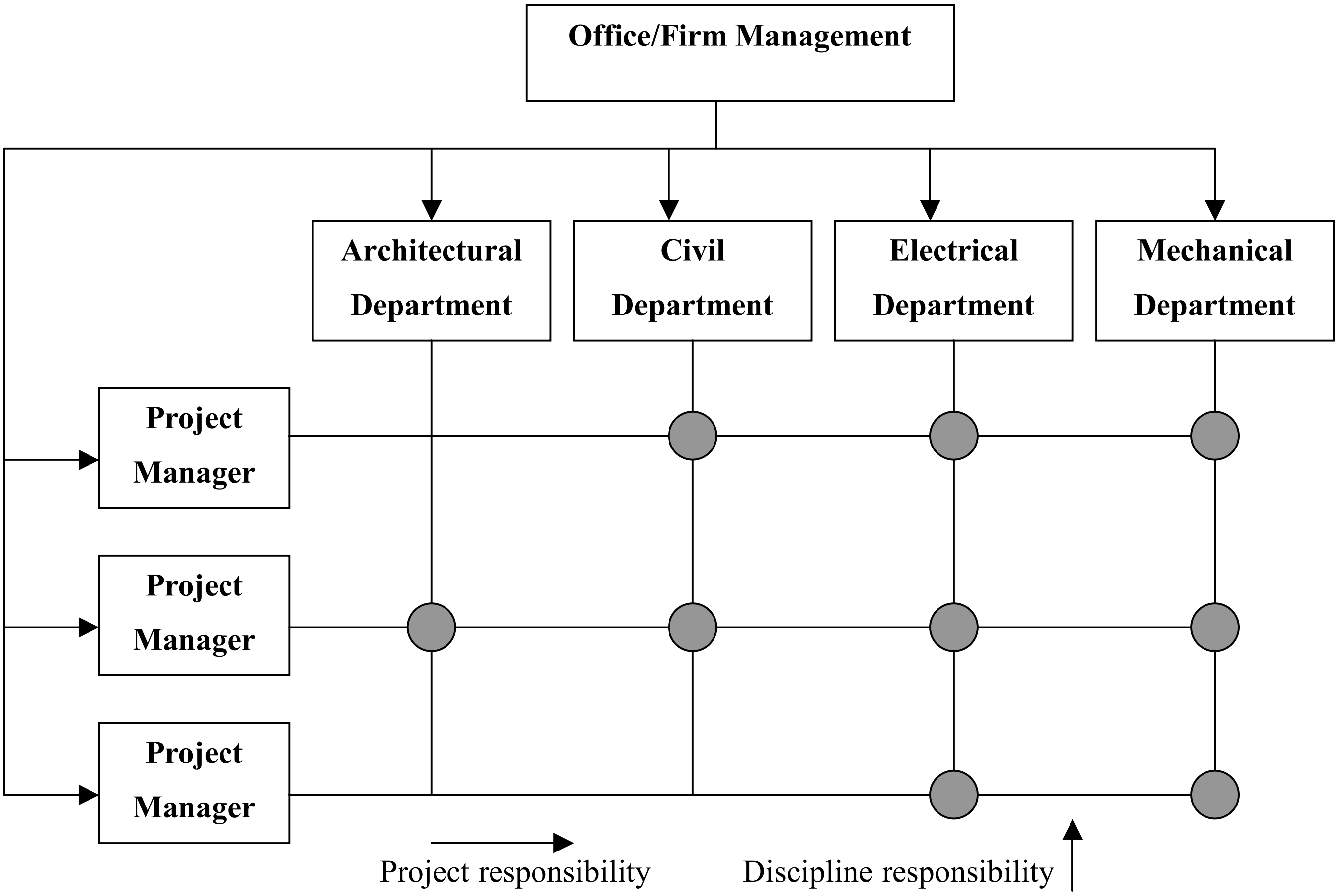

FIGURE 6.2: MATRIX ORGANIZATIONAL CHART FOR DESIGN OFFICES/FIRMS

The matrix organization is preferred as it combines two major benefits. The first benefit is that the design engineers are retained in the same department, so technical expertise accumulates by the time and transferred efficiently from senior designers to the junior engineers. The second benefit is to create "a project team" that is responsible for overall project coordination.

The project team organization is depicted in Figure 6.3. The project manager or the team leader is in charge of the design planning, organizing, coordination, leading and control. He is also responsible for coordination with the client and other sub-consultants involved in the project. The design manager should acquire technical qualification as well as managerial skills.

Every department is responsible for the technical aspects related to its discipline. The department may allocate a senior engineer supplemented with a junior engineer for each design project. The senior engineer is responsible for defining the design criteria and follow up, check, review and approve the design performed by the junior engineer.
Drafting technicians (CAD operators) are part of the design staff. They are responsible for producing drawing in the required format. Administrative and clerical support is also needed for documents production, communication with the client, and other logistic services.

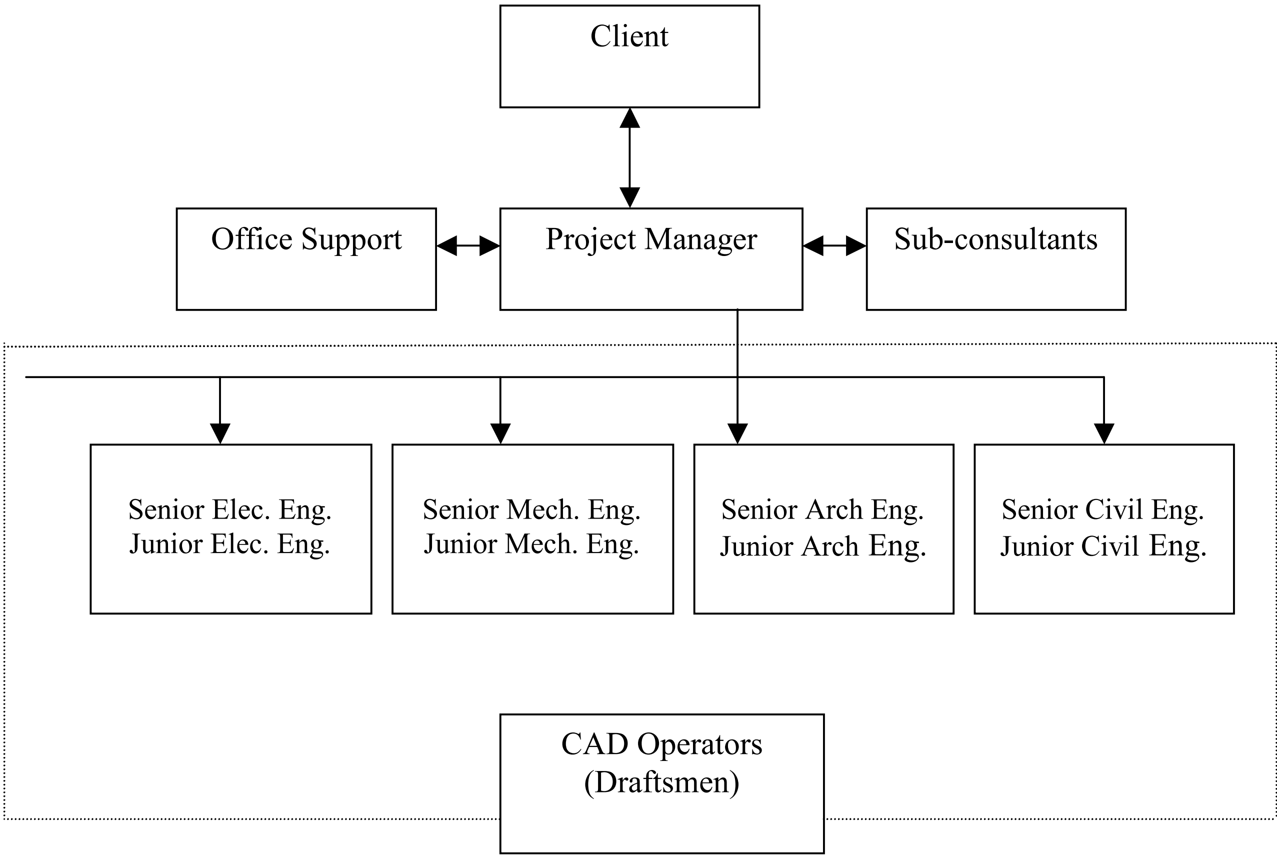

FIGURE 6.3: PROJECT TEAM ORGANIZATION

6.5 The stages of the design process

As stated in chapter 2, the design process has three main stages namely: client's brief, preliminary design and final or detailed design.

For local practice, the following are the design stages:

1- Tendering stage.
2- Data collection and establishing the design criteria.
3- Preliminary design stage.
4- Final design stage.
5- Finalization, production and final submission.

Figure 6.4 depicts the sequence of these stages and their interdependencies. These stages are divided into sub-stages or activities. The activities of each design stage are as follows:

6.5.1 Tendering Stage

The activities included in this stage are:

1- Client issues Request for Proposal (RFP) including Terms of Reference (T.O.R) which state the project requirements.
2- Consultants prepare and submit technical and financial proposals in two separate envelops. The technical proposal demonstrates the technical capabilities of the consultant and his methodology of executing the work. The financial proposal indicates the fees to be paid to the consultant in return of performing the design assignment.
3- Client evaluates the technical and financial proposals and awards the design works to the consultant who has the best combined technical and financial evaluation results.

6.5.2 Data collection and establishing design criteria

The design works start after signing the contract with the client. The consultant starts collecting and analyzing data and then establishes the design criteria. This stage includes the following activities:

1- Site topographical survey.
2- Soil investigation.
3- Collection and analysis of relevant existing reports.
4- Establishing design criteria.
5- Submission of (Inception Report).

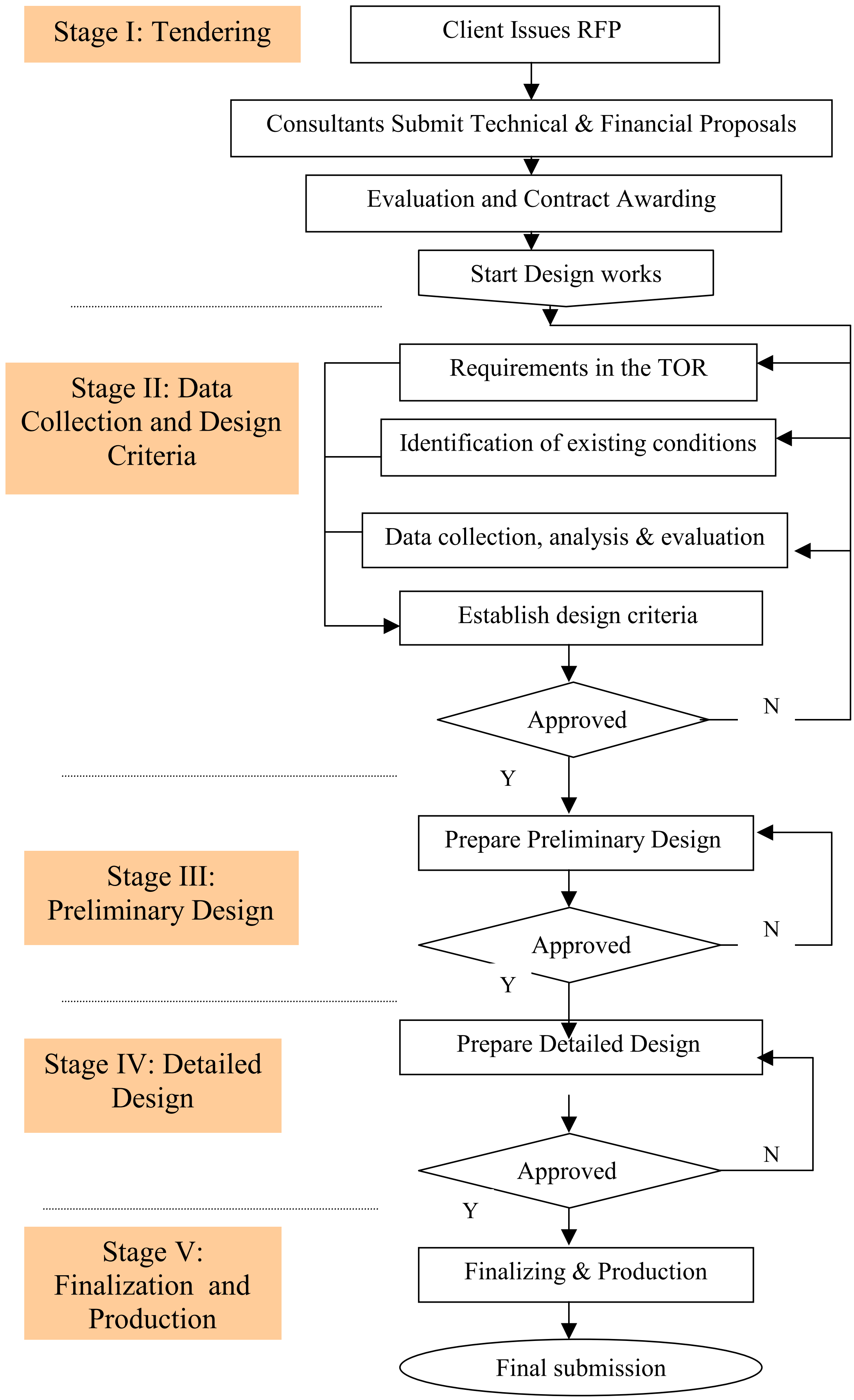

FIGURE 6.4: FLOW CHART OF THE DESIGN PROCESS

6.5.3 Preliminary design

After the client's approval of the design criteria, the preliminary design stage starts. It typically includes:

1- Architectural preliminary design.
2- Structural preliminary design.
3- Electrical preliminary design.
4- Mechanical preliminary design.
5- Design report including design calculations.

6.5.4 The detailed design stage

After the approval of the preliminary design the consultant starts the final detailed design stage. It typically includes the following activities:

1- Architectural final plans.
2- Structural final plans.
3- Electrical final plans.
4- Mechanical final plans.
5- Preparation of tender documents. (Bill of Quantities, specifications and contract conditions).
6- Preparation of draft final design report.

6.5.5 Finalization and final submission

After the approval of the final design, the consultant finalizes the plans and tender documents and produces the required number of copies of the design plans and tender documents.

This stage includes the following activities:

1- Fine touches and finalization of design plans and tender documents.
2- Printing the required copies of the design plans and tender documents.
3- Submission of final design report.

6.6 Outputs and inputs of design stages

Table 6.1 indicates the inputs and outputs of the various design stages.

Table 6.1: Design inputs and outputs.

Stage	Inputs	Outputs
Stage I: Tendering	▪ Clients statement of needs and RFP. ▪ Technical and financial proposals submitted by the consultant.	▪ Selection of the consultant. ▪ Contract signing.
Stage II: Data collection and design criteria establishments	▪ Client requirements in the T.O.R. ▪ Data collected from the site. ▪ Existing reports. ▪ Technical expertise of the consultant. ▪ Sub-consultants contribution in site investigation.	▪ Design criteria ▪ Inception Report
Stage III: Preliminary design	▪ client comments on design criteria. ▪ Technical expertise of the design team.	▪ Preliminary design plans. ▪ Preliminary design report and design calculations.
Stage IV: Detailed design	▪ clients comments on the preliminary plans. ▪ Technical expertise of the design team.	▪ Final design plans. ▪ Draft tender documents. ▪ Draft final design report.
Stage V: Finalization and production	▪ clients comments on final design plans and draft tender documents. ▪ Technical expertise of the design team.	▪ Final plans and tender documents in the required number of copies. ▪ Final design report.

6.7 Key issues in the design management

There are some key issues that should be emphasized in the design management. The importance of these issues stems from their major contribution to the success of the design process. As an output of the literature review and the field survey, the researcher thinks that the following are the key issues in the design management.

- Clear client brief and precise scope definition of the design assignment.
- Design planning in the beginning of each assignment. The design plan should be coordinated with the client.
- Work coordination among the design team members and between the consultant and the client. Coordination is achieved through periodical meetings and frequent reporting to the project manager and to the client. An important meeting that should not be neglected is the kick-off meeting.
- Diligent record keeping of the design cost.
- Tight system for design review by the consulting team. Assigning senior engineers in the design team is of good contribution in this context. Sufficient time should be allocated for such reviews when preparing the design plan.
- Evaluation of the design process in the end of each design assignment. The feedback should be considered in the new design assignments.

6.8 Model Summary

The proposed design model components and key issues are summarized in Figure 6.5.

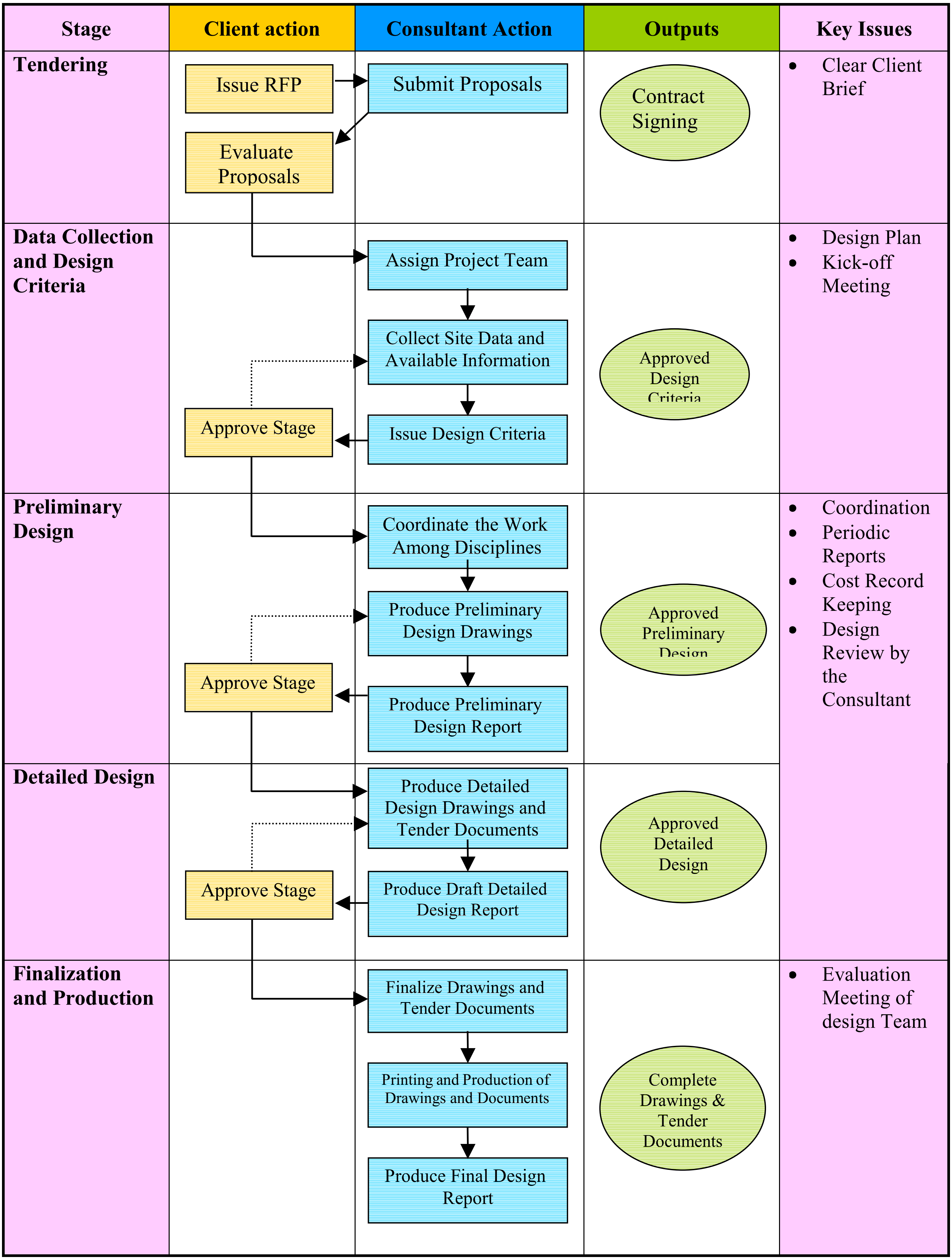

Figure 6.5: Design Model Summary

CHAPTER SEVEN

Fees Estimating Model (FEM)

7.1 Introduction

Fees estimating model (FEM) is a computer based model which serves as a decision support system (DSS) to help consultants in estimating their fees. The model utilizes Microsoft Excel spreadsheets. Monte Carlo Simulation technique and the probabilistic concepts are used, together with the expert opinion, to determine the expected fees of a certain consulting assignment. FEM's outputs are dynamic and its results are related to uncertainty levels.

In this chapter, FEM is introduced and the underlying concepts of the model are stated and discussed. A comprehensive look at the model's inputs, procedures and outputs is presented together with the model limitations. The model evaluation and verification procedure is described as well.

7.2 FEM basic concepts

FEM is based mainly on the World Bank guidelines for the evaluation of two envelop consulting tenders. As described in Chapter 3, the consultant submit two proposals: technical proposal and financial proposal. After that the client evaluates the proposals, starting by the technical proposals evaluation, and every consultant is assigned a technical score (S_t). Then, the financial proposals are opened and each consultant is assigned a financial score (S_f), calculated as follows:

$$S_f = \text{(The Minimum Financial Proposal) / (The Financial Proposal Amount)}$$

The consultant offer is finally evaluated according to the total combined score according to the following formula

$$\text{Total Score} = (S_t * T) + (S_f * F)$$, where

T= Technical weight.

F= Financial weight.

T + F= 100%

Together with the total score formula, statistical techniques and Monte Carlo simulation are used in the model. As a result of that, FEM helps to identify and minimize uncertainties. Consultants bidding in the commonly used two envelop tendering procedure are supposed to benefit from this model. Furthermore, FEM can be modified to deal with the cases where only a financial proposal is required. It helps to identify the expected cost of a specific consulting assignment corresponding to a certain level of uncertainty. Literature investigated by the researcher doesn't show any published work dealing directly with uncertainty of consulting fees. However, similar approaches have been used by others such as Sha'at (1993) and Nassar (2002) for contractors cost estimating .

FEM is designed to handle probabilistic values. Actually, almost every thing in the real life is probabilistic, but this becomes clearer in handling cost relevant functions. Monte Carlo simulation technique has been used for such purpose. It is simple to deal with and is flexible enough to accept probability distributions of any shape (Shaat, 1993).

FEM can also be perceived as a Decision Support System (DSS) designed for consultants to help them make decisions more rationally and with minimum levels of uncertainty. By utilizing the facilities available in MS Excel, FEM is made as friendly to use as possible .

It is assumed that the consulting offices have records of previous cost history for every cost item. These records are supposed to be tabulated in a cumulative frequency distributions of values with the probabilities of (0, 0.25 , 0.5, 0.75 and 1). The value of "0" probability corresponds to the value that the certain cost item would not be lower than it. The value of "1" probability corresponds to the maximum value that is not exceeded in any case.

The tender evaluation results history, mentioned in Chapter 5, is utilized in the model. It is used to determine the probability of winning the assignment when getting a certain total score.

7.3 Handling of Uncertainties within FEM

Uncertainty is common in cost estimating. By definition, estimation is an approximation or a prediction of what is going to happen. Therefore, estimation contains a significant amount of uncertainty. One of the commonly used techniques to handle such situations is the full probability distribution method based on Monte Carlo Simulation

7.3.1 Simulation

Simulation in general is conducting an experiment with a system in order to understand its behavior and to make better decisions with regard to the system. There are many kinds of simulations. One important class of simulation models is mathematical simulation. It involves modeling the key aspects of events in mathematical terms (Stevenson, 1989). A simulation model usually takes the form of set of assumptions about the operation system, expressed as a mathematical or logical relations between the objects of interest in the system. The simulation process involves running the model through time, usually on a computer, to generate samples of the measures of performance (Sha'at, 1993).

7.3.2 Monte Carlo Method

Monte Carlo method is a commonly used approach for achieving randomness. It derives its name from the similarity to games of chance such as rolling a dice or spinning a roulette wheel (Stevenson, 1989). Monte Carlo simulation seeks optimal alternatives through trial-and error process. It evaluates each alternative by generating a series of values for each random variable at the frequencies indicated by their probability distribution. The resulting quantities are combined in accordance with a mathematical model to provide a particular value for the payoff measure. After a number of repetitions, a statistical pattern of the results can be identified (Shaat, 1993).

7.3.3 Monte Carlo Simulation procedure

The following brief description of the Monte Carlo simulation procedure is summarized from Shaat (1993). It involves the following steps:

a) **Build model for objective in terms of variables:**

   The objective or objectives of the model are formulated in "*objective functions*". The objective functions contain the variables that control the objective. These variables are dealt with as random values within certain probability distributions.

b) **Obtain probability distribution for each variable:**

   These distributions are the input data in the simulation procedure. Historical data and expert opinion are utilized to determine these probability distributions.

c) **Generate random numbers**

   Random numbers are generated using the computer built-in functions. These numbers should comply with two conditions (Stevenson, 1989):

1- All numbers are equally likely
2- No pattern appears in sequences of numbers.

d) Take sample value from each probability distribution:

The generated random numbers are used to pick randomly a value from the probability distribution of each variable.

e) Calculate a value of the objective:

By repeating the previous steps (c) and (d), of generating random numbers and picking the corresponding values in the probability distributions of the various variables in the objective function, the objective value is calculated. This value is just a sample of the population of indefinite number of the possible values of the objective function.

f) Produce objective distribution:

A simulation cycle consists of the steps (c), (d) and (e). This cycle is repeated many times in order to get many possible values of the objective. These values are sorted and their cumulative probabilities are obtained in order to construct the probability distribution of the objective.

g) Make decisions

After getting the probability distribution of the objective, the decision maker can adopt one value to use in tendering. The uncertainty level of the picked value is much better defined. The guess in this case, if any, will be an educated guess.

7.4 FEM Procedures

FEM follows the previously described Monte Carlo simulation procedure. As depicted in Figure 7.1, the model starts with the insertion of cost and technical inputs. The random number generation function is used to produce random numbers (between 0 and 1) for each cost and technical elements. The corresponding values within the probability distribution of each cost and technical elements are calculated. The total expected cost is calculated as well as the total technical score. The process is repeated "n" times and the average expected cost and the average technical score are calculated using the statistical techniques.

An uncertainty level (UL), which means the probability of exceeding the total cost, is assumed and the corresponding cost and total score are calculated. Using this calculated total score the winning chance (probability to win) is determined utilizing the tender evaluation results history.

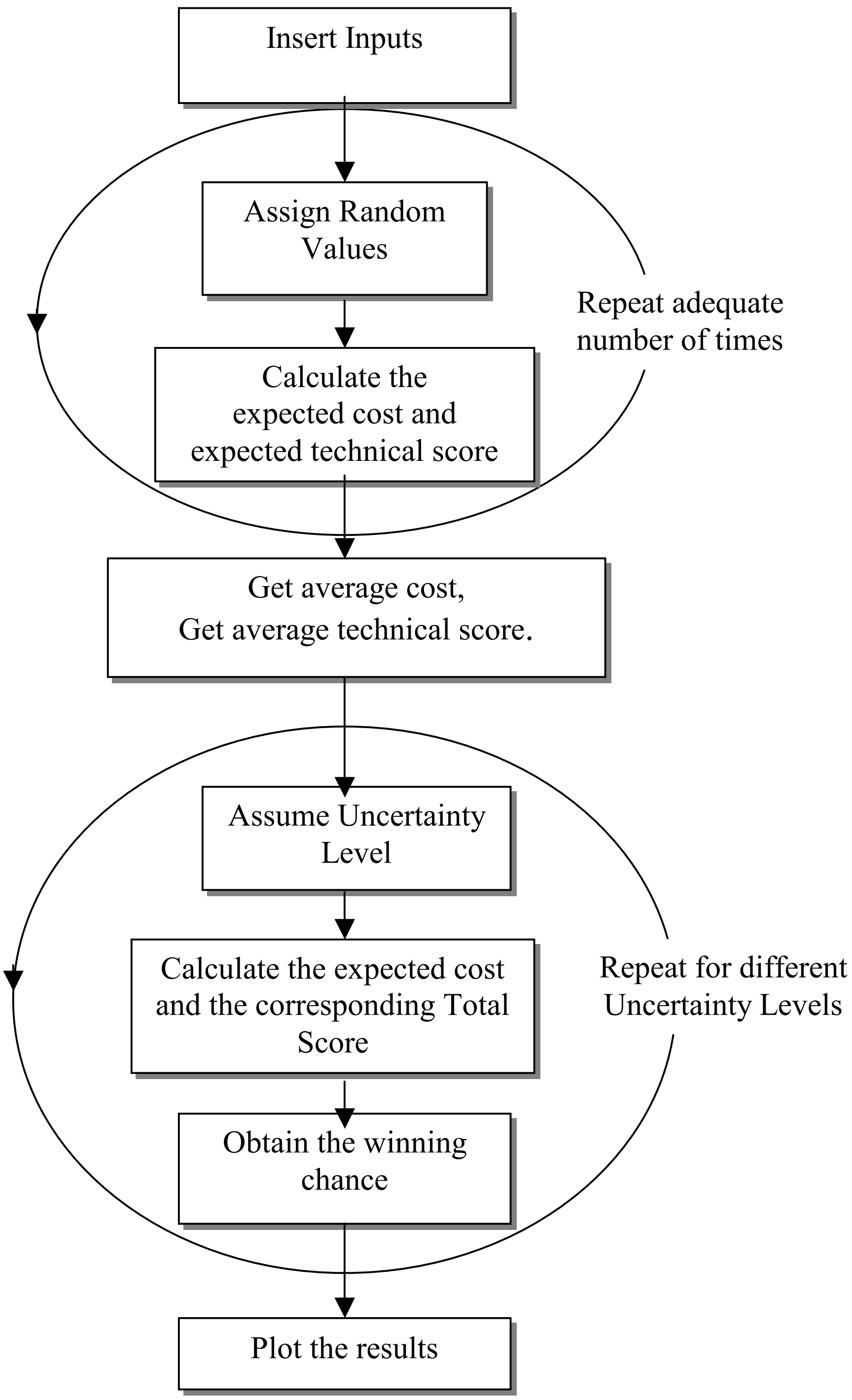

FIGURE 7.1 FEM FLOW CHART

7.5 FEM calculations

FEM scheme and method of cost and total technical score calculations are as depicted in Figure 7.2. It consists of the following:

7.5.1 Cost calculations

As previously explained in chapter 3. The design fees are calculated as follows:

Total Fees (Cost) = Direct cost + Indirect cost + profit

The direct cost is composed of staff salaries, sub-consulting costs and printing and documents production costs. The staff salaries are calculated by adding social allowances and direct (project) overheads to the basic salary. These additions are calculated as a percentage of the basic salary.

Staff salary = Basic Salary (1+ Social Allowances + Direct Overhead)

Where:

Basic Salary: Monthly wages paid in hand to the staff members.

Social Allowances: a percentage of the basic salary that accounts for fringe benefits (vacations and pensions allowances, etc.)

Direct Overhead: a percentage of the basic salary that accounts for the portion of the salaries of the employees, other than the project staff, who are involved in the project (Clerical and administrative support)

The salaries contribution to the direct cost is calculated by the multiplication of the staff salary by the duration of involvement and by the staff input of every staff member. The input of the staff member denotes the level of his/her involvement in the project i.e. full or part time involvement.

$$\textbf{Total salaries} = \sum_{r=1}^{n} \textbf{(staff salary * Duration * Input)}_{r}.$$

(Where: r = (1,2,3, ….., n), and n = Number of staff members)

The indirect cost is composed of: general overheads (or company overheads) and the risk allowance. Both are calculated as a percentage of the total direct cost. The profit is inserted as a percentage of the total cost. Different values of the profit are used in the model.

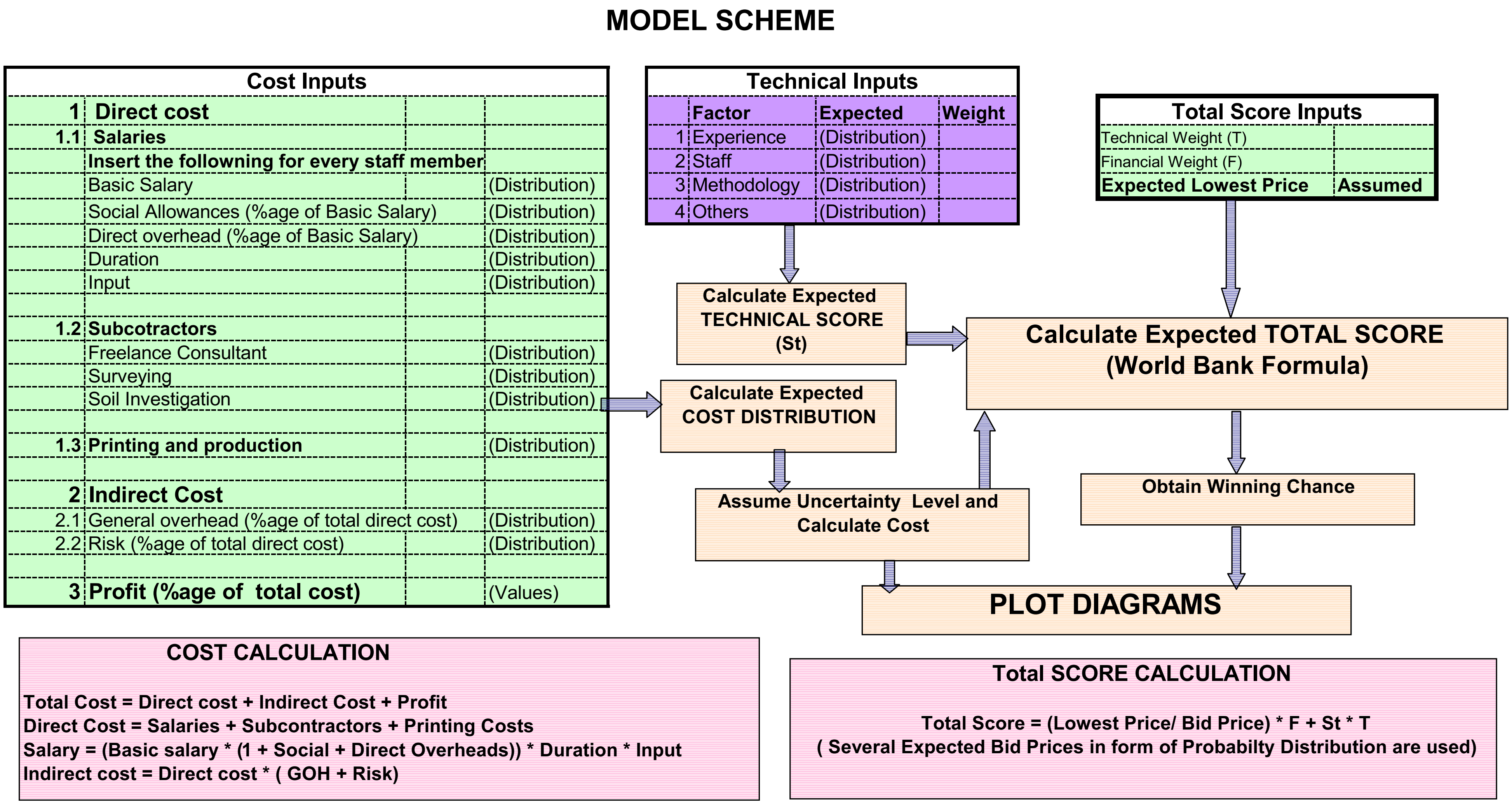

Figure 7.2: FEM scheme and cost calculations

For every staff member, the distributions of the basic salary, social allowances and the direct overheads are inserted. Distributions of the sub-consultants and the production costs are inserted as well. The same is done for the indirect cost items.

Monte Carlo simulation technique is used to calculate the total cost. The average and the standard deviation of the results are calculated. It is assumed that the distribution of the results is a normal distribution (according to the central limit theorem).

7.5.2 Technical score calculations

The total technical score is composed of several weighted factors, as previously explained in chapter 3. The total score is calculated by the summation of the expected score of every factor multiplied by its weight. The process is repeated for different random values of every factor, and the average expected total score is calculated.

7.5.3 Uncertainty levels and corresponding costs

Statistical techniques are used to calculate the expected cost corresponding to a certain level of uncertainty. Assuming that the total cost distribution is a normal distribution values of the Average Cost (mean) and the Standard deviation are calculated. From the normal distribution we know that:

z = (Expected Cost – Average cost) / (Standard Deviation).

z= the normal distribution value corresponding to the certain expected cost.

Probability of any cost value = 1- Uncertainty level (UL)

So, to get the expected cost, UL is assumed and the probability is calculated, then ***z is determined using excel statistical functions.***

The expected cost is calculated by the formula,

Expected cost = (z * (Standard Deviation)) + (Average Cost)

7.5.4 Total score and winning chance

For every UL the expected cost is calculated, then the following World Bank formula is used to calculate the total score

Total score = (Minimum Expected cost/ Expected Cost) * F + Expected total score * T

Where T and F are the technical and financial weights respectively.

The calculated total score is used to predict the expected winning chance relying on the historical data of the total score of the consultants who won the bids.

7.6 FEM Inputs and outputs

7.6.1 Inputs

The inputs of FEM are divided into two main categories: cost inputs and technical inputs. The cost inputs include:

- **The probability distribution corresponding to each cost item**

This may be derived from the historical data of the consulting firm. In the absence of such data, FEM user may utilize his experience and judgment to assume the required probability distributions.

- **Expected minimum price of the competing consultants**

This depends on the judgment of the user. Historical data about the (man-month) rate may be utilized. In most consulting assignments, the total expected (man-months) are stated in the terms of reference (T.O.R). The trend of the (man-month) rate in the local practice is described in Chapter 5 of this research.

The technical inputs include:

- **Probability distribution of the technical score factors:**

These factors are frequently stated in the T.O.R. The user has to enter the probability distribution of his score in each factor depending on his judgment and the available historical data.

- **History of the winning total score:**

This history is a table including the total score value and the cumulative frequency of winning corresponding to this value. It is a fixed component in FEM. As indicated in Chapter 5, the values in the table are derived from a survey of about forty tenders for consulting services during the last six years (1997 to 2003).

Together with the cost and technical inputs, values of T and F are needed. These values are frequently indicated in the T.O.R. It is to be noted that FEM inputs depend mainly on the record keeping and historical data in addition to the experience of the model user.

7.6.2 Output

FEM main outputs are two charts. The first is the cost distribution chart which includes different UL values and the corresponding expected cost with different profit values (0, 0.05, 0.01, 0.15, 0.2 and 0.25). The second is the winning chance chart which shows the winning chance corresponding to different cost values. Sample of the model output charts are depicted in Figure 7.3.a and Figure 7.3.b.

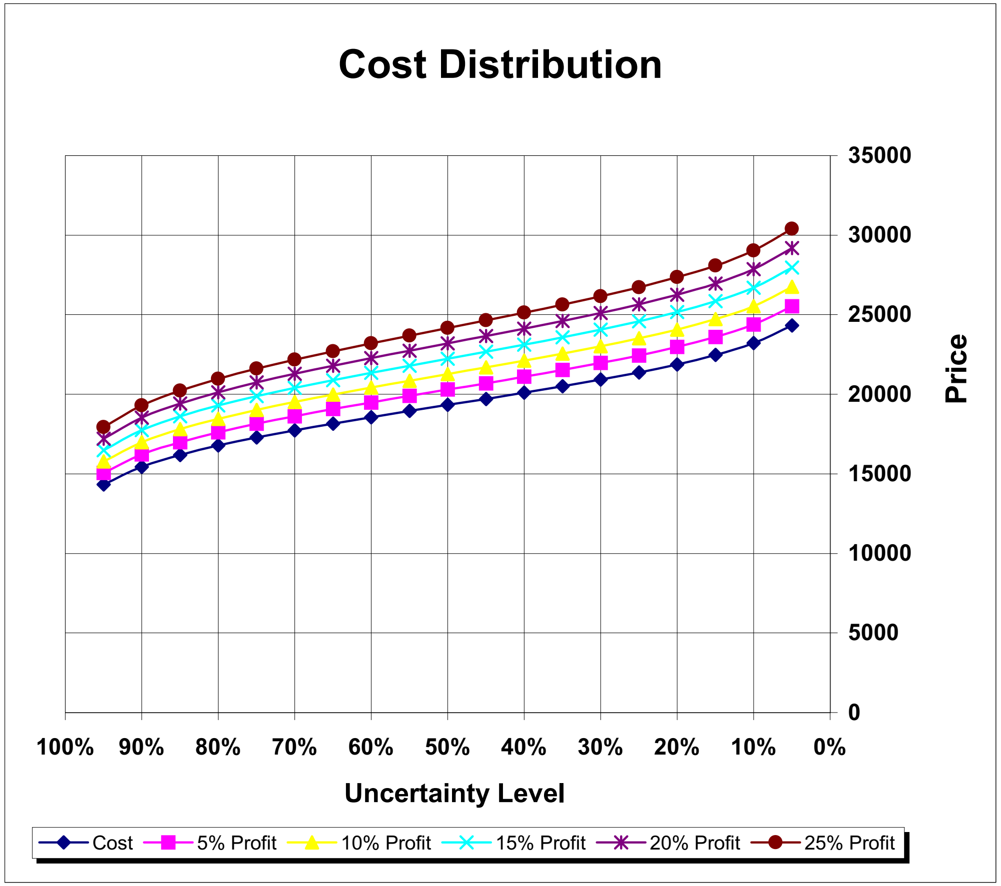

Figure 7.3.a: Cost Distribution Chart

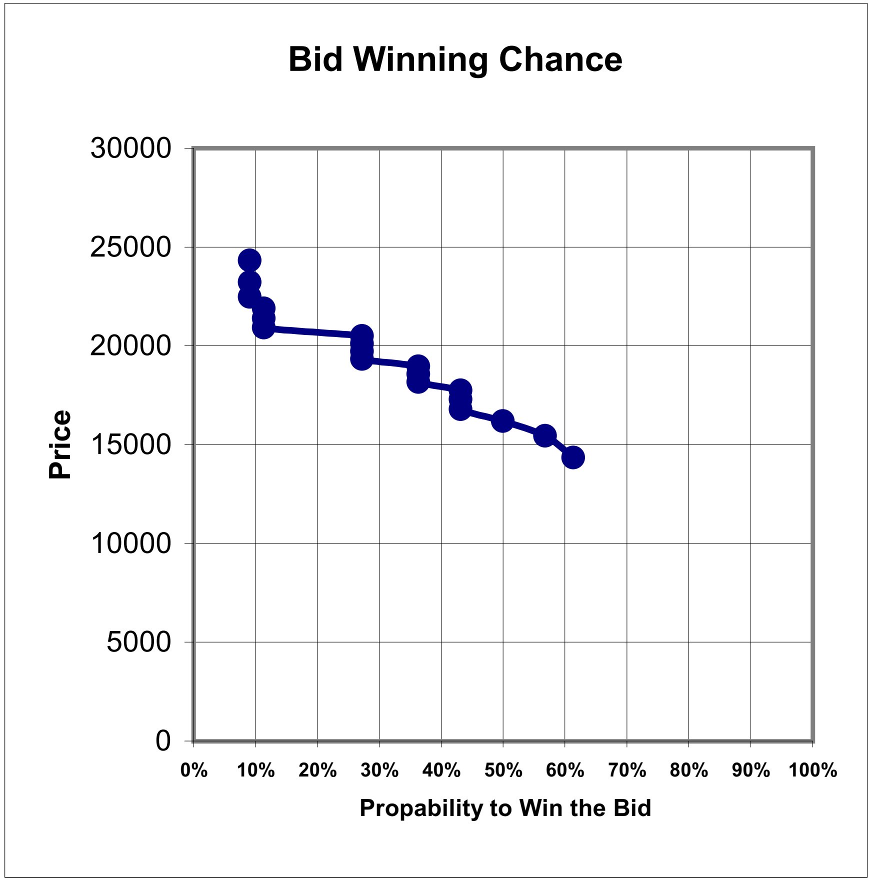

Figure 7.3.b: Bid Winning Chance Chart

7.7 FEM operation

FEM is introduced in the form of MS Excel file. When the file is opened, the option "Enable Macros" must be chosen and the protection level must be "low" in order to work properly. The model is composed of the following sheets:

1. "FEM" sheet: It is an introductory sheet which welcomes the user and directs him to the other sheets of the model. The user can choose any sheet by clicking the button of the required sheet. Figure 7.4 depicts "FEM" sheet.

2. Cost inputs sheet

In this sheet, as depicted in Figure 7.5, the user has to insert the cost inputs including the probability distributions of every cost item. In the rows corresponding to every staff member, it is needed to insert the values corresponding to the cumulative probability of (0, 0.25, 0.5, 0.75 and 1) of the following:

- Basic salary (frequently monthly salary).
- Social allowances (as a percentage of the basic salary).
- Direct overheads (as a percentage of the basic salary).
- Duration of the staff member involvement (frequently expressed in months).
- The input of the staff member, or the level of involvement, expressed as a fraction ($0 < \text{Input} \leq 1$).

Distributions of the social allowances and the project overheads, calculated from the field survey results in Chapter 5, are proposed as guiding values in the model. The user can use these values or insert other values he thinks more appropriate.

The user can enter up to ten staff members. In case that the staff members are more than ten, it is recommended to insert probability distributions of the most significant staff members and add the salaries of the remaining staff as a fixed value. Below the staff members, the user will find the (others) rows where he is required to insert the probability distribution of the external consultants, soil test laboratories, surveying consultants, etc. In the last row of the "others" part, it is required to insert the probability distribution of the printing and production costs. In the last two rows, the user finds the “indirect” part where the probability distribution of the general overheads (GOH) and the risk factor are inserted expressed as a percentage of the direct cost. Distributions of GOH and risk from the field survey are proposed to the user. He can use these distributions or insert the distributions he think to be appropriate.

In the top left part of the sheet, number of the calculation repetitions (n) is to be inserted. Then the user may click the button (Calculate the Cost n Times) in order to run the cost simulation. Three other buttons may be used: the “New Project” button which resets the inputs to zero values in order to insert new inputs for a new project, the (Back to FEM) button which leads to the first sheet, the “Charts ” button which leads to the outputs charts, and the “Technical Inputs” button which leads to the technical inputs sheet.

3. Technical inputs sheets

In the top left corner of the sheet, as depicted in Figure 7.6, the user will find the buttons: “New Project”, “Bach to FEM , “Charts”, and “Calculate the Technical Score n Times”. The functions of these buttons are similar to those of similar buttons in the cost inputs sheet. The “Cost Inputs” button leads to the cost inputs sheet.

The user is to insert number of simulations in the cell opposite to “insert number of runs”. Values of F, T, passing score, the assumed minimum bidding price are to be inserted in the corresponding cells as well. In the technical inputs rows the probability distribution of the various technical score components are to be inserted. After inserting all the required inputs, the “Calculate Technical Score n Times” button is clicked in order to run the simulation. The average technical score value will appear in its corresponding cell. The “Charts” button is then clicked to view the output charts.

In case that no information is available about the technical evaluation elements, the user may insert the assumed technical score in its corresponding cell. This assumed value will be used in the total score calculations. It is obvious that if the technical score is assumed there is no need to run the simulation for technical score calculation.

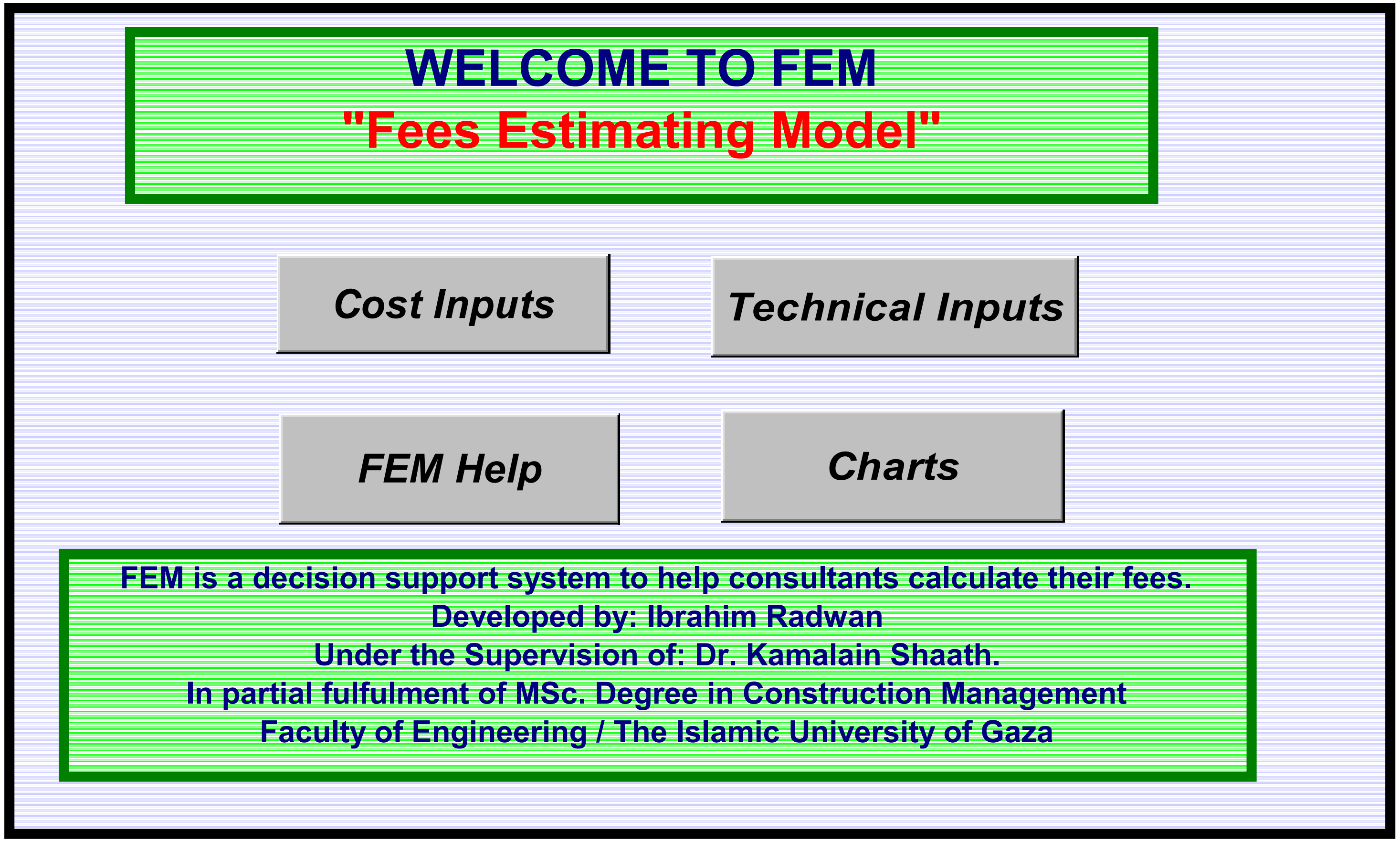

Figure 7.4: FEM sheet

New Project | Back to FEM | Charts

Calculate The Cost n Times | Technical

No. of Runs	100
Min Cost	12491.0857
Max Cost	27201.6863
Average Cost	19329.4417

		Cumulative Probability	0	0.25	0.5	0.75	1
Staff	Staff 1	Basic Salary	800	900	1100	1150	1200
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration	10	10	10	10	10
		Input	0.2	0.25	0.4	0.45	0.5
	Staff 2	Basic Salary	600	650	750	800	900
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration	10	10	10	10	10
		Input	1	1	1	1	1
	Staff 3	Basic Salary					
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration					
		Input					
	Staff 4	Basic Salary					
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration					
		Input					
	Staff 5	Basic Salary					
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration					
		Input					
	Staff 6	Basic Salary					
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration					
		Input					
	Staff 7	Basic Salary					
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration					
		Input					
	Staff 8	Basic Salary					
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration					
		Input					
	Staff 9	Basic Salary					
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration					
		Input					
	Staff 10	Basic Salary					
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration					
		Input					
Others		Consultant 1	500	600	800	850	1000
		Consultant 2					
		Consultant 3					
		Consultant 4					
		Printing					
Indirect		GOH	0.03	0.09	0.15	0.2	0.35
		Risk	0.03	0.05	0.1	0.15	0.25

Total Cost

Figure 7.5: Cost inputs sheet

New Project **Charts** **Back to FEM**

Calculate Technical Scores n Times **Cost Inputs**

Insert number of runs (n)	100		
Insert Financial Weight	**20**		
Insert Technical Weight	**80**		
Insert Passing Score	**70**	Calculated Min Score	77.861587
Assumed Min Price	**13000**	Calculated Min Cost	12491.086
Assumed Technical Score	**88**	Average Technical Score	82.338075

Technical Inputs

			Cumulative Probability				
Criteria	**Sub-Criteria**	**Weight**	**0**	**0.25**	**0.5**	**0.75**	**1**
Experience	**General**	10	5	6	7	8	9
	Specific	15	12	13	13.5	14	14.5
Work Plan and Methodology	**A**	30	22	23	24	25	26
	B						
	C						
Staff	**A**	45	35	37	38	39	40
	B						
	C						
Others	**A**						
	B						
	C						
Total		**100**			Total Score		

Figure 7.6: Technical inputs sheet

4. **History sheet**

The frequencies of winning total scores, derived from the projects survey previously mentioned in Chapter 5, is included in this sheet. It is a fixed component in FEM. The sheet is protected and the user cannot change the values in it.

5. **Charts sheet**

It includes the output charts as depicted in the previously explained Figure 7.3.

6. **Help sheets**

Two supplementary sheets: one is including Arabic summary about FEM and the Other is including the Model Scheme Diagram presented in Figure 7.2.

Full description of FEM operation is demonstrated on a real sample project in Annex E.

7.8 FEM limitations

It is obvious that FEM is limited to the consulting tenders conducted in Gaza Strip according to the World Bank guidelines for two envelop consulting tenders. The model depends, to a great extent, on the experience of the model user. The user has to predict his expected technical score elements. Also, he needs to predict the minimum cost that the lowest bidder will give. On the other hand, FEM dose not consider the technical scores and the prices of the competing consultants (except the lowest bidder price), so the bidder can not compare his total score with the others total scores. Of course, these limitations may be tackled in further studies.

7.9 FEM evaluation

Getting feedback from the prospective users is an integral part of the development process of any system. To get this feedback, five local consulting firms, that may be considered as the top consulting firms in Gaza Strip, are asked to evaluate FEM. For this purpose, an evaluation questionnaire is filled by the consultants after trying the model in one or more of their projects. The evaluation questionnaire is in Arabic and it includes the following four topics:

1. Data entering and model techniques.
2. Main advantages of the model
3. Difficulties faced in using the model.
4. Suggestions for model improvement.

(The evaluation questionnaire form and its translation into English are attached in Annex C and Annex D, respectively).

Data entering and model techniques:

The evaluating consultant is asked to state his opinion, on a five level scale, regarding twelve statements related to the ease of using the model and the benefits and suitability of its outputs. Table 7.1 indicates the responses of the consultants on this topic and the average of these responses measured on a nominal scale of 1 to 5, where 1 corresponds to "Do not agree" and 5 corresponds to "Very much agree".

Table 7.1: Consultants responses regarding model techniques and data entering.

N.	Data and Techniques	Very Much Agree	Agree	Intermediately Agree	Weakly Agree	Do Not Agree	**Average**
1	In general, the way of data entering in the model is suitable.	20%	60%	-	-	20%	**3.6**
2	The way of entering cost data is suitable.	20%	60%	-	20%	-	**3.8**
3	The way of entering technical data is suitable.	20%	40%	20%	20%	-	**3.6**
4	It is easy to get the required cost data.	20%	40%	40%	-	-	**3.8**
5	It is easy to get the required technical data.	20%	60%	20%	-	-	**4**
6	In general, the model outputs are useful.	20%	40%	40%	-	-	**3.8**
7	"Cost Distribution Chart" is easy to understand.	20%	20%	60%	-	-	**3.6**
8	"Winning Chance Chart" is easy to understand.	-	40%	60%	-	-	**3.4**
9	"Cost Distribution Chart" is useful.	20%	-	80%	-	-	**3.4**
10	"Winning Chance Chart" is useful.	-	40%	60%	-	-	**3.4**
11	FEM is a user friendly program and it does not need much training	20%	60%	-	-	20%	**3.6**
12	FEM is suitable for using in Gaza Strip	-	80%	20%	-	-	**3.8**

It is noted that the average of the responses range between 3.4 and 4 (intermediately agree to agree). This means that almost all the evaluating consultants agree that FEM is suitable for using in Gaza Strip. They think that in general, the way of data entering is suitable. The same is true for entering the cost and technical inputs. The consultants think that it is easy to get the cost and technical data required for the model. Almost all of them agree/intermediately agree that the output charts are easy to understand and are useful for the decision maker in fees estimating. All the consultants requested a demonstration on the model before trying it. They think that FEM is a user friendly model but it needs at least one training session.

Main Advantages of FEM

The following are the main advantages of FEM as stated by the evaluating consultants:

- FEM is a unique decision making tool for fees estimating. It may lead to some improvement in the local engineering consulting practice.
- FEM gives a good perspective for the fees estimating process and the expected bid evaluation results.
- FEM doesn't need high computer skills. Persons who are familiar with MS Excel will be able to deal with it easily.
- FEM is a time saving tool in fees estimating.
- FEM may be used as a cost record keeping tool.

Difficulties faced in using FEM

The evaluating consultants show different opinions regarding the difficulties faced in using FEM. One consultant thinks that there are no difficulties, whilst another consultant thinks that it is very difficult to use FEM, mainly because it requires feeding several types of data into different sheets. The remaining consultants state that the difficulties are overcome by the demonstration session held by researcher upon their request.

Suggestions for FEM improvement

The evaluating consultants suggest some improvements that make FEM more interactive. These suggestions are considered and the model is amended accordingly. Other suggestion related to the concept of the model and its output are:

- Considering the expected prices and technical scores of the competing consultants in order to identify the bid winning chance.
- Providing a DEMO version to train the user before utilizing the model.
- Changing the data entering techniques by relying on a computerized database and minimizing the manual data entering.
- Adding the possibility of reports production in a tabular form in addition to the available output charts.

The researcher thinks that these suggestions are valuable and they worth considering in further researches.

Chapter 8
Conclusions and Recommendations

8.1 Introduction

This research is conducted in order to form a conceptual model that is suitable for the design management in Gaza Strip and to develop a computer based decision making tool to help local consultants estimate their fees rationally. The researcher relied on literature review, field survey and his experience to achieve the goals of the research. In the process of field survey and the software development and evaluation, some conclusions and general recommendations emerge. This chapter also includes recommendations for further studies.

8.2 Conclusions

- Design management is an essential factor in the success of the construction industry. A successful design process leads to high quality construction projects with minor wastes in both time and cost. The existence of a solid conceptual foundation of the design process contributes a lot in the design management improvement. The proposed design model in this research is supposed to emphasize this conceptual foundation in the local practice. By adopting this model, the design management is anticipated to be improved.
- Local consultants have a good theoretical perception of the design process but more efforts are needed to apply this theoretical background in a way that lead to the improvement of local practices in design management. Training of the design staff in both managerial and technical fields will contribute to such improvement.
- Co-ordination is a keyword in the design management. The most common defects in the construction industry are caused by design errors. Lack of co-ordination among design departments and between the consultant and the client are the major causes of design defects. Periodic meetings of the design team during the design process is a very effective tool of co-ordination among the different design departments. Also, frequent contacts with the client and the client's active involvement in the design process will lead to a successful design process with minimum defects.

- Cost monitoring and record keeping is one of the powerful tools of cost management. The consultants have to monitor, record the costs of design process, and compare the actual costs with the estimated costs in order to control the design expenses. Regular cost record keeping leads to establishing a database which is useful in predicting the cost of new projects with a reasonable accuracy. In this context, it is noted that the local consultants generally do not have such database.

- Uncertainty is a dominant factor in cost estimating. In the design fees estimating, this becomes clearer due to the ever changing factors that contribute to the design costs. The level of effort and time required to perform design assignments are difficult to predict. Having a facility that helps the consultants rationally predict the uncertainty and risks related to their fees estimating is necessary. FEM is supposed to help the local consultants handle uncertainties in their fees estimating. It also can deal with deterministic data.

- The developed Fees Estimating Model (FEM) has implemented the powerful technique of Monte Carlo simulation utilizing the commonly used MS Excel software. This may be considered a contribution towards simplifying such technique and making it easily available to a wider range of local consultants.

- For cost estimating, the estimator needs, beside his experience, a clear bidding strategy. In design fees estimating, consultants have to adopt a bidding strategy: whether to aim for lower fees or to aim at getting high technical scores, and accordingly cost estimates are prepared. FEM is designed to utilize the estimator's experience to enter the required data. Then by using FEM's outputs the user can choose, with a reasonable accuracy, the cost that complies with his strategy.

8.3 General Recommendations

- Successful design must be the target of all parties involved in the construction industry. All efforts should be exerted by the consultants, the clients and other construction stakeholders to minimize the design defects.
- Clients should be proactive. A clear identification of the construction project requirements is essential before the start of the design. Care should be taken to keep changes in the scope of work as minimum as possible.
- The consultants have to allocate all the required resources, co-ordinate the design activities and keep close coordination with the client throughout the design process.
- Design team meetings should be given the required attention. These meetings should be well prepared and utilized effectively and efficiently in the design coordination and management.
- The consultants should adopt a clear and systematic record keeping procedure of the design process expenses. The use of common computer software such as MS Excel and MS Access is recommended.
- Consultants have to account for all major cost components when they calculate their fees. A reasonable amount of profit is to be considered. Underestimated fees may result in losses to the consultant and eventually it may lead to the collapse of the consulting firm. On the other hand, overestimation may keep the consultant with no work in hand and eventually the collapse of the firm, as well.
- It is recommended to conduct training courses in the design management, pricing of the design process and computer applications in fees estimating. The Association of Engineers is invited to arrange for such training courses in coordination with governmental and academic institutions.
- Consultants are advised to have a software package to be used in estimating their fees. The use of computer packages is supposed to save time, minimize errors and the chance of winning the tender is hoped to be better.
- Professional associations, such as the Association of Engineers should adopt a policy that urge local consultants abide to the minimum fees stipulated by the Association. In this context, it is recommended that the Association

Engineers endorses all the design consulting contracts and take the necessary measures to guarantee the compliance of the consulting fees with the Association rates.

8.4 Recommendations for further studies

- The design management process introduced in this research adopts the traditional management techniques and project management concepts. Contemporary management approaches have been applied to the design management in other developed countries. These approaches include: lean management, the last planner concept, concurrent engineering and de-plan technique. Researchers are invited to investigate these new approaches and to examine their suitability to the local practice.
- FEM is designed to handle uncertainties and it is tailored for the two envelop evaluation procedure. Researchers are invited to develop FEM in order to deal with other bid evaluation procedures.
- FEM is an overall fees estimating tool that deals with all types of consulting services. Researchers are encouraged to develop different versions of FEM to deal with different specific types of consulting services such as: building design, road works design, water and wastewater works design, etc.
- Researchers are also invited to improve FEM to handle the following issues:
  - Making more comprehensive database for different design cost components and creating a dynamic link to FEM with this database.
  - Considering the expected technical scores of the competing consultants in predicting the bid winning chance.
  - Extending the use of FEM to design cost monitoring and design cost control.

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List of Annexes

Annex A: Field Survey Questionnaire

الجامعة الإسلامية بغزة
كلية الهندسة – قسم الهندسة المدنية

استبيان حول إدارة المكاتب الاستشارية
وطرق تسعير الخدمات الهندسية الاستشارية

في إطار متطلبات البحث التكميلي للحصول على درجة الماجستير في إدارة المشاريع الهندسية

الباحث: م. إبراهيم رضوان

بإشراف/ الدكتور كمالين شعث

مقدمة

السيد / ....

تحية طيبة، وبعد:

للمكاتب والشركات الاستشارية دور هام وفعال في نجاح صناعة التشييد والإنشاء ، إذ يبدأ دور المهندس الاستشاري منذ بداية التفكير في المشروع ويستمر حتى تشغيله مرورا بعملية التصميم والإشراف علي التنفيذ.

وكما هو واضح لجميع المعنيين بالعمل الاستشاري الهندسي في فلسطين ، هناك مشاكل عدة تواجه العمل الهندسي الاستشاري ، واكثر هذه المشاكل حدة هي مشكلة محدودية فرص العمل والتنافس الشديد عليها مما يؤدي إلى خفض أسعار الخدمات الهندسية الاستشارية بشكل كبير.

بناء على ما سبق، هناك حاجة إلى دراسة العمل الاستشاري الهندسي في قطاع غزة ومحاولة وضع الحلول التي تساعد على تطور العمل مع تقديم أداة علمية تساعد المهندس الاستشاري علي تقدير أتعابه بحيث تكون الأتعاب المقدرة مناسبة للحصول على العمل بسعر منافس مع ضمان حد معقول من الربح.

هذا الاستبيان يهدف إلى الحصول على معلومات حول إدارة المكاتب الاستشارية، وطريقة تسعير الخدمات الهندسية في قطاع غزة كجزء من محاولة وضع تصور حقيقي للعمل الاستشاري الهندسي في قطاع غزة وبالتالي اقتراح برنامج كمبيوتر يساعد على تقدير الأتعاب الهندسية بشكل علمي يضمن، بدرجة معقولة من الدقة، أن تكون الأسعار منافسة مع الحصول على حد معقول من الربح.

نتوجه إليكم راغبين في الحصول على مساعدتهم في إنجاح هذا الجهد العلمي راجين الإجابة على الأسئلة المرفقة بدقة ووضوح، ونؤكد أن كل المعلومات في هذا الاستبيان ستستخدم فقط لغرض البحث العلمي، وسنوافيكم بما نتوصل إليه من نتائج عند انتهاء العمل إذا رغبتم في ذلك.

شاكرين لكم حسن تعاونكم

مع وافر الاحترام،،

الباحث

م. إبراهيم عبد الرؤوف رضوان

استبيان حول إدارة المكاتب/الشركات الهندسية الاستشارية

أولا:التعريف بالشركة/ المكتب الاستشاري

1- اسم الشركة/ المكتب: (اختياري) ______________________________.

2- سنة التأسيس: ــــ 3- التصنيف: ــــ

4- التخصصات:

☐ عمارة ☐ إنشاءات ☐ كهرباء ☐ ميكانيك ☐ مياه ومجاري ☐ طرق

☐ إدارة مشاريع ☐ تربة وأساسات. ☐ مساحة ☐ أخرى (حدد:...............)

5- المتوسط السنوي لعدد الموظفين خلال السنوات الخمس السابقة:

السنة	1998	1999	2000	2001	2002
فنيون (شهادة متوسطة)					
مهندس معماري					
مهندس مدني					
مهندس كهرباء					
مهندس ميكانيك					
مهندسون تخصصات أخرى					
شهادات عليا ماجستير و دكتوراه (هندسة)					
شهادات عليا (تخصصات أخرى)					
موظفون اخرون					
العدد الكلي					
نسبة العاملين المتفرغين					

6- أنواع المشاريع التي تم تصميمها خلال السنوات الخمس الماضية:

☐ مباني صغيرة (حتى 5 طوابق) ☐ أبراج ☐ مباني عامة

☐ مياه ومجاري ☐ طرق ☐ إدارة وإشراف ☐ أخرى (حدد ....)

7- يرجى توضيح النسبة التقريبية لحجم العمل في كل نوع من أنواع المشاريع من إجمالي الأعمال التي تقومون بها.

نوع العمل	النسبة المئوية
مباني صغيرة (حتى 5 طوابق)	
أبراج	
مباني عامة	
مياه ومجاري	
طرق	
إدارة وإشراف	
أخرى	
الإجمالي	%100

8- متوسط الأتعاب السنوية خلال الخمس سنوات الماضية (ألف دولار):

☐ أقل من 50 ☐ 50-99 ☐ 100-149 ☐ 150-199 ☐ 200 فأكثر

9- قامت الشركة/ المكتب بالعمل بالاشتراك مع مكاتب عربية وأجنبية (Joint Venture) خلال السنوات الخمس الماضية:

☐ لا ☐ نعم (بنسبة .... من إجمالي حجم عمل الشركة)

ثانيا: إدارة المكاتب الهندسية

يرجى إبداء الرأي في المفاهيم التالية من حيث صحة المفهوم ومدى التطبيق والممارسة لديكم وذلك بوضع علامة (X) في الخانة المناسبة.

الرقم	المفهوم	درجة الموافقة					التطبيق				
		موافق جدا	موافق	موافق بدرجة متوسطة	موافق بدرجة ضعيفة	موافق بدرجة ضعيفة جدا	دائما	عادة	أحيانا	نادرا	أبدا
1. طبيعة عملية التصميم Design Process											
1-1	نجاح التصميم يعتمد على التنسيق الفعال لنشاطات التصميم علاوة على توفر الطاقم القادر على التصميم فنيا.										
2-1	مالك المشروع له دور مهم في نجاح عملية التصميم.										
3-1	التصميم الجيد هو الذي يقدم أكبر قدر ممكن من التفاصيل في مخططات المشروع.										
4-1	التصميم الجيد هو الذي يعطي المجال لاستغلال خبرة المقاول في إعداد التفاصيل.										
5-1	إدارة عملية التصميم تحتاج إلى دعم الكفاءة الفنية بالقدرات الإدارية لدى مدير التصميم.										
6-1	تتبع مخططات المشروع ووثائق المناقصة نظاماً محدداً وثابتاً (Fixed Standard).										
7-1	يتم تجهيز كشف بالمخططات (Drawing Index) في بداية المشروع لمتابعة تقدم العمل.										
8-1	من المهم أن تتبع عملية فحص ومراجعة المخططات منهجا واضحا.										
9-1	من المهم الاحتفاظ بنسخ من التصاميم السابقة على شكل مكتبة مرتبة.										
10-1	يلزم عمل اجتماع تقييمي في نهاية كل مشروع.										
11-1	من الضروري للمكتب/الشركة الهندسية أن يعتمد نظام رسمي لمراقبة الجودة(مثل ISO).										

2. التخطيط للتصميم وإعداد الجدول الزمني Planning and Scheduling

الرقم	المفهوم	درجة الموافقة					التطبيق				
		موافق جدا	موافق	موافق بدرجة متوسطة	موافق بدرجة ضعيفة	موافق بدرجة ضعيفة جدا	دائما	عادة	أحيانا	نادرا	أبدا
1-2	توفر رؤية واضحة للمشروع من قبل المالك يساهم في نجاح التخطيط لعملية التصميم.										
2-2	يلزم تحديد المخرجات المطلوبة من عملية التصميم قبل البدء بها.										
3-2	من المهم تحديد الجدول الزمني لأعمال التصميم بالتنسيق مع المالك.										
4-2	قبل البدء في عملية التصميم يلزم تقسيم العمل إلى مهام محددة تسند كل منها إلى شخص/مجموعة لمتابعتها وإنجازها.										
5-2	من الضروري اعتماد المالك لكل مرحلة من مراحل التصميم قبل الانتقال إلى المرحلة التالية.										
6-2	من الضروري تخصيص وقت كاف لمراجعة واعتماد المالك لمراحل التصميم المختلفة.										
7-2	خطة العمل في التصميم هي الأساس لتنسيق العمل بين جميع العاملين في التصميم.										
8-2	خطة العمل في التصميم هي أساس للرقابة ومتابعة تقدم العمل.										
9-2	خطة العمل في التصميم توضح لكل فرد من أفراد طاقم التصميم العمل المطلوب منه وتوقيته.										
10-2	خطة العمل في التصميم وسيلة لإنهاء العمل في الوقت المحدد.										
11-2	خطة العمل في التصميم وسيلة لتشجيع طاقم التصميم على العمل وزيادة إنتاجهم.										
12-2	تستعمل طريقة مخطط جانت (Bar chart) للتخطيط لعملية التصميم.										

3. القيادة و التوجيه في عملية التصميم Leading in design											
الرقم	المفهوم	درجة الموافقة					التطبيق				
		موافق جدا	موافق	موافق بدرجة متوسطة	موافق بدرجة ضعيفة	موافق بدرجة ضعيفة جدا	دائما	عادة	أحيانا	نادرا	أبدا
1-3	لنجاح عملية التصميم يلزم عقد اجتماعات دورية لطاقم التصميم.										
2-3	تساهم الاجتماعات الدورية بين أعضاء طاقم التصميم في تشكيل قاعدة فهم مشتركة بينهم.										
3-3	يعتبر الاجتماع الأول "Kick-off Meeting" ضرورياً لنجاح عملية التصميم.										
4-3	يمكن خلق دافعية (motivation) لدى كل فرد من أفراد الطاقم باعتماد الشركة سياسات توفر ظروف عمل مريحة.										
5-3	يمكن خلق دافعية (motivation) لدى كل فرد من أفراد الطاقم بتحسين المردود المادي.										
6-3	شعور العاملين بالراحة يؤدي إلى سرعة إنجاز الأعمال.										
7-3	شعور العاملين بالراحة يؤدي إلى تحسين جودة العمل.										
8-3	يلزم أن تتيح الشركة/ المكتب للعاملين فيها فرصة للتدريب في المجال الفني (التخصص).										
9-3	يلزم أن تتيح الشركة/ المكتب للعاملين فيها فرصة للتدريب في المجال الإداري.										
10-3	يلزم أن تتيح الشركة/ المكتب للعاملين فيها فرصة للتدريب في مهارات الكمبيوتر.										
11-3	يلزم أن تتيح الشركة/ المكتب للعاملين فيها فرصة للتدريب لامتلاك المهارات في استخدام اللغة الإنجليزية.										

4. الهدف من ممارسة المهنة في مجال التصميم والاستشارات الهندسية هو:											
		درجة الموافقة					التطبيق				
		موافق جدا	موافق	موافق بدرجة متوسطة	موافق بدرجة ضعيفة	موافق بدرجة ضعيفة جدا	دائما	عادة	أحيانا	نادرا	أبدا
1-4	تحقيق الربح المادي.										
2-4	تقديم عمل على مستوى عالي من الجودة.										
3-4	تحقيق انتشار وتوسع أكبر في سوق العمل.										
4-4	اكتساب خبرات ومعارف في مجالات جديدة.										

5. جودة التصميم:											
		درجة الموافقة					التطبيق				
		موافق جدا	موافق	موافق بدرجة متوسطة	موافق بدرجة ضعيفة	موافق بدرجة ضعيفة جدا	دائما	عادة	أحيانا	نادرا	أبدا
1-5	التصميم الجيد هو الذي يخلو من الأخطاء.										
2-5	التصميم الجيد هو الذي يتم إنجازه في الوقت المحدد.										
3-5	التصميم الجيد هو الذي يوفر كل المعلومات اللازمة للتنفيذ.										
4-5	التصميم الجيد هو الذي يخلو من التناقضات بين مخرجات المشروع.										

6. تقدير الأتعاب الهندسية

1-6 يتم الحصول على العمل عن طريق التنافس القائم على التقييم الفني أولاً ثم التقييم المالي (Two Envelope Proposal).

☐ دائماً ☐ عادة ☐ أحياناً ☐ نادراً ☐ أبداً

2-6 يتم استخدام برامج الكمبيوتر في تقدير أتعاب التصميم.

☐ دائماً ☐ عادة ☐ أحياناً ☐ نادراً ☐ أبداً

3-6 أ– يتم التركيز على الحصول على تقييم فني مرتفع للفوز بالعمل بسعر مريح.

☐ دائماً ☐ عادة ☐ أحياناً ☐ نادراً ☐ أبداً

ب– يتم التركيز على تقليل السعر للحصول على العمل.

☐ دائماً ☐ عادة ☐ أحياناً ☐ نادراً ☐ أبداً

4-6 يتم رصد وتسجيل التكاليف الحقيقية لعملية التصميم للاستفادة منها في تقدير تكاليف المشاريع اللاحقة.

☐ دائماً ☐ عادة ☐ أحياناً ☐ نادراً ☐ أبداً

5-6 طبيعة المالك لها تأثير كبير على تحديد تكاليف التصميم.

☐ دائماً ☐ عادة ☐ أحياناً ☐ نادراً ☐ أبداً

6-6 مدى انشغال الشركة/ المكتب في مشاريع قيد التصميم يؤثر عل تقدير تكاليف التصميم للمشاريع اللاحقة.

☐ دائماً ☐ عادة ☐ أحياناً ☐ نادراً ☐ أبداً

7-6 مرتبات الموظفين في المكتب/ الشركة الهندسية تمثل في المتوسط النسبة التالية من إجمالي المصروفات:

☐ أقل من 40% ☐ 40% - 59% ☐ 60% - 79% ☐ 80% فأكثر

8-6 يتم تحديد أتعاب التصميم بالطريقة التالية:

	دائما	عادة	أحيانا	نادرا	أبدا
نسبة من إجمالي تكاليف إنشاء المشروع.					
مبلغ مقطوع يحدد حسب المشروع.					
حسب تسعيرة نقابة المهندسين.					
إجمالي أتعاب طاقم التصميم مضروبا في عامل.					
حساب المصروفات بالتفصيل ثم إضافة نسبة مئوية للمخاطرة والربح.					

9-6 عند احتساب رواتب العاملين في العرض المالي ، يتم إضافة ما يلي بنسبة من الراتب الأساسي المدفوع للموظف:

	أقل من 10%	10%-19%	20%-29%	30%-39%	40%-49%	50%-59%	60%-69%	60% فأكثر
علاوة اجتماعية.								
مصاريف غير مباشرة خاصة بالمشروع.								

10-6 عند احتساب التكاليف الإجمالية لعملية التصميم في العرض المالي ، و باعتبار التكاليف المباشرة كأساس للحساب ، يتم إضافة ما يلي بنسبة من التكاليف المباشرة:

	أقل من 5%	5%-9%	10%-14%	15%-19%	20%-24%	25%-29%	30% فأكثر
مصاريف عامة للشركة/ المكتب.							
عامل مخاطرة.							
الربح.							

11-6 أ– في المتوسط تزيد مدة التصميم عن المدة المقدرة بمقدار:

	دائما	عادة	أحيانا	نادرا	أبدا
أقل من 25%					
25% - 49%					
50% - 74%					
75% - 99%					
100% - 124%					
125% - 149%					
150% - 174%					
175% - 199%					
200% فأكثر					

ب- عند حدوث تأخير في إنجاز التصميم ، يكون المسئول عن ذلك:

	دائما	عادة	أحيانا	نادرا	أبدا
الاستشاري.					
المالك.					
ظروف خارجية لا تتعلق بالاستشاري أو المالك .					
مسئولية مشتركة، و مسئولية الاستشاري اكبر .					
مسئولية مشتركة ، و مسئولية المالك اكبر.					
مسئولية مشتركة ، و مسئولية الظروف الخارجية اكبر.					

Annex B: English Version of the Field Survey Questionnaire

Questionnaire about management and pricing of engineering consulting services in Gaza Strip

First: Information about the consulting office/firm

1- Name: ____.

2- Foundation Year: ____________ 3- Classification ____________.

4- Disciplines:

☐ Architectural ☐ Structural ☐ Electrical

☐ Mechanical ☐ Water & Wastewater ☐ Roads

☐ Construction Management ☐ Soil &Foundation

☐ Topographic Surveying ☐ Others (specify _____________).

5- Average annual number of employees in the last five years.

Year	1998	1999	2000	2001	2002
Technicians (Diploma)					
Architect. Eng.					
Civil Eng.					
Electrical Eng.					
Mechanical Eng.					
Other Engineers					
M Sc & Ph. D (Engineering)					
M Sc & Ph. D (others)					
Other Employees					
Total Number					
% of Full time Employees					

6- Types of projects designed in the last five years:

☐ Small Buildings (5 Stories) ☐ High rise buildings ☐ Public Buildings

☐ Water & Wastewater ☐ Roads

☐ Supervision & Management ☐ Others, (Specify __________).

7- Please indicate the approximate percentage from the total work volume, for each type of the projects you perform.

Project Type	Percentage
Small Buildings (5 Stories)	
High Rise Buildings	
Public Buildings	
Water & Wastewater	
Roads	
Supervisions & Management	
Others	
Total	**100%**

8- Average annual consulting fees in the last five years (Thousand US $).

☐ < 50 ☐ 50-99 ☐ 100-149 ☐ 150-200 ☐ >200

9- Your company worked in a joint venture with Arabic & Foreign consultants in the last five year.

☐ No ☐ Yeas (percentage ________).

Second: Management of Design Offices

Please indicate your degree of agreement and implementation for the following concepts by marking the proper choice with (X)

1- Design Process											
No.	Concept	Agreement					Implementation				
		Strongly Agree	Agree	Intermediately Agree	Weekly Agree	Very Weekly Agree	Always	Often	Some times	Rarely	never
1.1	Successful design process needs affective co-ordination of design activities in addition to the existence of competent technical design staff.										
1.2	Owner of the project has an important role in the success of the design process.										
1.3	Good design provides detailed drawings as much as possible.										
1.4	Good design allows for the use of the contractors experience in details preparation.										
1.5	The manager of the design process needs to have managerial skills in addition to the technical skills.										
1.6	Design drawings and tender documents have to comply with a fixed standard.										
1.7	A "Drawing Index" is prepared in the beginning of the design process in order to follow up the design progress.										
1.8	It is important to have a clear and known methodology in the design checking and review.										
1.9	It is important to keep copies of the previous design documents within a well arranged Library.										
1.10	An evaluation meeting is necessary in the end of every design project.										
1.11	The design office/company needs to adopt a formal quantity system (such as ISO 9001).										

2- Planning and Scheduling the Dsign Process											
No.	**Concept**	**Agreement**					**Implementation**				
		Strongly Agree	**Agree**	**Intermediately Agree**	**Weekly Agree**	**Very Weekly Agree**	**Always**	**Often**	**Some times**	**Rarely**	**never**
2.1	Clear client brief contributes to the successful planning of the design process.										
2.2	It is needed to identify the outputs of the design prior to staring the design process.										
2.3	It is important to agree the design time plan with the client.										
2.4	Prior to starting the design process, the work is divided into specific tasks. Each task is allocated to a person/group to perform it.										
2.5	It is necessary that the client approves each design stage before starting the next one.										
2.6	Sufficient time must be given for clients review and approval of each design stage.										
2.7	Design work plan is the basis of coordinating the work of the design team.										
2.8	Design work plan is the basis to control the design progress.										
2.9	Design work plan identifies the role of every member in the design team and when to deliver the work.										
2.10	Design work plan helps to finish the work on time.										
2.11	Design work plan is a motivation tool to increase the output of every member in the design team.										
2.12	The Bar chart or Gantt chart is used to show the plan of design process.										

3- Leading in the Design Process											
No.	**Concept**	**Agreement**					**Implementation**				
		Strongly Agree	**Agree**	**Intermediately Agree**	**Weekly Agree**	**Very Weekly Agree**	**Always**	**Often**	**Some times**	**Rarely**	**never**
3.1	Regular meetings are necessary for successful design process.										
3.2	Regular meetings contributes to common understanding among. the design team										
3.3	The first meeting (kick-off meeting) is necessary for successful design.										
3.4	The design team may be motivated when the firm adopts policies that offer comfortable work environment.										
3.5	The design team may be motivated when the firm adopts policies that improve the employees salaries.										
3.6	The employees' job satisfaction leads to finish the work in short time.										
3.7	The employees' job satisfaction leads to produce high quality work.										
3.8	The employees in the design firm need training in the technical field.										
3.9	The employees' in the design firm need training in the administrative field.										
3.10	The employees in the design firm needs training in computer skills.										
3.11	The employees in the design firm needs training in using the English language.										

4- The engineering design practice aims at											
No.	**Concept**	**Agreement**					**Implementation**				
		Strongly Agree	**Agree**	**Intermediately Agree**	**Weekly Agree**	**Very Weekly Agree**	**Always**	**Often**	**Some times**	**Rarely**	**never**
4.1	Achievement of profit.										
4.2	Production of high quality work.										
4.3	Getting bigger market share.										
4.4	Acquiring new knowledge in new fields.										

5- design Quality											
No.	**Concept**	**Agreement**					**Implementation**				
		Strongly Agree	**Agree**	**Intermediately Agree**	**Weekly Agree**	**Very Weekly Agree**	**Always**	**Often**	**Some times**	**Rarely**	**never**
5.1	The design is good when it is free from errors.										
5.2	The design is good when it is completed on time.										
5.3	The design is good when it provides all the required information for construction.										
5.4	The design is good when there are no contradiction in the design outputs.										

6- Estimating the design fees

6.1 The company gets the work through competitive tenders with two envelop proposals (Technical & Financial)

☐ Always ☐often ☐ Sometimes ☐ rarely ☐ never

6.2 The design fees are estimated using computer

☐ Always ☐often ☐ Sometimes ☐ rarely ☐ never

6.3 a) High technical score is aimed at in order to get the work with high prices.

☐ Always ☐ often ☐ Sometimes ☐ rarely ☐ never

b) Low price is aimed at in order to get the work.

☐ Always ☐ often ☐ Sometimes ☐ rarely ☐ never

6.4 The costs of design process are recorded to be used in estimating the cost of new design project.
☐ Always ☐ often ☐ Sometimes ☐ rarely ☐ never

6.5 The client has a great effect in estimating the design fees.
☐ Always ☐ often ☐ Sometimes ☐ rarely ☐ never

6.6 The volume of work in hands affects the fees estimation for new projects.
☐ Always ☐ often ☐ Sometimes ☐ rarely ☐ never

6.7 Employees' salary represents the following percentage of the total company expenses.
☐ < 40% ☐ 40%-59% ☐ 60%-79% ☐ > 80%

6.8 The design fees are calculated by the following:

	Always	**Often**	**Sometimes**	**Rarely**	**never**
Percentage to the total construction cost.					
A lump sum depending on the project type.					
Association of Engineers scale					
Salary cost times a multiplier.					
Detailed calculations of all cost elements and adding allowances for risk and profit.					

6.9 When calculating the employees salaries, in the financial proposal, the following is added as a percentage to the basic salary:

	< 10%	**10%-19%**	**20%-29%**	**30%-39%**	**40%-49%**	**50%-59%**	**60%-69%**	**>60%**
Social Allowances								
Project overheads								

6.10 When calculating the total design fees in the financial proposal, the following is added as a percentage to the direct costs.

	< 5%	**5%-9%**	**10%-14%**	**15%-19%**	**20%-24%**	**25%-29%**	**>30%**
General Over heads							
Risk							
Profit							

6.11 a) The actual design duration, in average, exceeds the planned duration by:

	Always	**Often**	**Sometimes**	**Rarely**	**never**
< 25%					
25%-49%					
50%-74T					
75T-99%					
100%-124%					
125%-149%					
150%-174%					
175%-199%					
> 200%					

b) When delay occurs in the design process it is the responsibility of :

	Always	**Often**	**Sometimes**	**Rarely**	**never**
The consultant					
The owner (the client)					
Other causes neither related to the consultant nor to the owner					
Joint responsibility, but consultant more.					
Joint responsibility, but owner more.					
Joint responsibility, but other causes more.					

Annex C: Evaluation Questionnaire for the Fees Estimating Model (FEM)

استبانه لمعرفة رأيكم في برنامج الحاسوب Fees Estimation Model (FEM)

للمساعدة في تقدير الأتعاب الاستشارية

السيد/ ____________________________

مدير مكتب/ __________________________

مـــرفق لســـيادتكم نســـخة عن برنامج تقدير الأتعاب الاستشارية الذي تم تطويره ليلبي متطلبات الاستشـــاري المحلـــي في مجال تقدير الأتعاب الاستشارية في المشاريع التي تعتمد طريقة التقييم الفني والمالي (Two Envelop Proposals).

يـــرجى مـــن ســـيادتكم تجربة البرنامج واختباره في واحد أو أكثر من المشاريع التي تقومون بتســـعيرها ومـــن ثـــم تعبئة الاستبيان من أجل التحقق من كفاءة البرنامج والتعرف على مزاياه وعـــيوبه، حيث أن رأيكم وملاحظاتكم على البرنامج ستساعد إلى حد كبير في تقييمه وتحسينه ، الأمر الذي نرجو أن يساهم في رفعة صناعة التشييد المحلية بشكل عام.

السؤال الأول: طرق إدخال المعلومات والتقنيات التي يوفرها البرنامج:

م	المعلومات والتقنيات	موافق جداً	موافق	موافق بدرجة متوسطة	موافق بدرجة ضعيفة	غير موافق
1	طريقة إدخال المعلومات مناسبة بشكل عام.					
2	طـــريقة إدخـــال المعلومـــات الخاصـــة بأسعار العناصر المختلفة للأتعاب مناسبة.					
3	طريقة إدخال المعلومات الخاصة بالتقييم الفني مناسبة.					
4	سهولة الحصول على المعلومات اللازمة للعناصر المختلفة للأتعاب.					
5	سهولة الحصول على المعلومات اللازمة للتقييم الفني.					
6	مخرجات البرنامج مفيدة بشكل عام.					
7	الرسم البياني للتوزيع الاحتمالي للأتعاب سهل الفهم.					
8	الرسم البياني للتوزيع الاحتمالي لفرص الفوز بالمشروع سهل الفهم.					
9	الرسم البياني للتوزيع الاحتمالي للأتعاب مفيد.					
10	الرسم البياني للتوزيع الاحتمالي لفرص الفوز بالمشروع مفيد.					
11	التعامل مع البرنامج سهل ولا يحتاج لوقت كبير للتدريب عليه.					
12	البرنامج مناسب للتطبيق في قطاع غزة.					

السؤال الثاني: ما هي في رأيك مميزات البرنامج الرئيسة؟

- ____
____
- ____
____
- ____
____
- ____
____

السؤال الثالث: ما هي الصعوبات التي واجهتك في استخدام البرنامج؟

- ____
____
- ____
____
- ____
____
- ____
____

السؤال الرابع: ما هي مقترحاتك لتحسين أداء البرنامج؟

- ____
____
- ____
____
- ____
____

مع جزيل الشكر

الباحث: م. إبراهيم رضوان

Annex D: English Version of the Evaluation Questionnaire for the Fees Estimating Model (FEM)

Evaluation Questionnaire for the Fees Estimating Model (FEM)

Dear Sir:

Kindly you find attached a copy of Fees Estimating Model (FEM), which has been developed to help local consultants estimate their fees in the two-envelop proposals. Please try the model in one or more of the design projects you are costing and the fill the following questionnaire. You contribution will evaluate FEM and consequently helps to improve to be more useful to the local construction industry.

1. Data entering and the model techniques

SN	Data and Techniques	Very Much Agree	Agree	Intermediately Agree	Weakly Agree	Do Not Agree
1	In general, the way of data entering in the model is suitable.					
2	The way of entering cost data is suitable.					
3	The way of entering technical data is suitable.					
4	It is easy to get the required cost data.					
5	It is easy to get the required technical data.					
6	In general, the model outputs are useful.					
7	"Cost Distribution Chart" is easy to understand.					
8	"Winning Chance Chart" is easy to understand.					
9	"Cost Distribution Chart" is useful.					
10	"Winning Chance Chart" is useful.					
11	FEM is a user friendly program and it does not need much training					
12	FEM is suitable for using in Gaza Strip					

2. In your opinion, what are the main advantages of FEM?

____

____

____

____

____

____

____

____

____

3. In your opinion, what are the main difficulties you faced in using FEM?

____

____

____

____

____

____

____

____

____ .

4. What are your suggestions to improve FEM?

____

____

____

____

____

____

____

Thank you very much.
Ibrahim Radwan

Annex E: FEM Applied to a Real Sample Project

Annex E: FEM Applied to a Real Sample Project

Table of Contents

E.1 Introduction :

The researcher works as a manager of a consulting firm, Universal Group for Engineering and Consulting (UG). He has tried the model in estimating the cost of some projects that the firm participated in the competition for providing consulting services. He found FEM realistic and helpful. The outputs of FEM were satisfactory and the actual prices of the competing consulting firms were within the prices predicted by FEM.

E.2 Project Description and TOR Requirements

- **Project Type:** Design of a sewage pumping station, pressure main and gravity collection network.
- **Client:** A Municipality in the Middle Area of Gaza Strip.
- **Invitation to Tenders:** In December 2003.
- **Design Works Start Date:** January 19, 2004.
- **Project Duration:** Two months.
- **Design Works Completion Date:** March 21, 2004.

- **Required staff**
  - o Project Manager (10 Year Experience).
  - o Water Engineer (10 Year Experience).
  - o Electrical Engineer (8 Year Experience).
  - o Mechanical Engineer (10 Year Experience).
  - o Surveyor (5 Year Experience).
- **Work Tasks**
  - Site investigation including topographical survey and soil investigation.
  - Preliminary Design of the pumping station, its pressure line and the collection network.
  - Detailed Design and preparation of tender documents of the above mentioned items.
  - Production of three hard copies of the tender document in five packages.
- **Technical Evaluation Criteria and Weights**

  (i) The firm general experience in the field of the assignment (15 points).

  (ii) The adequacy of proposed work plan and approach in responding to the T.O.R (35 points).

(iii) The qualifications and competence of the personnel proposed for the assignment (50 points). This item was rated as follows:

- General qualification (15 points).
- Adequacy for the assignment and experience in the region (30 points).
- The language (5 point).

- **Technical and Financial weights**

  Technical Weight (T) = 70% and Financial Weight (F) = 30%.

E.2 FEM Application

Before starting to use FEM in estimating the financial proposal amount, the firm management should decide the tendering strategy and then prepare the needed cost and technical data.

E.2.1 Tendering Strategy

The firm strategy was to do its best to win this project even with a low profit and high level of uncertainty (UL). On the other hand, the firm decided to aim at achieving high technical score in order to increase the winning chance. The firm decided to choose a competent senior staff supplemented with a junior staff in order to strengthen the project personnel and get high scores for the staff (The staff weight is 50 % of the technical score).

E.2.2 Cost Data

The firm prepared the design methodology and work plan including a staffing schedule. The project cost was broken down according to the "FEM Cost Inputs Sheet". The cost data was prepared by the firm's manager after consultations with the project proposed staff. The currency used is US$. Table E-1 was prepared and reviewed, then the data was entered in FEM Cost Inputs Sheet, as depicted in Figure E-1.

As noted in Table E-1, the following guidelines were adopted in determining the cost.

- For each team member:
  - Basic salary: (The min. value is as determined by the Association of Engineers scale of rates)
  - Social charges (Ranging between 5% - 30%, as per the field survey results).

- Project Overhead (Ranging between 3% - 40%, as per the field survey results).
- Duration of involvement:

  2.0 months for project manager.

  1.0 month for senior staff members.

  1.0 month for junior staff members.
- Input (Based on proposed methodology and work plan).

▪ For the other costs, the price was according to the previous agreements with the sub consultants.

▪ The GOH ranged from 3% to 15% while the risk was estimated to be between 3% to 20%.

E.2.3 Running the Cost Estimating Simulation

To run the cost estimation simulation it is needed to enter the cost data as previously mentioned. After that the required number of simulation runs is entered in the cell opposite to "No. of Runs" (The number entered is 200 runs). Then the button (Calculate the Cost n Times) is clicked. The computer runs the required simulations and the Min., Max. and Average costs appear in their corresponding cells. As noted in Figure E-1,

▪ **Min Cost = $8,463**

▪ **Max. Cost = $1,1959**

▪ **The average Cost = $10,256**

Table E-1: Sample project cost data

I- Staff	Cum. Probability	0	0.25	0.5	0.75	1
Project Manager	Basic Salary	1000	1050	1100	1150	1200
	Social Charges	0.05	0.1	0.13	0.17	0.35
	Direct Overheads	0.03	0.1	0.15	0.19	0.4
	Duration	2	2	2	2	2
	Input	0.2	0.25	0.3	0.325	0.35
Senior Electrical Eng.	Basic Salary	800	825	850	875	900
	Social Charges	0.05	0.1	0.13	0.17	0.35
	Direct Overheads	0.03	0.1	0.15	0.19	0.4
	Duration	1	1	1	1	1
	Input	0.1	0.125	0.15	0.175	0.2
Senior Mechanical Eng	Basic Salary	800	825	850	875	900
	Social Charges	0.05	0.1	0.13	0.17	0.35
	Direct Overheads	0.03	0.1	0.15	0.19	0.4
	Duration	1	1	1	1	1
	Input	0.1	0.125	0.15	0.175	0.2
Junior Structural Eng.	Basic Salary	500	500	525	525	550
	Social Charges	0.05	0.1	0.13	0.17	0.35
	Direct Overheads	0.03	0.1	0.15	0.19	0.4
	Duration	1	1	1	1	1
	Input	0.1	0.15	0.2	0.225	0.25
Junior Hydraulic Eng.	Basic Salary	500	520	550	570	600
	Social Charges	0.05	0.1	0.13	0.17	0.35
	Direct Overheads	0.03	0.1	0.15	0.19	0.4
	Duration	1	1	1	1	1
	Input	0.1	0.15	0.2	0.25	0.3
Junior Electrical Eng.	Basic Salary	500	500	525	525	550
	Social Charges	0.05	0.1	0.13	0.17	0.35
	Direct Overheads	0.03	0.1	0.15	0.19	0.4
	Duration	1	1	1	1	1
	Input	0.1	0.15	0.2	0.25	0.3
Junior Mechanical Eng	Basic Salary	500	520	550	570	600
	Social Charges	0.05	0.1	0.13	0.17	0.35
	Direct Overheads	0.03	0.1	0.15	0.19	0.4
	Duration	1	1	1	1	1
	Input	0.1	0.15	0.175	0.2	0.25
Draftsman	Basic Salary	350	360	375	400	420
	Social Charges	0.05	0.1	0.13	0.17	0.35
	Direct Overheads	0.03	0.1	0.15	0.19	0.4
	Duration	1.5	1.5	1.5	1.5	1.5
	Input	0.15	0.25	0.3	0.35	0.5

Table E-1: Sample project cost data (cont.)

II Others	**Cumulative Probability**				
	0	**0.25**	**0.5**	**0.75**	**1**
Hydraulic Engineer	1200	1400	1500	1550	1600
Soil Lab.	1500	1500	1600	1700	2000
Surveying Company	3000	3300	3500	3800	4000
Printing	350	450	500	550	600
III Indirect Costs	**Cumulative Probability**				
	0	**0.25**	**0.5**	**0.75**	**1**
GOH	0.03	0.09	0.1	0.12	0.2
Risk	0.03	0.05	0.1	0.12	0.15

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Calculate The Cost n Times | Technical

Sample Project

No. of Runs	200
Min Cost	8,464
Max Cost	11,959
Average Cost	10,256

		Cumulative Probability	0	0.25	0.5	0.75	1
Staff	Project Manager	Basic Salary	1,000	1,050	1,100	1,150	1,200
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration	2	2	2	2	2
		Input	0.2	0.25	0.3	0.325	0.35
	S. Electrical Engineer	Basic Salary	800	825	850	875	900
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration	1	1	1	1	1
		Input	0.1	0.125	0.15	0.175	0.2
	S. Mechanical Engineer	Basic Salary	800	825	850	875	900
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration	1	1	1	1	1
		Input	0.1	0.125	0.15	0.175	0.2
	J Structural Engineer	Basic Salary	500	500	525	525	550
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration	1	1	1	1	1
		Input	0.1	0.15	0.2	0.225	0.25
	J. Hydralic Engineer	Basic Salary	500	520	550	570	600
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration	1	1	1	1	1
		Input	0.1	0.15	0.2	0.25	0.3
	J Electrical Engineer	Basic Salary	500	500	525	525	550
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration	1	1	1	1	1
		Input	0.1	0.15	0.2	0.25	0.3
	J. Mechanical Engineer	Basic Salary	500	520	550	570	600
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration	1	1	1	1	1
		Input	0.1	0.15	0.175	0.2	0.25
	Drafts Man	Basic Salary	350	360	375	400	420
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration	1.5	1.5	1.5	1.5	1.5
		Input	0.15	0.25	0.3	0.35	0.5
	Staff 9	Basic Salary					
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration					
		Input					
	Staff 10	Basic Salary					
		Social Charges	0.05	0.1	0.13	0.17	0.35
		Direct Overheads	0.03	0.1	0.15	0.19	0.4
		Duration					
		Input					
Others	Hydraulic Engineer		1,200	1,400	1,500	1,550	1,600
	Soil Lab.		1,500	1,500	1,600	1,700	2,000
	Surveyng Company		3,000	3,300	3,500	3,800	4,000
	Consultant 4						
	Printing		350	450	500	550	600
Indirect	GOH		0.03	0.09	0.1	0.12	0.2
	Risk		0.03	0.05	0.1	0.12	0.15

Figure E-1: FEM Cost Input Sheet

E.2.4 Technical Data

The distributions of the different elements of the technical score were prepared according to the evaluation of the prepared technical proposal and the firm's previous technical scores for the similar projects. Table E-2 indicates the distributions of the technical score elements prepared by the firms manager together with the project proposed staff.

Table E-2: Technical score data for the sample project

Criteria	Sub-Criteria	Weight	Cumulative Probability				
			0	**0.25**	**0.5**	**0.75**	**1**
Experience	General	15	12	12.5	13	13.5	14
Methodology		35	30	31	32	32.5	33
Staff	Qualification	15	10	10.5	11	12	12.5
	Adequacy	30	25	25.5	26	27	28
	Language	5	4	4	4	4	4

After reviewing the technical data, it was entered in the "FEM Technical Inputs Sheet", as shown in Figure E-2.

E.2.5 Running the Technical Score Estimating Simulation

To run the technical score estimating simulation, it is needed to enter the technical data previously described. In addition, the following is to be entered in the corresponding cells of the "FEM Technical Inputs Sheet".

- Number of simulation runs. (The entered number is 200)
- Financial weight.(30%)
- Technical weight. (70%)
- Passing score. (70%)
- Assumed min. price. (The entered amount is $9,000. This amount is judged considering the min. calculated cost and the expected prices of competing firms).

After entering all the technical data, the button (Calculate the Technical Score n Times) is clicked. The computer runs the required number of simulations and the calculated Min and Average scores will appear in the corresponding cells of the "FEM Technical Inputs Sheet". As noted in figure E-2, Min. Tech. Score is **82%** and Average Tech. Score is **86.2%**

New Project | Charts | Back to FEM

Calculate Technical Scores n Times | Cost Inputs

Sample Project

Insert number of runs (n)	200
Insert Financial Weight	**30**
Insert Technical Weight	**70**
Insert Passing Score	**70**
Assumed Min Price	**9,000**
Assumed Technical Score	

Calculated Min Score	82.00549
Calculated Min Cost	8,464
Average Technical Score	86.202865

Technical Inputs

			Cumulative Probability				
Criteria	**Sub-Criteria**	**Weight**	**0**	**0.25**	**0.5**	**0.75**	**1**
Experience	**General**	15	12	12.5	13	13.5	14
	Specific						
Work Plan and Methodology	**A**	35	30	31	32	32.5	33
	B						
	C						
Staff	**Qualification**	15	10	10.5	11	12	12.5
	Adequecy	30	25	25.5	26	27	28
	Language	5	4	4	4	4	4
Others	**A**						
	B						
	C						
Total		**100**			Total Score		

Figure E-2: FEM technical Inputs Sheet

E.3 FEM Outputs and the Decision Making

After finishing the cost and technical simulations the FEM Output Charts are generated. Based on the firm strategy, the output charts are used to determine the bidding cost. The decision is made in the following steps:

- First, the "Winning Chance Chart", Figure E-3, is checked. It is noted that for a price ranging between $9,000 and $10,000, the probability of winning the tender ranges between 56% and 75%. This seems to be a good probability. Accordingly, the firm management decided to adopt the bidding price to be between $9,000 and $10,000.
- Second, the "Cost Distribution Chart", Figure E-4, is checked to identify the uncertainty level (UL) and the expected profit corresponding to the chosen price range in the previous step. As depicted in Figure E-4, if the price is $10,000, at UL of 65% the profit will be zero, whilst at UL of 85% the profit is 5%. (In other words, if the price is $10,000 the probability of working with a zero profit will be 35% and the probability to achieve 5% profit will be 15%).

  The firm strategy was to bid in a low price in order to maintain the high winning chance. The firm decided to bid with a price a bit below $10,000.
- Finally, the bidding price is calculated and broken down in accordance with the financial proposal formats. The calculated price was $9,920. By checking Figure E-3 again, it is noted that the probability of winning the tender corresponding to this price is about 57% which is a relatively good chance.

E.4 Actual Technical and Financial Results

Five consulting firms passed the minimum technical score (70%). Table E-3 depicts the technical scores, the prices and total scores of these firms.

Table E-3: Tender evaluation results for the sample Project

Firm	TECH.		FIN.		Total Score
	100%	**70%**	**$**	**30%**	
1	91.7	64.19	11500	25.88	**90.068**
2 (UG)	87.83	61.48	9920	30.00	**91.481**
3	81.53	57.07	10250	29.03	**86.105**
4	81.23	56.86	10265	28.99	**85.853**
5	80.7	56.49	11290	26.36	**82.85**

Table E-3 shows that the firm (UG) has won the project as it planned. It is noted that the actual prices are within the cost distribution calculated by FEM (Figure E-4). Also, UG actual technical score (87.8) is close to the estimated one (86.2).

E.5 The Project Actual Costs

The firm recorded all the costs related to the project until the design completion. Table E-5 depicts these actual costs.

Table E-5: Project Actual costs

1. Staff	**Salary ($)**	**Input**		**Duration of Involvement**		**Total Actual Cost ($)**
		Estimated	**Actual**	**Estm.**	**Act..**	
Project Manager	1300	0.2 to 0.35	0.2	2	2	520
Senior Electrical Eng.	800	0.1 to 0.2	0.16	1	1	128
Senior Mechanical Eng	800	0.1 to 0.2	0.2	1	1	160
Junior Structural Eng.	500	0.1 to .25	0.24	1	1	120
Junior Hydraulic Eng.	550	0.1 to 0.3	0.5	1	2	550
Junior Electrical Eng	500	0.1 to 0.3	0.2	1	1	100
Junior Mechanical Eng.	600	0.1 to .25	0.08	1	1	48
Draftsman	330	0.15 to 0.5	0.3	1	1	99
Total Staff Cost						**1725**
Overheads and Social Charges (20% of staff cost)						345
Total Staff Cost Including Project OH and Social Charges						**2070**
2. Others					**Estimated ($)**	**Actual ($)**
Hydraulic Consultant					1,200 to 1,600	1200
Soil Investigation					1,500 to 2,000	1800
Surveying Works					3,000 to 4,000	4000
Printing					350 to 550	400
Total Others						**7400**
Total (Staff + Others)						**9470**
3. General Overhead (4% of total staff + others)						378.8
Grand Total						**9848.8**
Bidding Price						**9920**

It is noted in Table E-5 that the actual cost is close to the bidding price. The profit is about 1% (The estimated profit ranged between 0 to 5%)

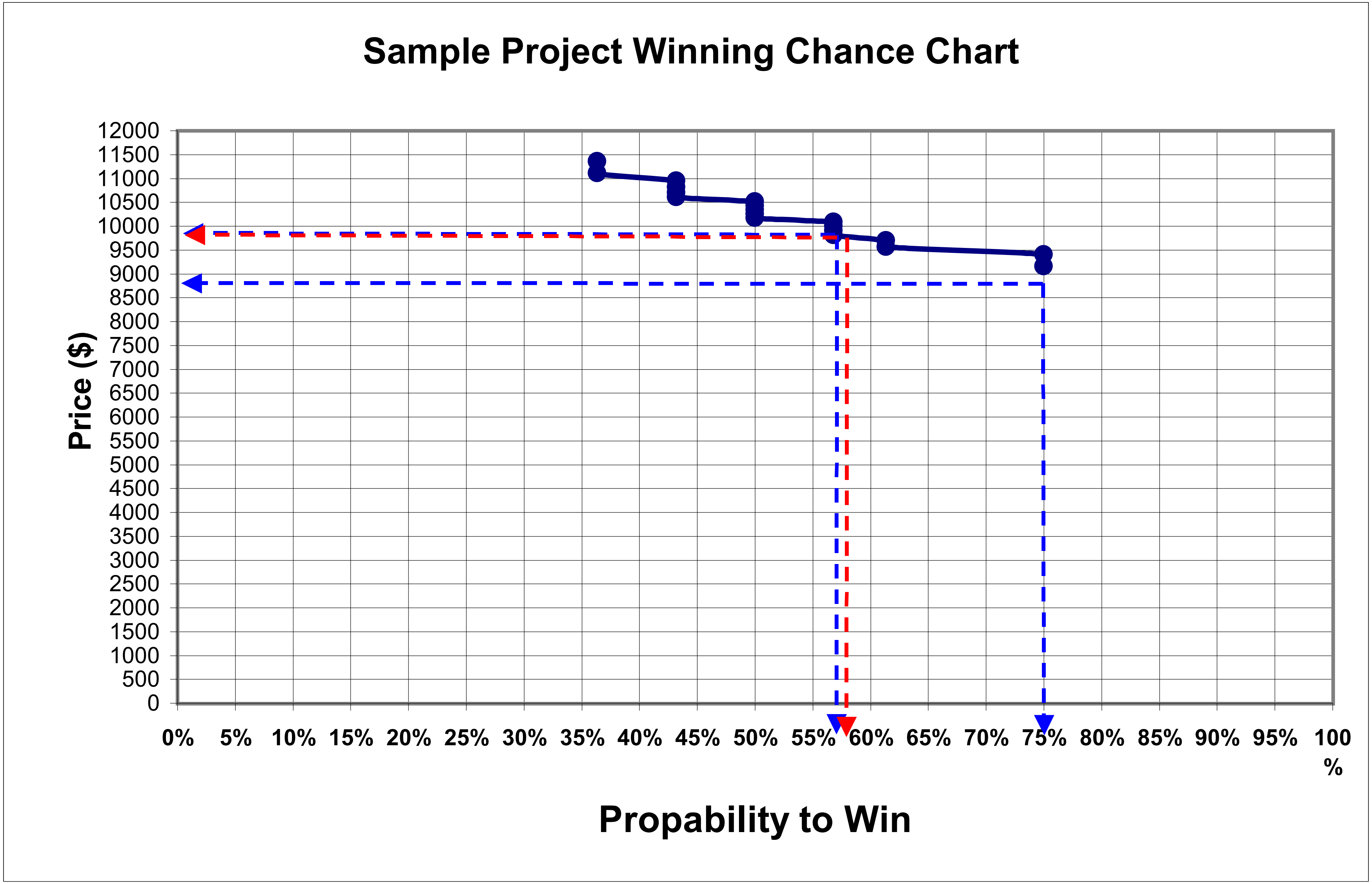

Figure E-3: Winning Chance Chart

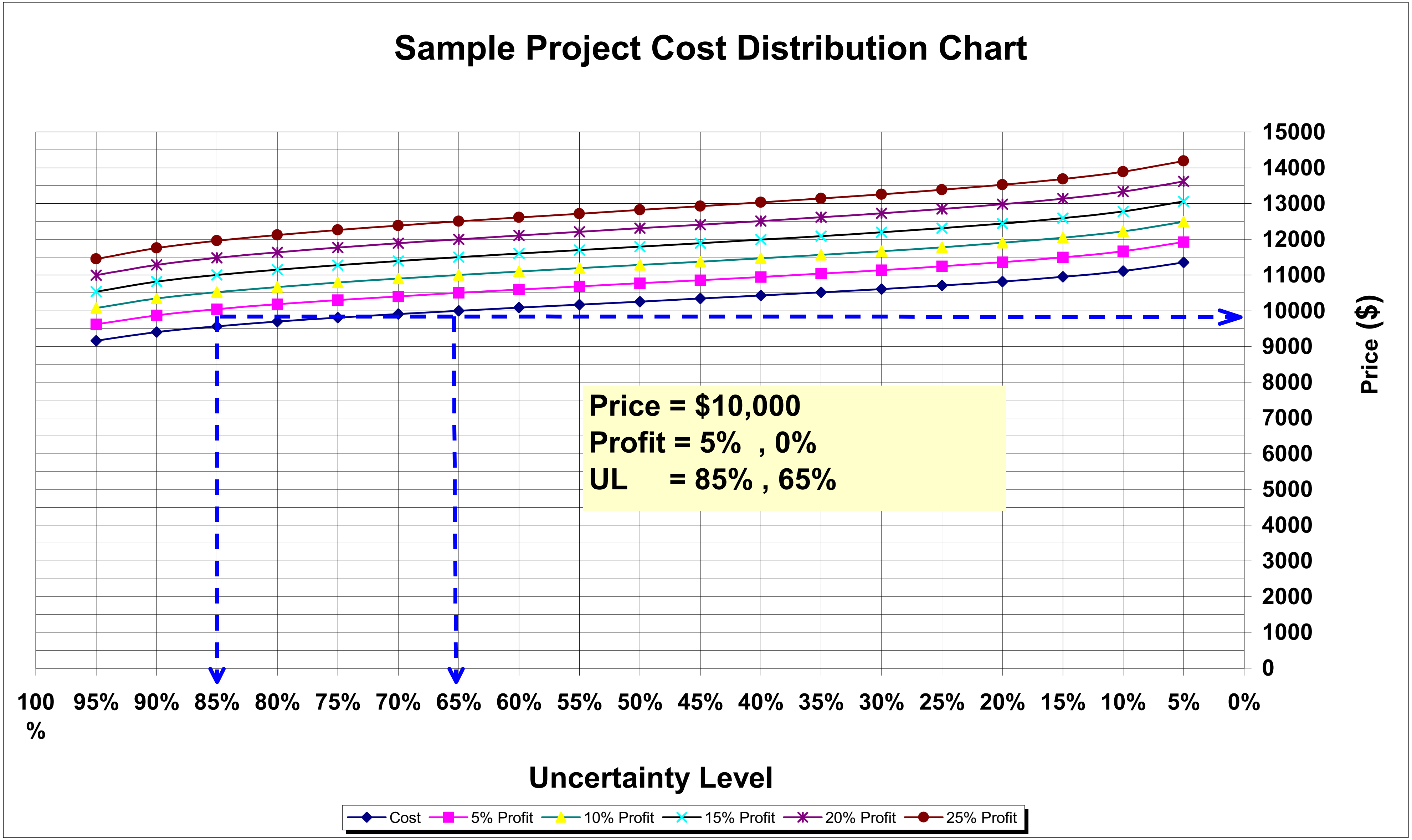

Figure E-4: Cost Distribution Chart