

Factors Affecting the Accuracy of Construction Costs Estimating in Saudi Arabia

by

Zaitoun Shadeed Al-Khaldi

A Thesis Presented to the

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In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

CONSTRUCTION ENGINEERING AND MANAGEMENT

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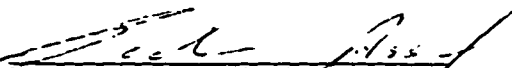
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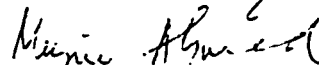
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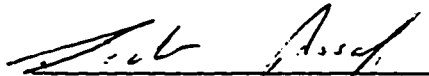
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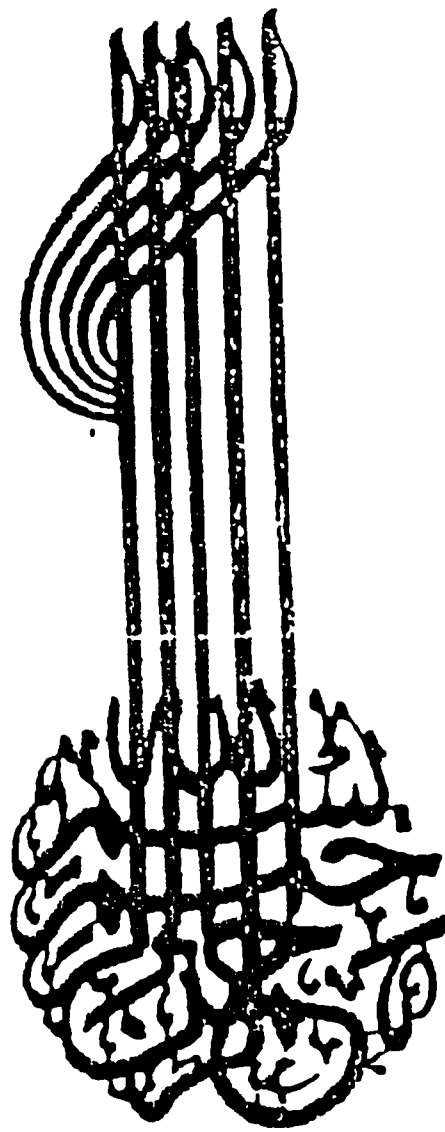

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إهداء

إلى الذين كانا سبب وجودي في الحياة فكانت هذه البذرة
إلى الذين كانوا معي بقلوبهم وأقوالهم وأعمالهم نرعى هذه النبتة
إلى الذين حُرِّموا مني وحُرِّمت منهم لتنضج الثمرة
إلى وطني الكبير..... أهدي هذه الثمرة

اللهم تقبل منا أحسن ما عملنا وتجاوز عن سيئاتنا .

زيتون

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خلاصة الرسالة

اسم الطالب الكامل : زيتون شديد زيتون الخالدي
عنوان الدراسة : العوامل المؤثرة على صحة تقدير التكاليف
التخصص : هندسة وإدارة المشاريع
تاريخ الشهادة : ذوالقعدة ، ١٤١٠هـ

تناقش هذه الرسالة التكاليف الإنشائية المختلفة والعوامل الرئيسية المؤثرة التي يلزم على مقاولي المباني مراعاتها عند تقدير التكاليف .

لقد قام الباحث بإجراء مسح إستبباني شمل ٣٤ مقاول بناء و ١٣ مكتباً هندسياً يعملون بالمنطقة الشرقية من المملكة العربية السعودية .

هناك عوامل رئيسية مختلفة يجب أن تؤخذ في الإعتبار عند تقدير تكاليف المشاريع . هذه العوامل صُنفت حسب تأثيرها على صحة تقدير التكاليف وذلك لمعرفة أهميتها ومراعاتها في المشاريع المستقبلية . وقد عمل تصنيفاً لهذه العوامل طبقاً لإيجابيات الإستشاريين والمقاولين كل على حده . وقد أستخدم الحاسب الآلي في تحليل المعلومات المقدمة .

وفي نهاية البحث قُدمت بعض الإقتراحات بشأن المواضيع التي يمكن التعمق في دراستها مستقبلاً .

درجة الماجستير في العلوم
جامعة الملك فهد للبترول والمعادن
الظهران - المملكة العربية السعودية
ذوالقعدة ١٤١٠هـ

ABSTRACT

This thesis discusses and analyzes the different classifications of construction cost and the essential factors which building contractors are advised to take into account in tendering their projects. A survey of 34 contractors and 13 consultants from the Eastern Province of Saudi Arabia was undertaken. There are different factors that are essential and should be considered in estimating construction cost. These factors were ranked according to an importance index. Ranking was done individually from contractors and consultants. A computer statistical package was used to analyze the data.

CHAPTER 1

I. INTRODUCTION

Cost estimating is essentially an accumulation of details. It is the process of calculating and analyzing all the costs which will enter into a particular job and arriving at a total. In nearly all contract types, the preparation of a realistic cost estimate is a necessary part of any construction operation (Clough 1981).

If a contractor bids in a competitive contract type, he must be the lowest bidder on a sufficient number of the projects if he wishes to stay in business. However, his bid must not be so low that it might lead him to complete the work without profit and sometimes at an actual loss of both time and money. Although negotiated contracts lack the competitive elements, a contractor has to estimate the construction cost accurately to attract owner clients. In other types of contracts, such as design-construct and construction management contracts, the contractor is assumed to provide expert cost assistance and advice as the design develops.

There are many factors that affect the accuracy of construction cost estimating of large buildings and which should be taken into account in the early stage of an estimate. Some factors can increase costs and the possibility of contractual disputes between the various parties involved. Other

factors can lead the estimator to decrease the cost of an item and hence lead to successful tendering in a very competitive market.

Therefore, accurate estimating, which is done before the physical realization of the work, requires detailed study of the bid document and the environmental situation. It also involves a careful analysis of the results of the study in order to arrive at the most accurate estimate of the probable cost consistent with the bidding time available and the accuracy and completeness of the information submitted. However, very few contractors in Saudi Arabia used to prepare detailed estimates in the 1970s and early 1980s.

The construction industry was the greatest recipient of Saudi Arabian Government spending during both the First (1970-75) and Second (1975-80) National Development Plan. At that time, there was plenty of work and plenty of money in terms of profit. Contractors did not have to spend much effort designing accurate construction costs in preparing their trends.

Partly because of some huge cost overruns in the past and because of oil price fluctuations during the mid-Eighties, the construction industry, like other sectors of the Saudi economy, has cooled down and changed its attitude to a *more conservative approach*.

Unfortunately, some contractors still do not realize this approach and work on a more conservative attitude. Therefore, to land a contract, to complete a profitable piece of work, to reduce the possibility of disputes

and to control the potential problems associated with construction cost estimating, *a realistic job estimate*, which requires adequate attention to the preparation of the estimate, emerged to satisfy this approach.

This study presents to the estimators proper methods for estimating large projects. Since the estimating process is an art, this study introduces the different factors that are essential and should be considered in estimating construction costs in order to have a realistic estimate that will secure a good market share and reduce the chance of conflict and future litigation. For this reason, this area of study is considered to be important for future improvement in the field of construction .

1.1 Statement of the Problem

The estimator does have available some reliable references for estimating labors, materials, equipment and other major components. These major items have a high visibility factor and consequently receive adequate attention in the preparation of the estimate. However, there are little-known, low visibility factors affecting the estimate accuracy which should be taken into consideration in the preparation of estimates. Unfortunately, these factors are either entirely overlooked or sadly neglected (Gladston 1976).

Identification of these low visibility factors is very important, especially for future projects, for business survival and risk elimination, or minimization. This study is an attempt to identify these factors, their importance and their impact on the accuracy of construction cost estimating.

This study will provide contractors with information that will help to avoid or reduce a loss on a construction job.

1.2 Objectives of the Study

The main objectives of this research are :

1. Identification of the different classifications of construction costs.
2. Identification of the essential factors that affect the accuracy of cost estimation of large building projects in Saudi Arabia.
3. Testing the hypothesis that contractors and consultants generally agree on the severity of the factors that affect the accuracy of cost estimating of large building projects in Saudi Arabia.

1.3 Scope and Limitations

The emphasis in this research will be on the essential factors which contractors should take into account in tendering for their projects. The study will be limited to public building projects in the Eastern Province of Saudi Arabia.

1.4 Thesis Organization

This thesis will discuss and identify the different classifications of construction cost and the essential factors which building contractors

should take into account in tendering their project.

The thesis is divided into six chapters. The first chapter gives general background information on construction cost estimating in the Kingdom of Saudi Arabia, gives a statement of the problem, the objectives of the study, its scope and limitations. Chapter two summarizes the related literature to construction process. Chapter three discusses the factors affecting the accuracy of costs estimating in the Eastern Province of Saudi Arabia and the research methodology used in this study. This chapter addresses questionnaire design, the sample size, the selection of the data collected and a method of collecting data from contractors and consultants related to the problem. The fourth chapter is an identification of the various types and classification of construction costs. The fifth chapter discusses the statistical methods used, tables and information deduced from statistical analyses and the statistical results and interpretation of these tables and information. It also contains the ranking by severity index of the factors affecting the accuracy of costs estimating by contractors and consultants. A hypothesis is set up and tested that the contractors and consultants, generally agree on the severity rank of the factors. Finally, chapter six is devoted to a summary and recommendations.

CHAPTER 2

LITERATURE REVIEW

A review of the literature indicates that extensive analysis of ideas, techniques and strategies has been carried out on the subject of construction cost types, estimation and bidding. Factors affecting the estimating of construction costs show a major shortage of articles. However, in Saudi Arabia no complete study has been done about this subject, which takes into consideration the possible effects of the different surroundings.

The cost of work is made up of different types of costs which constitute the total cost. Adrain (1982), Collier (1989), Ferry (1972), Chrystal-Smith and Jolly (1985) classified building costs as material, labor, equipment, overhead and profit.

Adrain (1982) emphasizes in his book, "Construction Estimating", the preparation of a general contractor's estimate for a construction project. The book illustrates how the estimator's knowledge of accounting and productivity analysis offer him the alternative construction methods that are essential to the estimating task.

Douglas (1972) discusses the cost planning of buildings. Douglas discusses two kinds of cost planning. Firstly, the "traditional" cost

planning techniques to deal with the ordinary competing tenders bill of quantity situation. Secondly, the awakening of cost consciousness in construction design has encouraged a more strategic look at cost requirements and how they may best be met in different circumstances bearing in mind the deficiencies of traditional techniques.

Chrystal-Smith and Jolly (1985) examine the factors that should be taken into account in estimating the cost and tendering for buildings and civil engineering works of construction. These involve the following factors.

1. "The output of mechanical plant is variable, for some plant operators are more efficient than others. This is particularly applicable to plant where the operator is himself chiefly responsible for the output concerned, such as mechanical excavating plant of the skimmer, shovel, tractor and scraper type.
2. The output of labour, both skilled and unskilled, is variable, for one man produces more of a similar kind in a given time than another.
3. Weather conditions have a marked effect upon output. Under wet weather conditions the output of excavation in particular is reduced, for site conditions become soft and heavy, excavating plant tends to become clogged, while internal transport on open sites becomes difficult. Frost also affects output; unless anti-freeszes are used, bricklaying, concreting, plastering, etc., cannot be carried out. Excessive heat can also affect output, for a man does not work energetically when he is uncomfortably warm."

Collier (1987) emphasized the importance of some factors that affect construction costs. He wrote:

"It would be wrong to give the impression that all estimates and bids for construction work are made up of costs of labors, materials, equipment, job overhead costs, and operating overhead costs, all estimated from determined facts and calculated probabilities, and with a profit margin precisely computed according to current economic indicators."

He added:

"there are other things that at times may have a greater influence on the amount of a bid than any variations of those costs and the most important of these is the demand for construction work."

Meyer (1979) mentioned some of the factors that should be considered by a contractor when tendering for a project inside and outside his own country. In his paper, Mayer did not classify the importance of these factors when estimating the construction cost.

Gladstone (1976) in his paper, analyzed low visibility items in mechanics estimates. He established some construction ratios in analyzing "invisibility items".

Walance (1977) outlined in his paper, "Construction Costs in Saudi Arabia", the various cost differentials and project scope additions required to "convert" a Gulf Cost U.S. estimate to an Arabian base. He discussed and illustrated the conditions giving rise to cost differentials and provided an adjustment conversion technique. Although his paper is concerned primarily with construction costs, some mention has been made of factors affecting capital cost components. Some unique conditions in Saudi Arabia, such as labor laws, climate, labor nationality and local market conditions all of which have a major impact on the cost of construction, were

highlighted in this paper.

Walker (1981) discussed in his paper, "Estimating Construction Costs Abroad", the major economic factors that can have such a dramatic effect on cost and need to be considered under each aspect of the economic system. These are:

"Political System

- Stability
- Attitude towards foreign investment
- Type of bureaucracy

Finance

- Banking system
- Insurance regulations
- Tax system
- Duties

Legal system

- Business ethics
- Education
- Language & religion

Geography

- Infrastructure & communication
- Climate

Industry

- Capacity
- Diversity
- Efficiency"

Brown (1977) emphasized the importance of the bidding strategy for competitively bid construction contracts. He wrote:

"The most sophisticated and efficient estimating and cost control system cannot insure that a construction

contractor will make a profit unless he can obtain sufficient work at the proper price. Because virtually all public work and a large portion of private work is obtained by competitive bidding the Construction Contractor and the Cost Engineer have a vital interest in bidding strategy."

Borritt (1988) raised the issue of laborers' nationality and how social and cultural issues affect their level of work. In his paper about Saudi Arabia, Borritt emphasized the importance of managing multinational staff. He wrote:

"By understanding the outside pressure under which his staff is living and by expressing a sincere interest in their culture, a manager can establish a rapport with his multinational staff that exceeds anything normally seen in the United States and produce quality work that is the envy of his colleagues."

Standell (1978) emphasized the importance of productivity in construction. He stated that:

"There is general agreement by owners, engineers and contractors that **PRODUCTIVITY** in the construction industry is a problem worthy of serious study. There is no question as to its effect on the cost and time involved in completing a constructed facility."

In view of the construction cost estimate reliability or accuracy, Taylor (1977) divided capital cost estimates into the following distinct parts:

1. "Those components for which available historical information has afforded reasonable certainty of expected costs. These items include such things as mechanical equipment, concrete and structural components as related to specific process units i.e. clarifiers, aeration basins, etc., certain piping

configurations of pumps; and standard electrical costs. These items are relatively easy to estimate, due to extensive historical files.

2. Those components which require precise information relating to specific philosophies of each client, although classified as indirect items, have a very significant effect on the estimated costs. Examples of this would be:
 - A. The flow diagram indicates pumps and piping for a pumping station. An expected value can be applied to the pump and the normal piping associated with suction and discharge headers. However, the structure is not defined at all on the flow diagram, but represents a significant dollar value to the project cost. In the transmittal of details between the engineer and estimator, it may have been disclosed that the client has most of these pumps located outside on pads with little or no shelter over them. This "philosophy" would be translated to quantifications of costs as a very low expenditure, compared to the cost of housing all the pumps.
 - B. Buildings on the client's site are of high quality and good aesthetics. It would only be natural that the new project built within an observing distance of the existing plant would maintain the same quality of standard.
 - C. Any notice of unusual site conditions, rock, water, heavy woods, and any mention of piling on existing structures, have tremendous impact on the estimated costs, and must be defined in the scope of work".

Hohne (1985) emphasized the importance of cost estimating for U.S. companies operating in Saudi Arabia. He wrote:

"A major problem for U.S. companies operating in Saudi Arabia is in making realistic job cost estimates to put into a proposal. While estimating the costs for equipment and consumables is relatively easy, estimating labor costs can be a real problem."

Beside the labor costs, Hoehne mentioned other issues of equal importance and having a major effect on the accuracy of the estimate.

Ioannov (1988) emphasized the importance of geologic uncertainty which has a significant effect on project cost. He wrote: "Site investigation can reduce this uncertainty and decrease costs by reducing the contingency amounts included in bids".

Koehn (1985) emphasized climatic effects on construction. The relationship between overall construction productivity, and temperature and humidity are presented in his paper.

Al-Jarallah (1983) highlighted the economical, social, technical, legal and management problems associated with the construction boom in Saudi Arabia. In his paper, future trends in the construction industry were discussed, and some recommendations were included for a better stay in the Saudi construction market.

Merrow (1979), in his paper, "A Review of Cost Estimation in New Technologies : Implications for Energy Process Plants" characterized factors responsible for cost growth in energy projects. It appears from Merrow's work that if one wishes an accurate and early prediction of the cost for a large product, one must start with a cost model which includes a number of variables and interrelationships which are not found in standard cost estimating formats.

In view of the factors affecting construction cost Itani (1985) wrote

a general paper on this subject as it applies to Saudi Arabia. . He wrote:

"The construction costs in Saudi Arabia are generally affected by all contributing organizations and resources, including clients, designers, contractors, construction materials, labor, machinery, and of course the economic and institutional environment of the Kingdom."

CHAPTER 3

RESEARCH METHODOLOGY

This chapter presents the procedures that have been followed for achieving the objectives set for this study. The procedures include all information relevant to what data are needed, why these data are needed, why these data are essential, where and how the data are secured, and the method whereby a sample unit is selected.

3.1 Required Data

There are two required data to be investigated in this research, namely the data relevant to the different classification of construction costs coupled with the data necessary for the major factors that affect the accuracy of construction costs estimating for large buildings.

3.2 Data Collection

Necessary data were collected from two different types of sources: (1) the literature review, and (2) construction contractors and consultants through a survey search.

3.2.1 Literature Search

The literature indicates that there are endless factors affecting the

accuracy of construction costs estimating for large buildings. Moreover, as the building project gets larger and more complex, the probability of having so many factors increases.

The literature search resulted in identifying twenty nine essential factors affecting the accuracy of costs estimating for large buildings. Some of these were the results of the other.

The twenty nine factors are combined into four major areas. These areas were further subdivided into divisions. These areas and divisions will be discussed in the following sections.

3.2.1.1 Environment

Unlike other industrial products, construction products (projects) are affected very much by the surrounding environment (Taylor 1977). Productivity and efficiency is influenced by the environmental situation. This environment will affect the project cost and time. The environment was divided into ten divisions, namely, weather, social and cultural impact, public exposure of the project, local laws and religious customs, project location, level of competition and number of competitors, laborers' nationality, lack of productivity and cost indices standards, and economic instability. Each one is discussed in the sub-sections which follow.

- Weather

Saudi Arabia has a long, hot and almost totally dry summer, with a short, cool, winter season during which a little rain falls.

"Because of the dryness of the air reaching Saudi Arabia and the consequent lack of cloud, insolation is considerable, producing very high summer temperatures of up to 45 or 50 degrees centigrade and sometimes even more in the deserts. But the cloudlessness also allows heat to escape from the surface at night, especially in winter; so, temperatures drop quite markedly between day and night, and between summer and winter. The night coolness, with a 10 to 20 °c drop both seasons, is a boon in summer but leads to sporadic frost in the interior during the winter (Al-Mutauwaa 1988)."

The climate of the Eastern Province of Saudi Arabia is directly affected by its geographic location. As it lies along the Arabian Gulf coast, relative humidity is generally high most of the year, especially in the summer, due to sea breezes that bring in moisture. The highest relative humidity is reached at the end of the summer season, in late August and early September.

Rainfall is irregular and unreliable, occurring mostly during the months from October to April. Summers are usually rainless. Surface winds are at light to normal speed during most of the year but may be active for certain periods after the passage of cold air fronts in winter. These winds are usually accompanied by a rise in temperature and humidity. They may become very active at times, gaining high speed, raising dust and causing sandstorms (Al-Mutauwaa 1988).

As is noted from the above, the Eastern Province of Saudi Arabia has some of the extreme climatic conditions that are most unfavourable for contractors to work with. So, operations conducted during such climatic conditions suffer a loss of productivity (Kochn 1985). Furthermore, an increase in the maintenance cost of the equipment will result from the

climatic variables of humidity and temperature.

- *Social/Cultural Considerations*

Social and cultural development in Saudi Arabia has rapidly changed during the last two decades due to the wealth created by the oil industry and the impact it gave to the Saudis. There is a widespread trend towards urbanization that has given rise to building employment opportunities.

At the start of the First National Development Plan (1970-1975), the construction workforce was composed of roughly 85-100% local and Arab national laborer (Wallance 1977). In order to build the facilities planned, laborers and craftsmen from different nations have had to be brought into the Kingdom. This importation of hundreds of thousands from different origins and habitats is reflected in the conservative society of Saudi Arabia.

Foreign laborers, because of their geographic isolation are not exposed to Saudi culture and frequently lack the knowledge necessary to accommodate themselves to the ways and custom of the local people. These social and cultural barriers affect the foreign workers' productivity and length of stay due to feelings of loneliness. Another barrier in using foreign workers is due to government security requirements for certain types of projects.

During the month of Ramadhan, all Moslems are prohibited by their religious beliefs from eating or drinking during the daylight hours.

Prohibition, coupled with a 36 hour work week, causes a loss in jobsite production, due to fatigue and to extended job schedules. On average, the decrease in work rates is less than 15%, although in the manual trade the decrease in work may reach 25-30%. In addition, the Islamic lunar calendar moves the start of Ramadhan through the seasons at a rate of 10-11 days per year. When Ramadhan falls during the hot months, production of work during Ramadhan will be affected. The effect on overall job productivity is in the range of 2-3% (Wallance 1977).

One of the basic tenets of the Islamic faith is the salat - the five daily prayer services. These are conducted at dawn, noon, afternoon, sunset and in the late evening. Facilities should be provided onsite for these services and allowances must be made for the time taken for daily prayer (Wallance 1977).

Social and cultural problems could affect the construction time or costs and hence the accuracy of the estimate as a result of one or more of the following factors :

- (a) Social and cultural impacts (Al-Jarallah 1983, Wallance 1977).
- (b) Local laws and religious customs (Al-Jarallah, 1983, Hoehne, 1985, Walker 1981, Wallance 1977).
- (c) Laborers' nationality (Borritt 1988, Wallance 1977).

- Area Condition

When a building project is in a very active area, the estimator must

familiarize himself with the general economy, regulation and rules of the area authority as well as the amount of construction activity in the area. He should take into account that his work needs special care and might face a certain amount of interference.

Also, how far the project is from home base should be considered. As a rule, a very active area enjoying a healthy economic climate will have a poor manpower pool: poor in quantity and quality (Gladston 1976). So, factors such as quality and quantity of available foremen and laborer, harsh local working rules, difficult living conditions, heavy traffic congestion, and poor unloading and transportation facilities should be considered.

Geotechnical formation problems, such as limestone solution cavities, a high water table, and the swelling of clay fills are just a few technical problems that should be checked. So, a careful inspection of the area is a must for the professional estimator and a correction factor must be applied.

The area condition could cause changes to construction time or costs and hence affect the accuracy of the estimate as a result of one or more of the following factors :

- (a) Public exposure of the project (Gladston 1976).
- (b) Project location (Al-Jarallah 1983, Gladston 1976, Ioannov 1988).
- (c) Economic instability (Gladston 1976).

- *Bidding Strategy*

The most efficient estimating and cost control system cannot ensure that a construction contractor will make a profit unless he can obtain sufficient work at the proper price. Because most public work is obtained by competitive bidding, the construction contractor and the cost engineer should have a good bidding strategy that helps the management in determining the optimum bid for each job. In addition to this, the contractor must decide which jobs to bid for and which jobs not to bid for. Many contractors mistakenly believe that the more work they obtain, the more profit they will make. A good bidding strategy can enable a contractor to earn more profit on fewer jobs by helping him carefully select the jobs to bid for and bidding for them with the optimum mark up (Brown 1977).

Although negotiated contracts lack the competitive elements, a contractor has to estimate the construction cost accurately to attract owner clients. In other types of contracts, such as design construct and construction management contracts, the contractor is assumed to provide expert cost assistance and advice as the design develops (Clough 1981).

A good bidding strategy could affect the probability of being the lowest bidder with a reasonable price and ensure the accuracy of the estimate as a result of one or both of the following factors :

- (a) Number of competitors (Brown 1977, Clough 1981).
- (b) Level of competitors (Brown 1977, Clough 1981).

- Productivity/Cost Index Considerations

One of the factors that requires consideration in estimating the cubic or superficial area rate from one job to another is studying the market conditions. This adjustment deals with the changes in building prices and in tendering conditions between the time when the previous job was priced and the anticipated date of tender for the new project. Some of these cost indices of building try to take into account every possible factor in construction costs; others will show in a graphical shape the changes in cost of building that help the surveyor or the cost engineer to add the proper allowance (Ferry 1972).

Another important component of any estimating system is collection of past project data for use in estimating direct laborer cost for future projects. These accounting data are used to develop standards for estimating future productivity or cost (Adrain 1982).

There is a general agreement by owners, engineers and contractors that the lack of productivity standards and cost indices publications in the construction industry in Saudi Arabia is a problem. There is no question as to the effect of their non-availability on the accuracy of the cost estimate.

3.2.1.2 Construction Parties

Most construction projects involve three construction parties, namely owners, consultants, and contractors. In some projects, the owner has a designing and supervision team that takes the place of consultants.

In this case, two parties are involved during the construction phase.

Coordination and the smooth flow of information within and between the parties involved are important at any stage of the project. Lack of coordination between the projects is a significant cause of a change to construction cost and time and hence affect the accuracy of the costs estimate.

The construction parties' items were divided into six divisions: previous experience of contract, knowledge of clients and consultants, government requirements, lack of information and coordination between government agencies, punitive damage, unforeseeable increase or decrease in certain taxes, and changes in local laws, procedures, permits or codes. Each one is discussed in the sub-sections which follow :

- Contractors' Issues

Having clear information during the estimating phase is very important for all parties involved. The financial viability of the project should be studied carefully before involvement in any project. Also, the contractor's ability to construct the project should be well-studied in terms of his experience of such contracts in order to be able to finish the project with all the requirements that satisfy the owner's need and with a reasonable profit.

There are many instances where an increase in the project's cost and time by the owner or by the owner's representative, such as the consultant can be reasonably predicted. Examples are a delay in making the site

available to the contractor, unreasonable delay in approval of shop drawings, delays in issuance of change orders, etc. Additionally, most designers and owners do not direct the general contractor's and sub-contractor's action in order to avoid being subject to legal damages. In some projects, poor communication between the site and the consultants leads to time and cost overruns. Therefore, knowledge of the client and the consultants will lead to clear cooperation which is necessary to enable the project to be built on time and according to cost budget and to the quality standards set out in the specifications.

Another major component which has a very significant effect on the estimated costs is punitive damage. The contractor is required to conform with laws and ordinances concerning job safety, licensing, building codes and other aspects of the work; in the event of failure to do so, a contractual punitive damage arises.

The contractor's issues could cause damages to construction time and costs and, hence, affect the estimated costs as a result of one or more of the following :

- (a) Previous experience of contract (Al-Mutauwaa 1988, Wood 1974).
- (b) Knowledge of clients and consultants (Al-Mutauwaa 1988, Wallace 1977).
- (c) Punitive damage (Clough 1981).

- *Owner's/Consultant's Issues*

Construction contracts typically reserve several rights to the owner. Depending on the type of contract and its specific wording, the owner may be authorized to award other contracts in connection with the work, to require contract bonds from the contractor, to approve the surety proposed to retain a specified portion of the contractor's periodic payments, to make changes in the work, to carry out portions of the work himself in case of contractor default or neglect, to withhold payment from the contractor for an adequate reason and to terminate the contract for just cause. The right of the owner to inspect the work as it proceeds, to direct the contractor to expedite the work, to use completed portions of the project before contract termination and to make payment deductions for uncompleted or faulty work are common construction contract provisions (Clough 1981).

Also, the consultant has direct responsibility to see that the workmanship and materials fulfill the requirements of the drawings and specifications. To ensure this fulfillment, the architect-engineer exercises the right of job inspection and approval of materials. He is also responsible for speeding up the work activities if the work is behind schedule.

This authority exercised by the owner or his authorized representative has a very significant effect on the estimated costs, especially when the poor organization of owner and consultant with unqualified personnel exists.

Many owners feel that their obligations are restricted to payment of

contractors' charges, but this is not true. Owners should fulfill the contractual obligations. Most contracts require actions on the part of the owner which are in addition to payment. They must also deal with timely owner-generated inspections and acceptance of the work product as it progresses. Sometimes they are required to review designs or shop drawings produced by the contractor in a timely manner (Al-Mutauwaa 1988).

Architects and engineers should make their designs suitable for the environment and culture and come up with contractual documents that include all changes in local laws, procedures, permits or codes rather than copying those of others that are not up to date.

Another major cause of changes in cost and time is in lack of coordination and information between government agencies. Too many permits and overlapping areas of authority will occur, which might result in unclear responsibilities for decision makers. This problem will increase the risk of conflicting decisions, leading to many changes in projects' cost and time (Al-Mutauwaa 1988).

The owner and consultant matters could cause changes to construction time and costs, and hence affect the estimated costs as a result of one or more of the following :

- (a) Government requirements (Al-Mutauwaa 1985, Clough 1981).
- (b) Lack of information and coordination between government agencies (Al-Mutauwaa 1985).

- (c) Unforeseeable increase or decrease in certain taxes (Cheat-harn 1981, Collier 1987, Clough 1981).
- (d) Unforeseeable changes in local laws, procedures, permits or codes (Al-Jarallah 1983).

3.2.1.3 Construction Items

The nature and size of the construction to be done through any type of contract are described in the contract documents. In the case of competitive bidding, these documents, which are prepared by the architect-engineer, are referred to as the "bidding documents" during the proposal or bidding phase. After the contract is signed, these same documents form the contract.

Work to be done, material to be provided and the quality of workers required are described by the drawings and specifications. These documents serve as a basis for the settlement of claims and disputes. So, it is important, therefore, that these documents are carefully examined by the contractor during the bidding or negotiation phase.

- Contract Documents

The three construction parties who are involved in the construction building process are brought together through the contract documents.

The owner can select a prime contractor to construct the project on the basis of competitive bidding, negotiation, or some combination of the two. A large proportion of the construction work in this country is done

by contractors who obtain their work in bidding competition with other contractors. In such cases, the work is normally awarded to the lowest responsible bidder. Competitive bidding for public construction projects is normally required by law and is standard procedure for public agencies. Essentially, all public works are done by this method (Clough 1981).

When tendering for a project, the contractor must provide the owner with the total cost estimate. Because the estimate is made a priori, it can only be an educated guess. If the bid is selected by the owner, the contractor should complete the project for the contracted amount. It is the contractor's responsibility to have an understanding of and an analytical approach to every detail.

Many types of defects could occur to contract documents, such as the omission of certain general conditions, typographical errors, spelling errors, arrangement of contract divisions, inaccurate quantities, conflicts between drawings and specifications, ambiguous wording in the arbitration clause, etc. Although the occurrence of one or more of those defects is of relatively minor consequence in small size building projects, they are a significant factor in large complex building projects.

In order to minimize their occurrence, good drawings and specifications should be maintained. Good construction specifications have certain fundamentals. They should be technically adequate for the purpose intended and clear in phrasing and expression. Furthermore, engineers should allow sufficient time to perform a detailed and comprehensive review of each drawing and specification (Al-Mutauwaa 1988).

Contract time is an important factor when estimating costs. It is usually convertible into money values. When there is a given date to handle the project, failure to complete the activities will put the contractor in a critical situation and can make him liable to the owner for damage.

So, the type and size of contract and its content, the contract period, the content of arbitration clauses and the content of specifications could cause changes to project cost and/or time and hence affect the estimated costs.

- *The Proposal*

A proposal or bid is a written offer, tendered by the contracting firm to the owner, which stipulates the price for which the contractor agrees to perform the work described by the bidding documents (Clough 1981).

Public contract documents have to be purchased by the contractor. The public agency sets the price of these documents according to the amount of work involved. Additional copies required by the general contractor may be purchased or copied.

There is a deadline designated by the owner for submission of the completed proposal form with other necessary information. It is usual for public contractors to deliver the sealed bid shortly before opening time. The time between project announcement and bid submittal is an important

issue to the general contractor. During the time, the general contractor seeks lower subcontract prices which will be included in the general contractor's estimate. On the other hand, it is important to investigate the defects that could occur to contract documents. So the bid submission period and the price of the bidding documents are construction costs of any kind that should be accounted for.

3.2.1.4 Financing

During the First (1970-75) and Second (1975-80) National Development Plans, there was plenty of work and plenty of money in terms of profit. During the mid-eighties, the situation differed. Severe rises in construction cost and overall inflation to construction occurred at an increasing rate, partly because of oil price fluctuations, less demand for construction, more competition between contractors and lack of well organized management finance and plans.

Poor management, finance and plans of a project will impose many different changes during the construction phase due to insufficient early communication in the design phase. Moreover, they might lead also to project cost and time overruns.

Contractors are highly dependent on receiving payments made by owners. However, these payments may be slow. Delays of a month or more are common. In addition to that, the owner may retain part of the payment until the construction project is completed. Payment retention is

usually 10 percent of the project's cost. (Al-Mutauwaa 1988).

Many construction firms within the Kingdom are small, under-financed and unable to finance payroll and material vendors. The result is that the construction firms often need bank loans to finance a project, which adds actual interest expenses on the firm. (Al-Mutauwaa 1988).

Construction of large building projects is complex and time-consuming. Estimation of their construction cost is subject to the influence of highly variable and often unpredictable factors. Currency exchange is a little known, low visibility item that should enter into the estimate. This factor increases or decreases other major capital cost components such as materials procurement, for example.

Financial problems could cause changes to construction time and/or cost and affect the estimated cost as a result of one or more of the following factors :

- (a) Availability of management finance & plans
- (b) Payments
- (c) Inflationary pressures
- (d) Estimating method used
- (e) Currency exchange rates.

3.2.2 Survey Search

After a review of references and information collected from a literature search, a list of research questions was prepared, redesigned and refor-

matted into the final questionnaire which is attached at the end of this thesis in Appendix A. The questionnaire was translated into Arabic for respondents who do not know English or have numerous demands on their time, and mark responses were requested. The questionnaire carries both the instructions and the questions for respondents. The researcher considered both the subject content and the wording of each question in terms of shared vocabulary and clarity. An attempt was made so that each question would be stated in such a way as to be as precise, short, simple and understandable as possible. Also, a pilot study was conducted to determine the relevance and responsiveness of the questions.

A cover page which contains an introduction to explain the idea and the purpose of the survey as well as the definition of the interested area of study was sent to each of the contractors and consultants along with the questionnaire , aimed at asking the respondents to fill up the needed information. The questionnaire was either picked up on a second visit when the information was filled or received by mail. Data were collected through the questionnaire which was left to be answered by a key informant, who was either the construction project manager, the planner, cost engineer or subordinate manager and resident engineer in case of the consultants.

There are three parts in the questionnaire . The first part (Part A) includes *general information questions* about, for example, the respondent's status, his relationship to construction , his role in construction , and his experience in construction . The respondent is requested to choose the

most appropriate answer.

The second part (Part B) concerns the *factors affecting the accuracy of cost estimate in building construction* . These factors are divided into four main areas. Each area contains a group of factors which are related to the same topic. For each factor, the respondents have five options. These are 'very major effects', 'major effects', 'minor effects', 'very minor effects' and 'no effect'.

Thus, the factors are in standardized format and sequence. This guarantees that questions about each factor are asked the same way in each interview. The factors which are considered in the questionnaire are related to the following areas :

1. Environment
2. Construction parties
3. Construction items
4. Financing

The third part (Part C) is designed to evaluate the *Saudi building construction firms current practice regarding the cost estimate*. This part includes questions about, for example, the respondent's idea about the uncertainty in the cost estimate, how frequent he considers all factors mentioned in Part 'B' in his contracts, whether he is comfortable about the way he sets up his cost estimate and how successful he is in realizing these factors.

A complete set of questionnaires in this study was distributed to contractors. Consultants were included in the study and given Part B of the questionnaires to get their views about the importance of the factors affecting the estimate accuracy because the researcher found that they are experts in their field.

3.3. Sample Selection

Questionnaires were distributed to randomly selected contractors and consultants by applying the generation of random digit procedure which is performed by numbering the whole population and each individual selected randomly.

3.3.1 Sample Size

The selection of samples for this study will be limited to consideration only of public projects in the Eastern Province of Saudi Arabia. The populations of contracting parties are divided into two parts.

Population I..... Contractors

Population II.... Consultants

For Population I, the number of contractors available in the Eastern Province of Saudi Arabia is 1916 for both public and private projects (Eastern Province Commercial Directory, 1986). For this population, post-stratification where contractors are dealing with public building contracts only will be recognized after a preliminary survey through telephone calls. So, the following formula will be used to determine the sample size of all

contractors:

$$n = (ts/d)^2 / [1 + (ts/d)^2/N]$$

where:

n : Sample size

N : Sample population

t : is the abscissa of the normal curve that cuts off an area of $\alpha = 0.01$ at the tails.

d : is the expected error in the estimate,

s : P_q , $P = 0.5$ and $q = 1 - P = 0.5$ Maximum standard deviation in proportion of estimation.

Therefore, the calculation of the sample will be as follows :

$$n_1 = (2*0.5 * 0.5/0.01)^2 / [1 + (2*0.5 * 0.5/0.01)^2/1916] = 1085$$

$$n_2 = 1085 / [1 + (1085/1916)] = 693$$

$$n_3 = 693 / [1 + (693/1916)] = 509$$

$$n_4 = 509 / [1 + (509/1916)] = 402$$

$$n_5 = 402 / [1 + (402/1916)] = 332$$

$$n_6 = 332 / [1 + (332/1916)] = 283$$

$$n_7 = 283 / [1 + (283/1916)] = 247$$

$$n_8 = 247 / [1 + (247/1916)] = 219$$

$$n_9 = 219 / [1 + (219/1916)] = 197$$

$$n_{10} = 197 / [1 + (197/1916)] = 179$$

$$n_{11} = 179 / [1 + (179/1916)] = 163$$

$$n_{12} = 163 / [1 + (163/1916)] = 150$$

$$n_{13} = 150 / [1 + (150/1916)] = 139$$

$$n_{14} = 139 / [1 + (139/1916)] = 130$$

$$n_{15} = 130 / [1 + (130/1916)] = 122$$

$$n_{16} = 122 / [1 + (122/1916)] = 115$$

$$n_{17} = 115 / [1 + (115/1916)] = 109$$

$$n_{18} = 109 / [1 + (109/1916)] = 103$$

$$n_{18} = 103 / [1 + (103/1916)] = 98$$

It is better to stop here because the difference will be insignificant. So, the total sample is 98, including all contractors. However, from the preliminary survey, it was found that only 35 percent of them are building contractors working with public projects. Therefore, the actual sample size is 34 contractors.

For Population II, there are 87 consultants in the Eastern Province of Saudi Arabia (Eastern Province Commercial Directory, 1986). So, by using the same formula, the following results are obtained.

$$n = (ts/d)^2 / [1 + (ts/d)^2/N]$$

$$n_1 = (2*0.5 * 0.5/0.01)^2 / [1 + (2*0.5 * 0.5/0.01)^2/87] = 84$$

$$n_2 = 84 / [1 + (84/87)] = 43$$

$$n_3 = 43 / [1 + (43/87)] = 29$$

$$n_4 = 29 / [1 + (29/87)] = 22$$

$$n_5 = 22 / [1 + (22/87)] = 18$$

$$n_6 = 18 / [1 + (18/87)] = 15$$

It is better to stop here because the difference between n_6 and n_5 is insignificant. Therefore, the sample size of Population II is 15 consultants.

Actually, the questionnaires were collected from 34 contractors and 13 consultants, with a total of 47 respondents.

3.3.2 Scoring

Part "A" of the questionnaire consists only of general information related to the respondent and his company. For this reason, no scoring was used.

The main part in the questionnaire is Part "B". It concentrates on the importance of factors affecting cost estimate accuracy. For each factor, the respondents have five options. Each factor has an importance index as follows :

$$\text{Importance Index (IM IND)} = \sum_{i=1}^5 A_i x_i$$

Where:

A_i = Constant expressing the weight given to each response, $i = 1, 2, 3, 4, 5$.

x_i = The i th variable expressing the degree of importance.

x_1 = The frequency of "very major effects" response(s).

x_2 = The frequency of "major effects" response(s).

x_3 = The frequency of "minor effects" response(s).

x_4 = The frequency of "very minor effects" response(s).

x_5 = The frequency of "no effect" response(s).

The scale value assigned for each response is as follows :

A1 = 4 for "very major effects".

A2 = 3 for "major effects".

A3 = 2 for "minor effects".

A4 = 1 for "very minor effect".

A5 = 0 for "no effect".

Part "C" of the questionnaire is an evaluation of the respondent's practice regarding the cost estimate and no scoring was used.

3.4 Statistical Data Analysis and Measures

The information collected from the questionnaire will be analyzed statistically by using SAS Computer Programming. The statistical methods which will be used for calculating and presenting the survey results are as follows :

1. Tabulation and Cross Tabulation

Cross tabulation involves placing the survey data into tabular form (a two-way table) so that the functional relationship of these data can be

described.

2. *Statistical Techniques*

The weighted mean, standard deviation, standard error of mean, and coefficient of variation will be used to aid the researcher in interpretation of the coming information.

3. *Ranking*

Part B of the questionnaire , which is concerned with the main factors affecting the accuracy of the costs estimate will be ranked by the measurement of the importance index.

4. *Correlation*

By the correlation coefficient, the extent to which two variables are linearly related to each other will be measured.

The hypothesis that the contractor and the consultant agree on the importance index of the factors will be tested using the t-test. Finally, the analysis of the data will be represented by sketches and other figures.

CHAPTER 4

CONSTRUCTION COSTS

After the drawings and specifications which represent the owner requirements have been completed by the designer or the owner himself, the costs of work have to be determined by the bidders (contractors) who will make offers to do the work for the owner.

The cost of work is made up of different types of costs which constitute the total cost. To analyze them, they may be classified as follows (Collier 1987):

1. Materials costs
2. Labor costs
3. Equipment costs
4. Overhead costs
5. Profit.

4.1 Material Costs

When we speak of material costs, we refer to the costs at the site to the contractor and to the owner. Different elements of costs are involved when estimating material costs. Storage, freight, transportation and inspection are different parts of the cost of material (Collier 1987).

An estimator may keep current price lists of material for reference, and he obtains revisions as they are issued. But for basic materials or products that represent a significant part of the total costs of a project, the estimator usually receives specific quotations from suppliers or manufacturers if the quantity is large. Written quotations are desirable so that such important considerations as prices, status of freight charges, delivery schedule and guarantees are explicitly covered. It is common practice to enter material prices as a lump-sum amount on the tendering sheet.

4.2 Labor Costs

A detailed contractor labor cost estimate includes two types of components : direct labor costs and indirect labor costs.

4.2.1 Direct Labor Costs

This is the cost of labor directly related to the project such as engineers, carpenters, foremen, etc. It can be calculated as follows :

$$A = B * C * D \text{ (Clough 1981A, Eid 1981).}$$

Where:

A = Estimated labor cost for a quantity of work.

B = Labor-hours or crew hours required to accomplish a unit of a given work type (production rate).

C = Appropriate wage scales per hour.

D = Total number of units of work of this category. For an accu-

rate production rate, which is the largest area of uncertainty facing the estimator, reliable labor productivity records from completed projects should be available.

4.2.2 Indirect Labor Cost

This is the cost of labor indirectly related to the project, such as payroll, taxes, insurance and employee fringe benefits of wide variety such as health paid vacations and pension plans.

Indirect labor cost normally constitutes a 35 to 50 percent addition to the direct payroll costs (Clough 1981).

4.3 Equipment Costs

To evaluate and select one particular piece of equipment, it is essential to determine its hourly cost very accurately.

The equipment cost is divided into owning cost and operating cost.

The manufacturer's data and past cost records constitute means of determining the equipment costs. Some factors have to be considered at this stage and they are (Cheatharn 1981) :

- * Number of hours used per day, month and year.
- * Severity of job conditions.
- * The way the equipment has been maintained.
- * Demand for used equipment when it is sold.

The above factors should be considered and studied carefully in the

light of the estimator's experience.

4.3.1 Owning Costs

Owning costs include the cost of depreciation, insurance and loss of interest. This cost, divided by the average number of hours utilized in a year will give the hourly owning rate. The straight line, sum of the year, or the declining balance method can be used in calculation of depreciation per year.

4.3.2 Operating Costs

Operating costs include the cost for fuel, lubricants, filters, grease, tires, repairs, maintenance and any other variable costs. The manufacturer data is a good reference but most of the time, for marketing reasons, they are lower than the actual figures which put more emphasis on previous cost records. One should also consider the job conditions. An accurate estimate of total hourly rate for the operating costs is essential.

4.4 Overhead Costs

These are construction costs of any kind that cannot be attributed to any specific item of work. Overhead costs can be classified into two types, namely, job overhead costs and office overhead costs. If costs can be attributed to a specific job site because the costs arise only out of that particular job, these costs are job overhead costs. If cost cannot be attributed to any particular job, they are office (operating) overhead costs (Ferry 1972).

Overheads are a significant item of expense and will generally run from 5 to 15 percent of the total project cost, depending somewhat on where certain project costs are included in the cost estimate (Clough 1981).

4.4.1 Office Overhead

The item of adequate overhead expense is sometimes neglected by many contractors, but it is of such importance that every contractor should give it careful consideration.

Every contractor has a certain fixed expense that must be paid regardless of the amount of work done or contracts received and these items should be charged to office overheads.

These include such items as office rent, fuel, lights, telephone and telegraph, stationery, office supplies, advertising, trade journals and magazines, legal and accounting expenses not chargeable directly to any one job, fire and liability, insurance for office, club and association dues, office employees such as bookkeepers, clerks, estimator, and janitor, services and salaries of executives, along with travel and entertainment expenses and depreciation of office furnishings and equipment.

4.4.2 Job Overhead

Each job will entail certain expenses that are chargeable to the job as a whole. These are set forth in the general conditions. These will include such items as superintendent, temporary buildings, offices, toilets, utilities, protection, clean-up, permits, surveys, photographs, tools and

equipment, insurance and benefits, sales taxes, surety bonds and warranties. Sometimes, these are covered only in a general way and it is up to the contractor to visit the site to determine what is needed.

As discussed above, job overheads and office overheads are best kept separately although, occasionally the cost of employees, insurance, tools and equipment and other items may be divided between office expenses and job expenses.

Many contractors figure a certain percentage of the cost of the job to take care of all overhead expenses and plant charge, but this is not the correct method to use and does not give the contractor or estimator a reliable basis for computing the cost of this work.

Each item entering into the cost of job overhead expenses should be estimated in the same way as any other branch of work.

4.5 Profit

The amount of profit to be added to the estimated cost of the work is a question which a contractor must answer individually for each bid. There is no set amount that can be added. It all depends on local conditions, competition, and how badly the job is wanted.

On small job alterations, remodeling and similar work a contractor is justified in adding twenty to twenty five percent to the actual cost for profit.

On new work where it is possible to estimate the cost with a fair

degree of accuracy, a contractor is entitled to ten percent on the actual cost of the work but, when submitting competitive figures, it is safe to say there are many jobs let on a five percent instead of a ten percent basis.

The amount of profit is generally computed as a percentage of the contract, or in some cases, as a percentage of each item in the contract (Eid 1981).

CHAPTER 5

ACCURACY OF CONSTRUCTION COST ESTIMATE

This chapter presents a full description of the analysis of the data which were collected from the survey and embodies the findings that are obtained from the analysis. However, before discussing on the data analysis and results, the characteristics of the construction firms who participated in the survey and their estimating practice are introduced.

5.1 Characteristics of Participating Contractors

The required data were secured from 34 contractors who are involved in building construction. The cross tabulation method, which involves placing the survey data into tabular form (a two-way table), was used to sort the obtained information. The cells in the tables which are designated observed frequency represents the point of occurrence in the sample subjects (variables) of the row level of the first criterion of classification with column level of the second. The expected percentages of each cell are derived by dividing the observed frequency by either the row or the column summation.

The participating contractors were crossed with the company size, working experience, average job size and duration, and volume of work subcontracted. The purpose of this classification was to obtain a general

description of the participating contractors.

5.1.1 Company Size

The participating contractors are classified into 'large', 'medium' and 'small' categories in accordance with the reported annual business volume. The large size category involves all contractors with annual business volume of greater than SR 56,000,000. The medium size category embodies those contractors who have annual business volume of less than SR 55,000,000, but greater than SR 15,000,000. The third category contains contractors with annual business volume of less than SR 15,000,000.

The survey results indicate that about 68% of the surveyed contractors are small size companies. The remaining contractors (32%) fall in the medium and large categories equally. Table 5.1 exhibits the profile of the participating companies.

Table 5.1 : Profile of Participating Companies

Company Size	Annual Volume (SR)	Percent of Respondents
Small	0 -14,000,000	67.74%
Medium	15,000,000-55,000,000	16.13%
Large	56,000,000 Plus	16.13%

5.1.2 Working Experience

Working experience is measured in number of years a contractor has been operating in the construction industry. The majority of the surveyed contractors (about 84%) have been practising the construction business for more than 5 years. None has one year or less of experience. Table 5.2 shows the working experience of the participating contractors stratified by company size. In fact, obtaining data from such experienced companies increases the reliability of the generated results.

Table 5.2 : Working Experience (Years)

Company Size	Under 1 year	1-5 Years	5-10 Years	10-15 Years	Over 15 Years
Small	-	9.68	25.81	19.35	12.9
Medium	-	6.45	3.23	6.45	-
Large	-	-	-	6.45	9.68
Total	-	16.18	29.04	32.25	22.58

5.1.3 Average Job Size

The majority of the survey contractors reported that they have capabilities for building projects with construction cost of greater than one million Saudi Riyals. Table 5.3 illustrates the percent distribution of each job size within each company size. It seems that small companies obtain the majority of projects that fall between 0.1-0.5 million Saudi Riyals. The survey results indicate that jobs with an average size of less than one million Saudi Riyals are in the business line of small sized contractors. Interestingly enough, the small sized companies share some projects with medium and large sized companies. The large sized companies build projects with an average size of greater than eleven million Saudi Riyals.

Table 5.3 : Average Job Size in terms of (SR)

Company Size	0.1-0.5 M	0.6-1.0M	1.1-5.0 M	6.0-10 M	11-50 M	51-100 M	101-200 M	201-500 M
Small	22.58	6.45	12.9	12.9	9.68	3.23	-	-
Medium	-	-	3.23	3.23	6.45	-	-	3.23
Large	-	-	-	-	9.68	6.45	-	-
Total	22.58	6.45	16.13	16.13	25.81	9.68	-	3.23

5.1.4 Project Duration

The majority of projects that are built by the contractors surveyed take on average two or more years. However, the small sized contractors construct projects over a period of six to twelve months. All the projects that are built by medium and large sized companies take more than eighteen months to build. See Table 5.4.

Table 5.4 : Average Job Duration (Years)

Company Size	0.5	1.0	1.5	2.0
Small	19.5	19.05	-	23.81
Medium	-	-	4.76	9.52
Large	-	-	4.76	19.05
Total	19.05	19.05	9.52	52.38

5.1.5 Volume of Work Subcontracted

A subcontract is an agreement between a prime contractor and a subcontractor under which the subcontractor agrees to perform a certain specialized part of the work. The type and the amount of the work subcontracted depend on the nature of the project and the type of contract. By subcontracting, the prime contractor can obtain workmen with the requisite skills when they are needed, without the necessity of maintaining an unwieldy and inefficient full-time labor force. At the same time, subcontractors are able to provide full-time employment for their workers. Another common reason for subcontracting is when the project requires construction equipment the prime contractor does not have. However, there are some limitations associated with construction subcontracting, such as complicating the overall scheduling of job operations, serious divisions of project authority, fragmentation of responsibility, poor coordination of construction activities and weak communications between management and the field. Obviously, the extent to which these difficulties may actually occur is greatly dependent on the experience, organization, and management skills of the prime contractor involved (Clough, 1981).

As far as this survey is concerned, the majority of building contractors in Saudi Arabia subcontract less than 20% of their project to special contractors. Table 5.5 illustrates the percent distribution of the work subcontracted within each company size. It seems that small sized companies represent the majority of those contractors who subcontract less than 20%

of the contract volume. Some small companies behave like a vendor where they subcontract the whole work to subcontractors. The large sized companies subcontract less than 50% of the project most of the time.

Table 5.5 : Average Work Subcontracted On Average Job

Company Size	19% or Less	20-49%	50-99%	100%
Small	48.39%	9.68%	3.23%	6.45%
Medium	6.45%	3.23%	6.45%	-
Large	6.45%	9.68%	-	-
Total	61.29%	22.59%	9.68%	6.45%

5.2 Estimating Practices

The estimating process is a tedious job that involves detailed study of the bidding documents, coupled with careful analysis of complicating factors such as weather, payments, productivity, prices and a myriad of others, in order to arrive at the most accurate estimate.

The required data to obtain the existing estimating practice were secured from the 34 contractors surveyed. The cross tabulation method was used to sort the information obtained.

The participating firms were crossed with the number of estimators, the price decision maker, the use of computers, the use of historical data, resource productivity and uncertainty of the estimate. The purpose of this

distribution is to present only the general aspects of construction estimating practice among the Saudi firms.

5.2.1 Observation Explanation

Construction estimators do a remarkably good job considering the project imponderables involved. They do quantity take off from the drawings and make basic decisions concerning construction methods, resource types, sequence of operations and prices to be used.

Examination by size of firms as shown in Table 5.6 indicate that 23 out of 34 contractors surveyed have more than two estimators on their firm. The survey results indicate that some large sized companies estimate projects by five or more estimators. Interestingly enough, small sized companies have more than five estimators.

Table 5.6 : Number of Estimators

Company Size	1-2	3-4	5 or More
Small	41.94	9.68	16.13
Medium	6.45	9.68	-
Large	13.23	13.23	9.68
Total	51.62	22.59	25.81

It was, however, noted that the final tendering price is set at the management level, as illustrated in Table 5.7. Only 13% of the participants set their firm's tendering price by the cost engineers' estimate and the large sized companies score the highest on this point.

Table 5.7 : Price Decision Maker

Company Size	At Management Level	Estimating Level	Management & Est. Level
Small	54.84	3.23	9.68
Medium	6.45	3.23	6.45
Large	6.45	6.45	3.23
Total	67.74	12.91	19.36

5.2.2 Use of Computer

The computer has become valuable in estimating costs. It can speed up the estimating process and minimize computational errors. Of real benefit is the computer's ability to make rapid cost comparisons between alternative methods of construction and different equipment choices.

In response to the question of using computers to assess the accuracy of the cost estimate, around 68% of the respondents checked "no". The remaining 32% do use some sort of computational technique using

computer software. Table 5.8 illustrates the percent distribution of computer usage within each company size.

Table 5.8 : Usage of Computer Program

Company Size	Yes	No
Small	16.13	51.61
Medium	6.45	9.68
Large	9.68	6.45
Total	32.26	67.74

5.2.3 Use of Historical Data

Labor and equipment expenses, in particular, are priced in the light of past experience. In essence, historical production records are the only reliable reference of information for estimating these two job expenses for future jobs.

The result, as indicated by Table 5.9, shows that 90% of the participants use historical records in the preparation of the cost estimate.

Table 5.9 : Usage of Historical Data

Company Size	Yes	No
Small	64.52	3.25
Medium	6.13	-
Large	9.68	6.45
Total	90.33	9.7

Table 5.10 illustrates the percent distribution of the resource productivity consideration within each company size. It is interesting to note that all the firms do consider the productivity of labor and equipment in estimating the cost.

Table 5.10 : Productivity Consideration

Company Size	Yes	No
Small	71.43	-
Medium	17.86	-
Large	10.71	-
Total	100.0	-

5.2.4 *Uncertainty of the Estimate*

The results of the questionnaires which seek the participants' evaluation of the firm's current practice regarding the cost estimate, as illustrated in Tables 5.11 to 5.14, demonstrate the importance of realizing the factors at the cost estimating stage. The majority of the participants consider them on all contracts by adjusting mark-up.

Table 5.11 : Uncertainty in the Estimated Costs

Company Size	Considered by a corrective factor	Considered by adjusting mark-up	Not Considered
Small	27.27	36.36	6.06
Medium	-	15.15	-
Large	9.09	6.06	-
Total	36.36	57.57	6.06

Table 5.12 : Frequency of Considering the Factors on the Estimated Costs

Company Size	On all contracts	50% or more of all contracts	Less than 50% of all contracts	Never
Small	42.40	24.24	3.03	-
Medium	12.12	3.03	-	-
Large	6.06	9.09	-	-
Total	60.42	36.36	3.03	-

When the general contractors were asked whether they are comfortable with the way they make cost estimates, 80% said "yes", and 20% said "somewhat". No participant replied "no". Obviously, most of the contractors are comfortable with their way of doing business and the majority of them are in the "modestly successful" range in realizing the various items affecting the accuracy of the estimated costs.

Table 5.13 : Satisfaction from the Way the Estimated Cost is Made

Company Size	Yes	Somewhat	No
Small	55.58	14.71	-
Medium	11.76	2.94	-
Large	11.76	2.94	-
Total	79.4	20.51	-

Table 5.14 : Successfulness of Realizing the Factors

Company Size	Very successful	Modestly successful	Unsuccessful
Small	23.53	47.06	-
Medium	5.88	8.82	-
Large	2.94	11.76	-
Total	32.35	67.64	-

5.3 Factors Affecting the Accuracy of an Estimate

The 29 factors listed in the second part of the questionnaire were believed to have an influence on the cost estimating process. These factors were compiled from relevant literature and discussions with some general building contractors and consulting offices. All the factors were ranked by the percent of respondents scoring 1 or higher for each of the participants.

Examination by all size of firms present the ranking of the major four divisions of the factors in terms of their degree of effect upon the accuracy of the construction cost estimating process as follows :

1. Financing
2. Construction parties
3. Construction items
4. Environment

Examination by consultants present the same ranking for the first and second divisions with no considerable difference between the other two. Hence, the construction item came last.

It is worth noting that some factors are considered to be very important by some participants but not by others.

Total investigation reveals that division of financing is the most severe factor and ranked the first with about 76%. There is, in fact, no great difference between the divisions. The second, which is the construc-

tion parties, is about 73%. Construction items comes next with about 69%. Environment comes last at about 66% with a difference from the first of about 10% (Fig. 5.1).

However, within each division, particular factors, due to their strong effect on the estimating process, scored high percentages although the division itself comes third or fourth, as can be seen next when each division will be discussed.

5.3.1 Financing

The influence of the five severe financial factors on the estimated costs is analyzed below, employing two views : a contractor's view and a consultant's view.

- Contractor's View

The questionnaire results show that the financial matters had a great influence on the accuracy of the estimating process. The delays in payments which may have resulted from payment retention, poor management, finance and plans, inadequate budget and inflationary pressures are the most severe item within the category among the different sized contractors with a score of about 95% for large and medium firms higher than the mean observed for the whole sample, which is about 89%. According to small sized companies, the score is about 85%. This high percentage indicates that such a situation leads the construction firms to get bank loans to finance payroll and material vendors and other needs. This adds actual interest expenses on the firm.

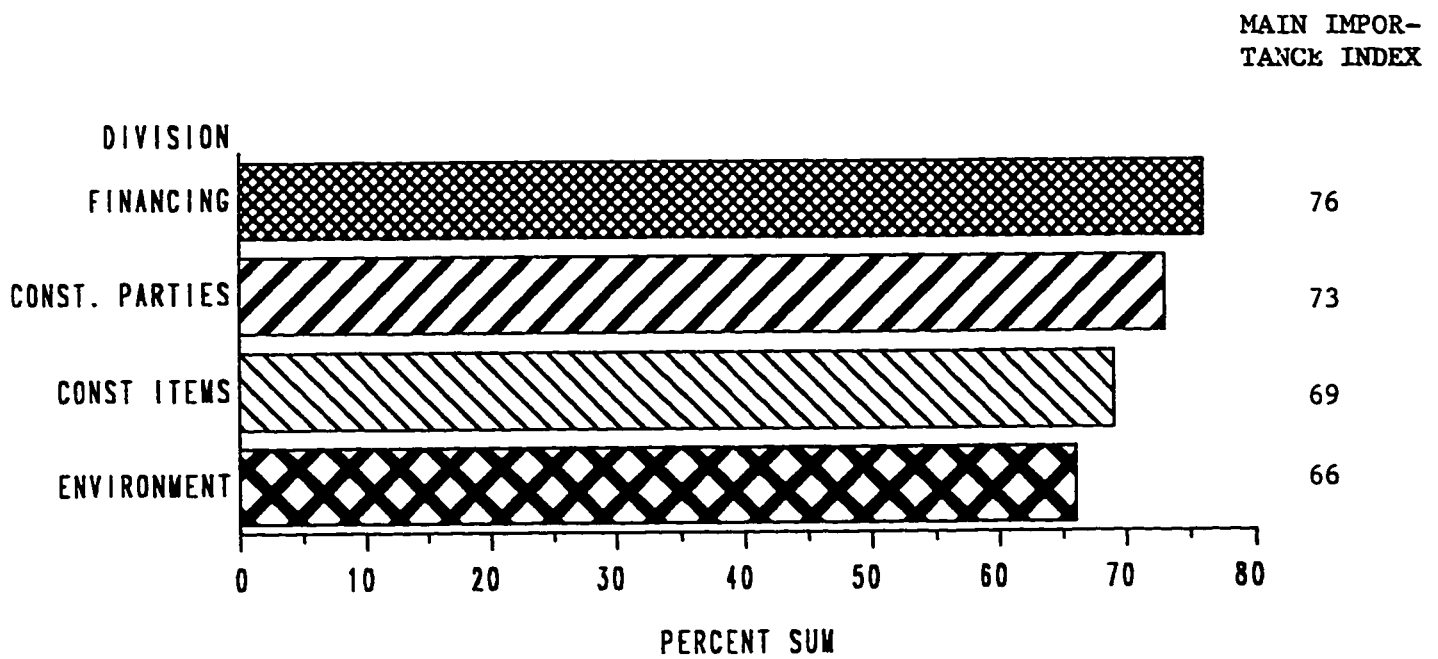


Fig. 5.1 : Main Division of Factors Affecting the Accuracy of the Estimated Costs.

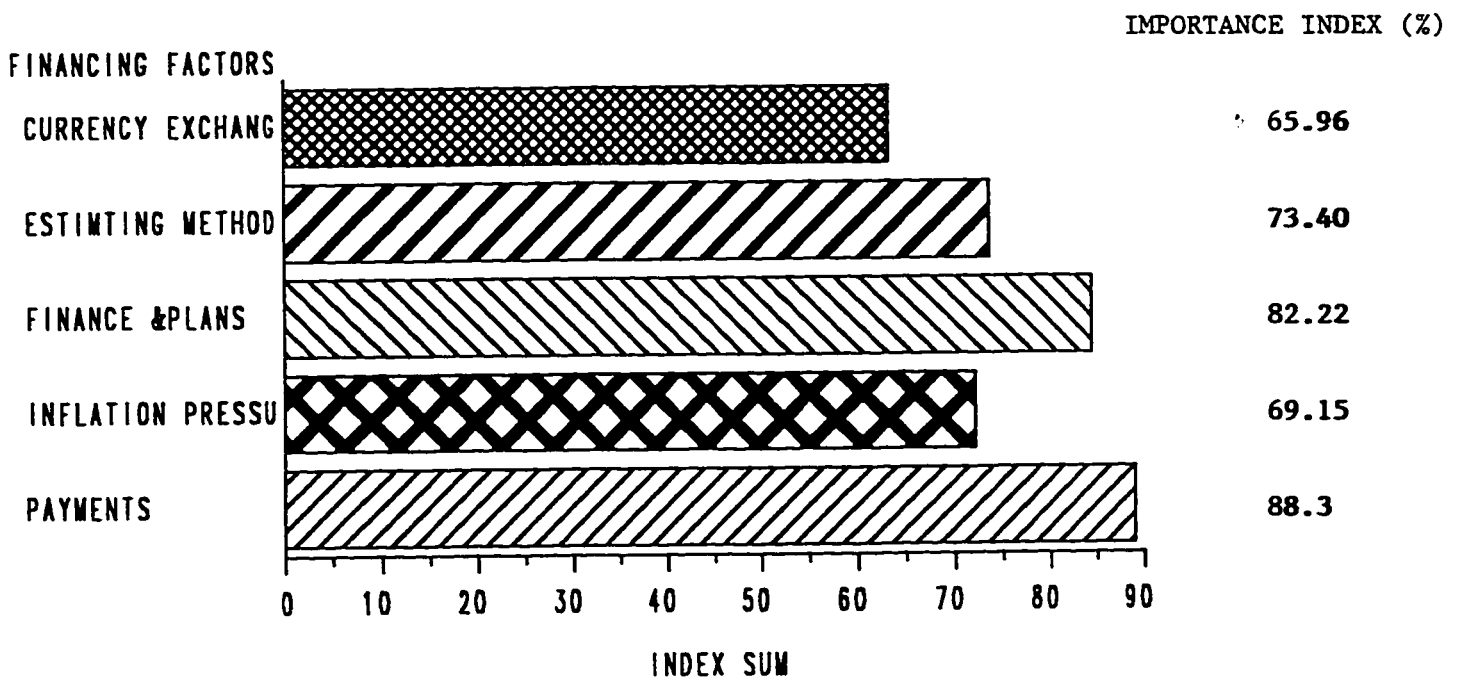


Fig. 5.2

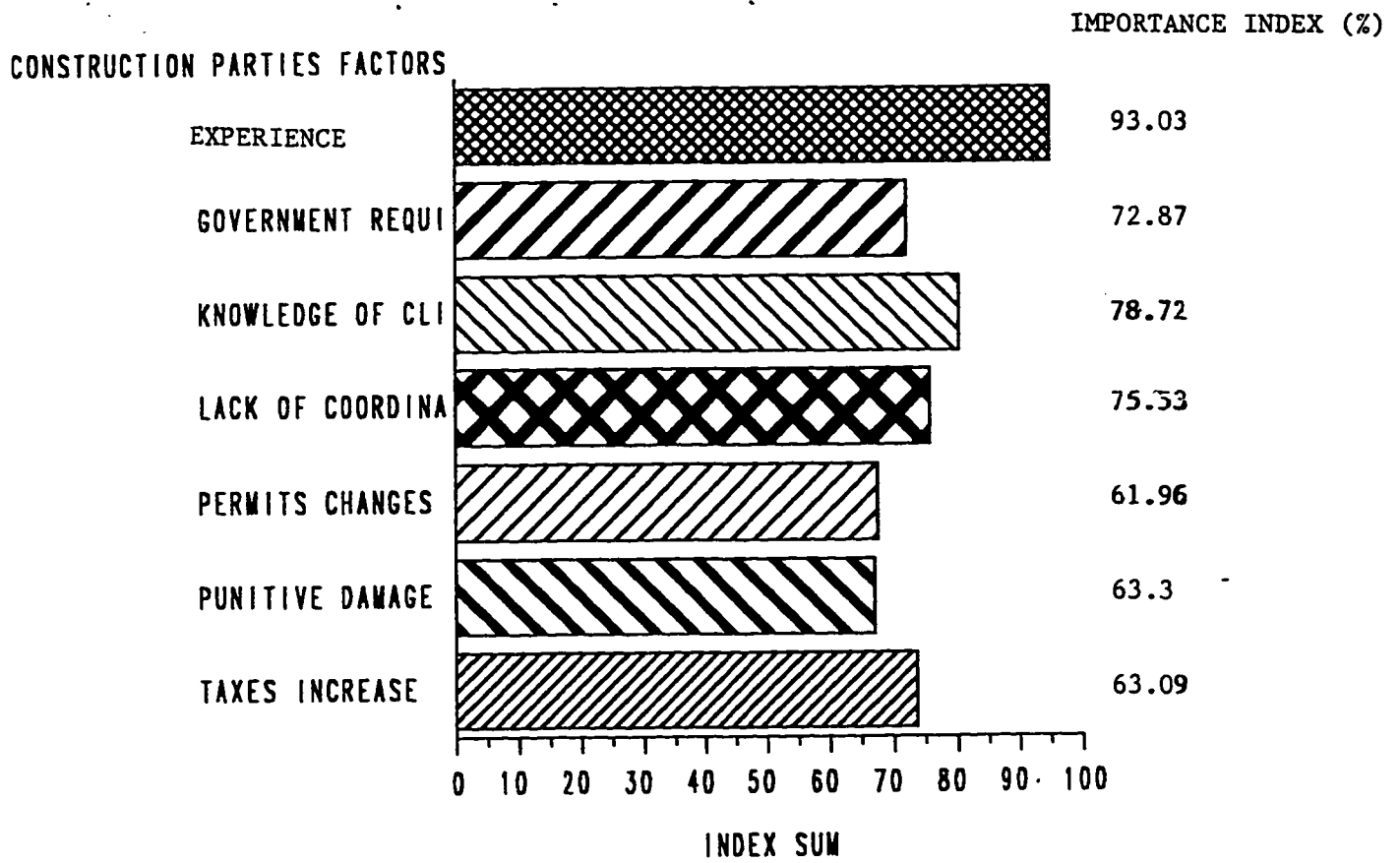


Fig. 5.3

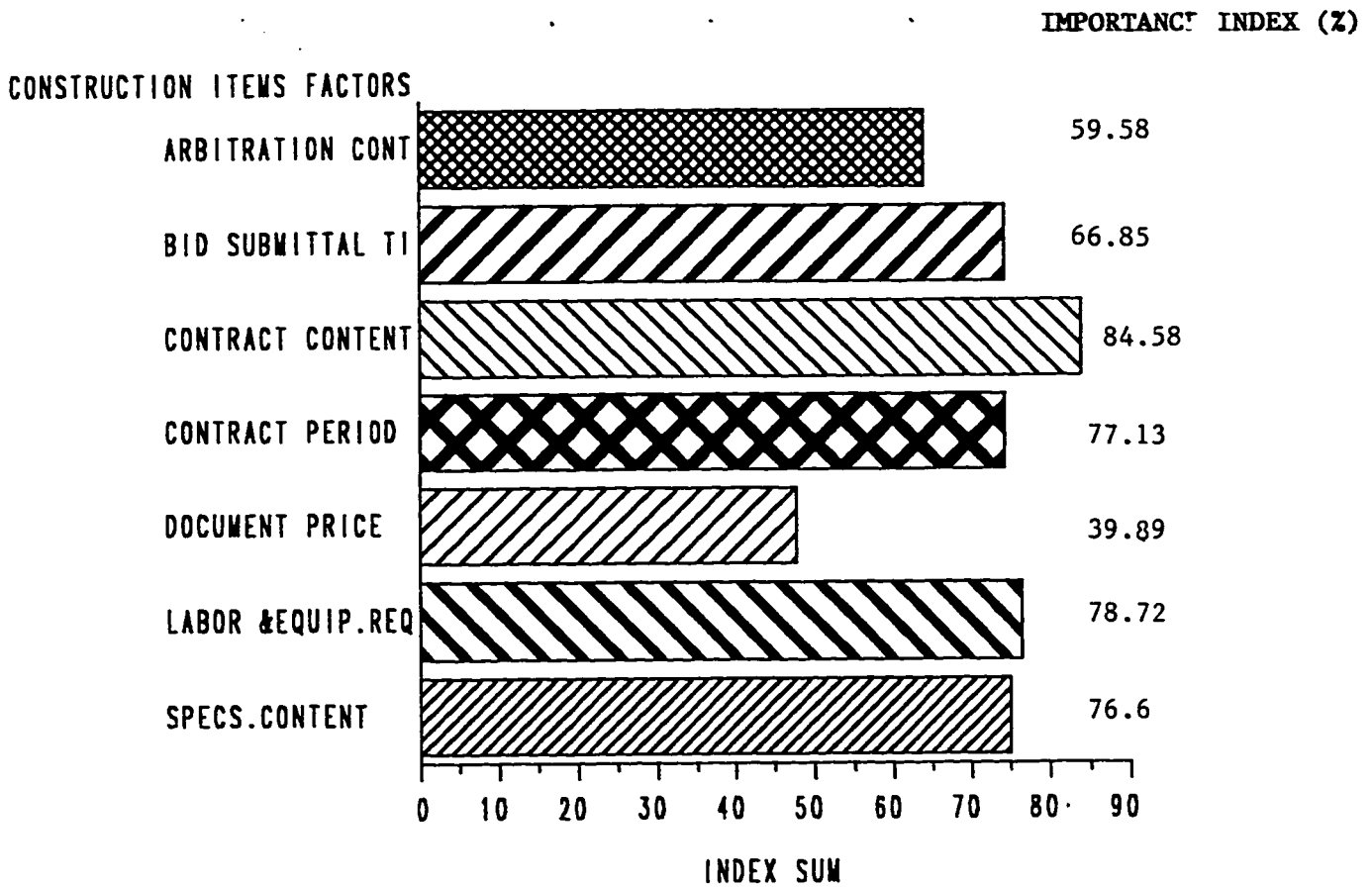


Fig. 5.4

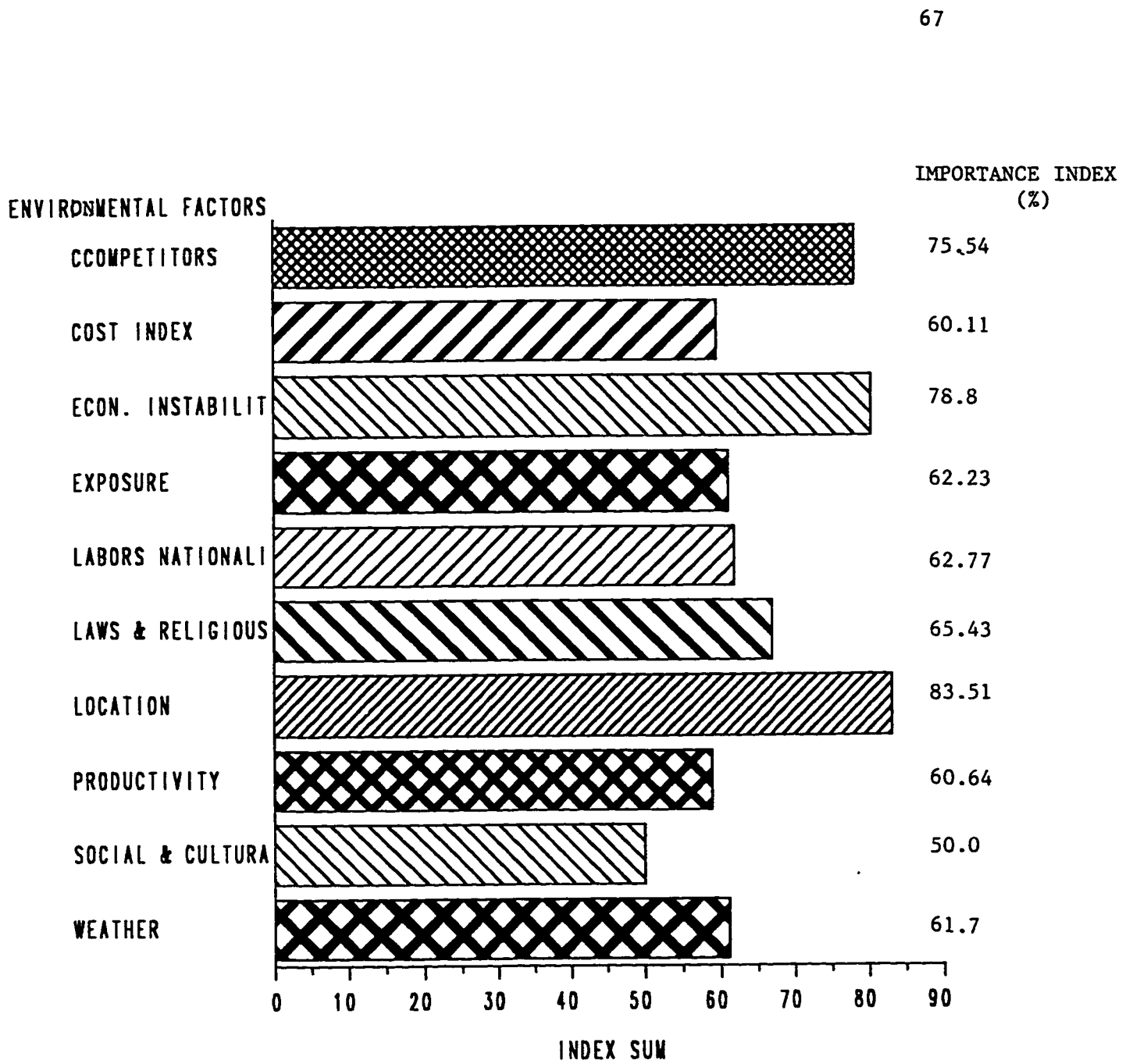


Fig. 5.5

The result demonstrates that most of the owners do not estimate the right progress in payments for the project. Furthermore, contractors do not consider such expected delays in payments when estimating for their projects. Thus, after winning the contract and facing the real cost, delay, claims, disputes and other contractual problems will be the result.

It was found that the availability of management finance and plans factor ranks second for medium and small firms with a score of about 85% and 81% respectively. However, according to the response of large sized firms, this factor shares equal importance with the payment factor, scoring 95% higher than the mean for the whole sample, which is about 84%. The questionnaire result clearly indicates that the great majority of public projects were poorly planned. Sometimes, neither are the objectives of the project well defined nor is the time of completion clearly and correctly specified.

Inflationary pressure is the third highest factor in this division with a score of 75% for both large and small sized contractors. This is higher than the mean observed for the sample which is about 72%. The medium sized response ranked this factor last with a score of about 65%.

The estimating method used is the fourth highest factor in this financing division with a score of 70% and 74% for large and small contractors respectively. The mean observed for the whole sample is about 74%. Medium sized firms ranked this factor last in this division with a score of about 65%.

Therefore, the above factors together with the negligence of the currency exchange factor, which scored 65%, 75% and about 57% for large, medium and small sized firms respectively, can tell why such financial issues have a strong effect on the accuracy of the cost estimating process.

- Consultant's View

Delays in payments are given the second highest rank and scored about 87%. It is the highest in the financial division. As expected, such a major financing item strongly affected the accuracy of the estimated costs. Such results show that the majority of construction parties suffered a great deal from such situations.

It was found that the availability of management finance and plans factor ranked second within the division, as illustrated in Table 5.19, with a score of about 77%. Estimating method with currency exchange issues, which both scored 73%, add another dimension to violate the estimated costs. The inflationary pressure factor comes last on the list with a score of about 62%.

5.3.2 Construction Parties

The influence of the seven important factors of this category on estimated costs is discussed below according to contractors' and consulting offices' views.

- Contractor's View

Previous experience of contracts is the most severe item of all the 29 factors among all parties. The scoring was 100%, 95% and 93% for medium, large and small sized companies respectively. Such results as can be seen from the ranking tables (15.15 to 15.18) show that the majority of construction parties suffered a great deal from this situation. This might be due to the unavailability of qualified professional estimators that have previous experience of different contracts to come up with the real cost. Moreover, the demand for construction work which has a greater influence on the amount of bid than any variations of costs lead contractors to bid even with little or no previous experience of such work.

The other construction parties items scored 60% and above. It appears that the actions and behavior of any of the construction parties have a very significant effect on the estimated costs.

Knowledge of client and consultants will lead to clear co-operation, which is necessary to enable the project to be built on time and cost and to satisfy the quality standards set out in the specification. This is why such a contractor's duty, which scores about 81% for small and 75% for both large and medium sized firms, have that major effect on the estimate accuracy.

It is obvious that actions which involve the owner or his authorized representative or other government agencies have a tremendous impact on

Table 5.15 : Small Contractor Rank of Factors Affecting the Accuracy of Estimated Costs

RANK	Q #	F A C T O R S	Important Index (%)
1	BB1	Previous Experience of Contract	92.86
2	BD2	Payments	84.52
3	BA6	Level and Number of Competitors	82.5
4.5	BA10	Economic Instability	82.14
4.5	BC1	Type and Size of Contract and its Content	82.14
6	BD1	Availability of Management Finance & Plans	81.25
7.5	BA5	Project Location	80.95
7.5	BB2	Knowledge of Clients and Consultants	80.95
9.5	BB4	Lack of information and coordination between government agencies	77.38
9.5	BC3	Labor & Equipment Required	77.38
11.5	BC6	Time Between Project Announcement and Bid Submittal	75.00
11.5	BD3	Inflationary Pressure	75.00
13	BD4	Estimating method used	73.81
14	BB6	Unforeseeable Increase or Decrease in Certain Taxes	72.62
15	BC2	Contract Period	71.43
16	BC5	Content of Specification	69.05
18	BA1	Weather	67.86
18	BB3	Government requirements	67.86
20.5	BB7	Unforeseeable Changes in Local Laws, Procedures, Permits or Codes	65.48
20.5	BC4	Content of Arbitration Clause	65.48
22	BA4	Local Laws and Religions	64.29
22	BB5	Punitive Damage	64.05
23	BA3	Public Exposure of the Project	60.71
24	BA9	Lack of Cost Indices Publication in Saudi Arabia	58.33
25.5	BA7	Labor's Nationality	57.14
25.5	BD5	Currency Exchange	57.14
27	BC7	Price of Bidding Document	54.76
28	BA8	Lack of Productivity Standard in Saudi Arabia	53.57
29	BA2	Social and Cultural Impacts	52.38

Table 5.16 : Medium Contractor Rank of Factors Affecting the Accuracy of the Estimated Costs

Rank	Q #	THE FACTORS	Important Index (%)
1	BB1	Previous Experience of Contract	100
2	BD2	Payments	95
3	BC1	Type and Size of Contract and its Content	90
4.5	BA8	Lack of Productivity Standards in Saudi Arabia	85
4.5	BD1	Availability of Management Finance and Plans	85
8	BA5	Project Location	80
8	BA10	Economic Instability	80
8	BB3	Government Requirements	80
8	BC2	Contract Period	80
8	BC5	Content of Specification	80
13	BA4	Local Laws and Religions	75
13	BA6	Level and Number of Competitors	75
13	BB2	Knowledge of Clients and Consultants	75
13	BB6	Unforeseeable Increase or Decrease in Certain Taxes	75
13	BD5	Currency Exchange	75
17	BA7	Labor's Nationality	70
17	BC3	Labor and Equipment Required	70
17	BC6	Time Between Project Announcement and Bid Submittal	70
22	BA1	Weather	65
22	BA9	Lack of Cost Indices Publication in Saudi Arabia	65
22	BB4	Lack of Information and Coordination Between Government Agencies	65
22	BB7	Unforeseeable Changes in Local Laws, Procedures, Permits or Codes	65
22	BC4	Content of Arbitration Clause	65
22	BD3	Inflationary Pressure	65
22	BD4	Estimating Method Used	65
26	BB5	Punitive Damage	60
27.5	BA2	Social and Cultural Impacts	45
27.5	BA3	Public Exposure of the Project	45
29	BC7	Price of Bidding Document	40

Table 5.17 : Large Contractor Rank of Factors Affecting The Accuracy of the Estimated Costs for the Total Surveyed Population

Rank	Q #	F A C T O R S	Important Index (%)
2.5	BB1	Previous Experience of Contract	95
2.5	BC5	Content of Specification	95
2.5	BD1	Availability of Management Finance and Plans	95
2.5	BD2	Payments	95
5	BA5	Project Location	90
6.5	BA4	Local laws and religions	85
6.5	BC1	Type and Size of Contract and its Content	85
8.5	BB3	Government Requirements	80
8.5	BB4	Lack of information and coordination between Government Agencies	80
12.5	BA3	Public exposure of the Project	75
12.5	BB2	Knowledge of Clients and Consultants	75
12.5	BC2	Contract Period	75
12.5	BC3	Labor & Equipment required	75
12.5	BC6	Time between project announcement and bid submittal	75
12.5	BD3	Inflationary Pressure	75
18	BA2	Social and cultural impacts	70
18	BA7	Labor's nationality	70
18	BA10	Economic Unstability	70
18	BB6	Unforeseeable increase or decrease in certain taxes	70
18	BD4	Estimating Method Used	70
22	BA6	Level and Number of Competitors	65
22	BB7	Unforeseeable changes in local laws, procedures, permits or codes	65
22	BD5	Currency exchange	65
25	BA8	Lack of productivity standards	60
25	BA9	Lack of cost indices publication in Saudi Arabia	60
25	BB5	Punitive damage	60
27	BC4	Content of arbitration clause	55
28	BA1	Weather	45
29	BC7	Price of bidding document	35

Table 5.18: All Contractor Rank of Factors Affecting the Accuracy of the Estimated Costs

Rank	Q #	THE FACTORS	Important Index (%)
1	BB1	Previous Experience of Contract	94.853
2	BD2	Payments	88.971
3	BD1	Availability of Management Finance and Plans	84.375
4	BC1	Type and Size of Contract and its Content	83.824
5	BA5	Project Location	83.088
6	BA10	Economic nstability	80.303
7	BB2	Knowledge of Clients and Consultants	80.147
8	BA6	Level and Number of Competitors	78.030
9	BC3	Labor and Equipment Required	76.471
10	BB4	Lack of Information and Coordination Between Government Agencies	75.735
11	BC5	Content of Specification	75.00
12	BC2	Contract Period	74.265
13	BC6	Time Between Project Announcement and Bid Submittal	74.242
14.5	BB6	Unforeseeable Increase or Decrease in Certain Taxes	73.529
14.5	BD4	Estimating Method Used	73.529
16.5	BB3	Government Requirements	72.059
16.5	BD3	Inflationary Pressure	72.059
18	BB7	Unforeseeable Changes in Local Laws, Procedures, Permits or Codes	67.424
19.5	BA4	Local Laws and Religious	66.912
19.5	BB5	Punitive Damage	66.912
21	BC4	Content of Arbitration Clause	63.971
22	BD5	Currency Exchange	63.235
23	BA7	Laborers' Nationality	61.765
24.5	BA1	Weather	61.029
24.5	BA3	Public Exposure of the Project	61.029
26	BA9	Lack of Cost Indices Publication in Saudi Arabia	59.559
27	BA8	Lack of Productivity Standard in Saudi Arabia	58.824
28	BA2	Social and Cultural Impacts	50.000
29	BC7	Price of Bidding Document	47.794

Table 5.19 : Consultant Rank of Factors Affecting the Accuracy of Estimated Costs

Rank	Q #	F A C T O R S	Important Index (%)
1	BB1	Previous Experience of Contract	88.462
2.5	BC1	Type and Size of contract and its content	86.539
2.5	BD2	Payments	86.539
5	BA5	Project Location	84.615
5	BC2	Contract Period	84.615
5	BC3	Labor & Equipment Required	84.615
7	BC5	Content of Specification	80.769
8	BD1	Availability of Management Finance & Plans	76.923
10.5	BA10	Economic Unstability	75.00
10.5	BB2	Knowledge of clients and consultants	75.00
10.5	BB3	Government requirements	75.00
10.5	BB4	Lack of information and coordination between government agencies	75.00
13.5	BD4	Estimating method used	73.077
13.4	BD5	Currency exchange	73.077
15	BA6	Level and number of competitors	69.231
17	BA3	Public exposure of the project	65.385
17	BA7	Laborers' Nationality	65.385
17	BA8	Lack of productivity standard in Saudi Arabia	65.385
19	BA1	Weather	63.462
21	BA4	Local Laws and Religions	61.539
21	BA9	Lack of cost indices publication in Saudi Arabia	61.539
21	BD3	Inflationary Pressure	61.539
23.5	BB5	Punitive Damage	53.846
23.5	BB6	Unforeseeable Increase or Decrease in Certain Taxes	53.846
25	BA2	Social and Cultural Impacts	50.00
27	BB7	Unforeseeable Changes in Local Laws, Procedures, Permits or Codes	48.077
27	BC4	Content of Arbitration Clause	48.077
27	BC6	Time Between Project Announcement and Bid Submittal	48.077
29	BC7	Price of bidding document	19.231

Table 5.20: Mean Rank of Factors Affecting The Accuracy of the Estimated Costs for the Total Surveyed Population

Rank	Q #	F A C T O R S	Important Index (%)
1	BB1	Previous Experience of Contract	93.085
2	BD2	Payments	88.298
3	BC1	Type and Size of Contract and its Content	84.575
4	BA5	Project Location	83.511
5	BD1	Availability of Management Finance and Plans	82.222
6	BA10	Economic Instability	78.804
7	BB2	Knowledge of Clients and Consultants	78.723
8	BC3	Labor & Equipment Required	78.723
9	BC2	Contract Period	77.128
10	BC5	Content of specification	76.596
11	BA6	Level and Number of Competitors	75.544
12	BB4	Lack of information and coordination between Government Agencies	75.532
13	BD4	Estimating Method Used	73.404
14	BB3	Government Requirements	72.872
15	BD3	Inflationary Pressure	69.149
16	BB6	Unforeseeable increase or decrease in certain taxes	68.085
17	BC6	Time between project announcement and bid submittal	66.848
18	BD5	Currency exchange	65.957
19	BA4	Local laws and religious	65.426
20	BB5	Punitive damage	63.298
21	BA7	Laborers' Nationality	62.766
22	BA3	Public exposure of the Project	62.234
23	BB7	Unforeseeable changes in local laws, procedures, permits or codes	61.957
24	BA1	Weather	61.702
25	BA8	Lack of productivity standard	60.638
26	BA9	Lack of cost indices publication in Saudi Arabia	60.106
27	BC4	Content of arbitration clause	59.575
28	BA2	Social and cultural impacts	50.000
29	BC7	Price of bidding document	39.894

the estimated costs. Government requirements, which scored 80% for large and medium firms and 68% for small, lack of information and coordination between government agencies (86%, 77% and 65% for large, small and medium sized firms respectively), unforeseeable change in local laws, procedures, permits or codes (65% for all sized companies), could cause changes to construction time and cost which thereby affect the accuracy of the estimated costs. For instance, after the contract has been signed, the owner may not be able to get permission from the municipality to start the work unless certain codes and precautions are to be followed. Consequently, to do so, extra time and cost are factors. Again, the contractor may not be able to bring his labor from abroad in the proper time due to bad coordination with migration and labor office. Thus, the contractor will have to spend time and money bringing his labor and to fulfilling his contractual obligations.

Punitive damage comes the fifth highest factor in this division with a score of 64% for small sized contractors, less than the mean observed for the whole sample which is about 67%. Medium and large sized firms ranked this factor last in this division with a score of 60%. Such a result shows that the majority of construction contractors suffered a great deal and this might be due to failure to conform to the required laws and ordinances concerning job safety, licensing, building codes and other aspects of work.

- Consultant's View

Previous experience of contracts is given the highest rank with a

score of about 88%. As can be seen from this result compiled with the contractor's results, past experience seems to have a strong effect on the estimate. Therefore, contractors need, in this case, to study their capability of doing business before landing a contract. Knowledge of client and consultant, government requirements and lack of information and coordination between government agencies ranked equally with a score of 75%.

On the other hand, it does not seem that punitive damage, unforeseeable increase or decrease in certain taxes and unforeseeable change in local laws, procedures, permits or codes have that strong an effect on an estimate according to the surveyed consultants. The effects are only 54%, 54% and 48% respectively.

5.3.3 Construction Items

The influence of the seven factors of this division on the accuracy of an estimate is discussed and analyzed below according to contractors' and consulting offices' view.

- Contractor's View

It seems that all the surveyed contractors agreed that type and size of contract and its content, contract period, labor and equipment required, time between payment announcement and bid submittal, and content of specification are the major items in this division that have a great influence on the estimated costs. In fact, they ranged between 70% to 82%, 70% to 90% and 75% to 95% for small, medium and large sized contractors respectively.

It is the responsibility of contractors to carefully examine the contract documents during the bidding or negotiation phase. In such cases, future discovery of defects such as inaccurate quantities, misunderstanding of some details, ambiguous wording in the arbitration clauses, etc., could have a significant impact on contract time and cost and hence affect the estimated costs. Although the occurrence of one or more of those defects are of relatively minor consequence in small size building projects, they are a significant factor in large complex building projects.

It is the contractor who suffers when the required material, equipment and labor are not available. For instance, certain materials cannot be found locally either because they are not manufactured locally or they do not conform to specifications. Therefore, they have to import them from abroad. It is not only more time that may be required, but also there is the problem of uncertainty about the quantity and about damage which may occur during shipment. Also, it happens sometimes that the labor groups are not up to standard and perform badly, so owners may suspend the work until good performance is achieved. Therefore, that usually adds cost and time for a contractor to bring more skilled labor. The same rule is however applicable to equipment. When a contractor suffers from the unavailability of certain types of equipment, it results in more time and cost to import them. Therefore, work to be done, material and equipment to be provided and the quality of workers required should be carefully examined before the submission of the completed bid.

The time between the payment announcement and the bid submittal are an important issue to the general contractor. The results indicate clearly that the time is of value to contractors in order to seek lower sub-contract prices which will be included in the general contractor's estimate and to investigate the defects that could occur to contract documents.

On the other hand, it does not seem that the price of the bidding document has as strong an effect as expected on the accuracy of the estimated costs. The effects are 35%, 40% and 55% for large, medium and small sized firms, which indicates that contractors know exactly how many documents and additional copies they require at the beginning of the contract.

- Consultant's View

Consultants share the contractors opinion that type and size of contract and its content, contract period, labor and equipment required, and content of specifications are the major items in this category and have a great influence on the estimated costs, with a score of about 87%, 85%, 85%, and 81% respectively.

On the other hand, it does not seem that content of arbitration clause and time between payment announcement and bid submittal have that strong an effect on an estimate according to the surveyed consultants. The effects are only 48% for both factors. Price of bidding document ranked the last of the 29 factors with a score of about 19%.

5.3.4 Environment

The effect of the ten factors of this category on the accuracy of an estimate is discussed and analyzed below according to contractors' and consulting offices' view.

- Contractor's View

The result shows that two out of the ten items seem to have a major effect on the accuracy of the estimated costs for all parties. These items are economic instability with a score of about 82%, 80% and 70% for small, medium and large sized contractors, together with project location with a score of 90%, 81% and 80% for large, small and medium sized firms. The importance of the other issues vary according to the different opinions of the surveyed parties.

For small and medium sized contractors, the level and number of competitors is a significant issue with an effect of 83% and 75% respectively. However, this item has a moderate effect for large sized firms and is indicated by a score of 65%. This result indicates clearly that the majority of small and medium public contractors suffered from competition which violates the estimate. This might be due to the decline in the number of projects due to oil price fluctuations and a lower demand for construction. Furthermore, the criteria for selection of a suitable contractor is not mentioned in proper detail; thus future problems of contractor weakness will come to the surface. So, it is the contractor who should

come up with a good bidding strategy, in order to obtain sufficient work at the proper price, and this can be sustained by studying carefully the number and level of competitors.

Local laws and religions together with public exposure of the project have a major effect for large companies and scored 85% and 75% respectively. However, these two issues have a moderate effect for small firms and scored 64% and 61% respectively. Local laws and religions ranked second for moderate sized companies, with a score of 80%, while the other factor ranked last on the list. So, it appears that certain laws and exposure of the project lead to violation of the estimated cost.

The laborer's nationality has a major effect on the estimate for large and medium sized companies with a score of 70% for both. Its effect on the estimate, according to small small sized firms, is low and scores only 57%. The result demonstrates that contractors do not estimate the right cost of this issue. Labor productivity is the target point in this item and, for example, because of government requirements for security purposes, a contractor is prohibited from using certain foreign workers on such government projects. The result is extra time and cost that are not recognized on the estimation phase.

Lack of productivity standard in Saudi Arabia ranked the highest with a score of 85% for medium contractors while it comes out much lower for large and small sized contractors with a score of 60% and 54% respectively.

Social and cultural impact is a significant item for large firms and shows a score of 70%. However, it ranked last for medium and small sized contractors with a score of 45% and 52% respectively. It appears that certain social and cultural considerations lead to an increase or decrease in the estimated cost.

Items of weather and cost indices ranked last of the ten factors in this division according to large sized firms' responses. They scored 45% and 60% respectively. These two factors have a moderate effect for small (68% and 58% respectively) and medium sized contractors (65% for both).

- Consultant's View

The survey showed that project location and economic instability have a major effect on an estimate with a score of 85% and 75% respectively. Level and number of competitors (69%), exposure of the project (65%), labor nationality (65%), lack of productivity standards (65%), weather (63%), laws and religious customs (61%), and cost indices shortage (61%), have moderate effects and could cause changes to construction time and cost which thereby affect the accuracy of the estimated costs. Social and cultural impacts have a low significance on the estimating process and score 50%.

5.4 Contractors/Consultants Agreement

One of the objectives of this research is to see where there is an agreement between contractors and consulting offices on the severity of the factors that affect the accuracy of cost estimating for large building

projects in Saudi Arabia.

Before proceeding to test this objective, statistical techniques are highlighted here to help in explaining the existing information.

5.4.1 Measures of Dispersion and Data Distribution

Tables 5.21 and 5.22 present the mean, standard deviation, standard error of mean and coefficient of variance (C.V.) for the factors affecting the estimated costs as assessed by contractors and consultants respectively.

For contractors, participants' replies are uniformly distributed on both sides of the mean. The predictive values of variation are considered reasonable because the variation of the responses is somewhat small in this study and indicates small dispersion. However, the values of the coefficient of variation (CV) of the consultants' responses in general are somewhat large. The reason for the high values of the coefficient of variation is that in answering the questions the consultants used their experience from different types of construction divisions (buildings, highways, utilities, etc.). So, the variation comes from their different backgrounds and experiences while this research is limited to building contracts for the contractors' respondents. This difference in background and experience between the two sets of data leads to the high values of the coefficient of variation.

5.4.2 Spearman Rank Correlation

The Spearman rank correlation coefficient is used here to measure

Table 5.21 : Mean, Standard Deviation, Standard Error of Mean, and Coefficient of Variance by Questions for Contractors' Responses

Factors	Mean	Standard Deviation	Standard Error of Mean	Coefficient of Variance (C.V.)
BA1	2.44	0.89	0.15	36.63
BA2	2.00	0.95	0.16	47.67
BA3	2.44	0.82	0.14	33.74
BA4	2.68	1.07	0.18	39.80
BA5	3.32	0.59	0.10	17.72
BA6	3.12	0.74	0.13	23.70
BA7	2.47	0.79	0.14	31.88
BA8	2.35	0.88	0.15	37.55
BA9	2.38	1.02	0.17	42.62
BA10	3.21	0.74	0.13	23.03
BB1	3.79	0.41	0.07	10.82
BB2	3.21	0.64	0.11	19.99
BB3	2.88	0.59	0.10	20.51
BB4	3.03	0.67	0.12	22.23
BB5	2.68	0.68	0.12	25.56
BB6	2.94	0.74	0.13	25.03
BC1	3.35	0.54	0.09	16.22
BC2	2.97	0.76	0.13	25.52
BC3	3.06	0.49	0.08	15.98
BC4	2.56	0.86	0.15	33.59
BC5	3.00	0.78	0.13	25.95
BC6	2.97	0.88	0.15	29.75
BC7	1.91	0.97	0.17	50.48
BD1	3.38	0.55	0.10	16.40
BD2	3.56	0.89	0.15	25.12
BD3	2.88	0.84	0.14	29.30
BD4	2.94	0.78	0.13	26.39
BD5	2.53	0.86	0.15	34.04

Table 5.22 : Mean, Standard Deviation, Standard Error of Mean and Coefficient of Variance by Question for Consultants' Response

Factors	Mean	Standard Deviation	Standard Error of Mean	Coefficient of Variance (C.V.)
BA1	2.54	1.56	0.43	61.48
BA2	2.00	1.29	0.36	64.55
BA3	2.62	1.39	0.38	53.02
BA4	2.46	1.05	0.29	42.66
BA5	3.38	0.77	0.21	22.69
BA6	2.77	1.01	0.28	36.57
BA7	2.62	1.39	0.38	53.02
BA8	2.62	0.87	0.24	33.25
BA9	2.46	1.13	0.31	45.77
BA10	3.00	1.00	0.28	33.33
BB1	3.54	0.52	0.14	14.66
BB2	3.00	1.08	0.30	36.00
BB3	3.00	0.91	0.25	30.43
BB4	3.00	1.29	0.36	43.03
BB5	2.15	1.21	0.34	56.38
BB6	2.15	1.28	0.36	59.48
BB7	1.92	1.32	0.37	68.66
BC1	3.46	0.52	0.14	14.99
BC2	3.38	0.65	0.18	19.22
BC3	3.38	0.51	0.14	14.96
BC4	1.92	1.44	0.40	74.94
BC5	3.23	0.83	0.23	25.75
BC6	1.92	0.95	0.26	49.61
BC7	0.77	1.01	0.28	131.66
BD1	3.08	1.04	0.29	33.73
BD2	3.46	0.66	0.18	19.07
BD3	2.46	0.97	0.27	39.30
BD4	2.92	0.95	0.26	32.64
BD5	2.92	0.95	0.26	32.64

the degree of correspondence between the two lists of ranks of the sample observations. In this research, this test is used to find and compare how well the contractors and consultants in the samples (and as an estimate of the sampled population) agree on the severity of the factors affecting the accuracy of the construction cost estimations for large buildings in Saudi Arabia.

The following formula is used for the calculation of the Spearman rank correlation:

$$r_s = 1 - \frac{6 \sum d^2}{N(N^2 - 1)} \quad (5.1)$$

Where:

r_s = Spearman rank correlation coefficient (the agreement between contractors and consultants)

d = difference between ranks on one variable and ranks on the other variable.

N = Number of factors

By applying the formula and using Table 5.23:

$$r_s = 1 - \frac{977.25}{29(29^2 - 1)} = 0.7593$$

5.4.3 Hypothesis Testing

The Spearman correlation coefficient 0.7593 becomes an estimate of the true but unknown population coefficient (ρ). Yet, we may be uneasy

Table 5.23 : Computation of Spearman Rank Correlation

Factor #	Rank by		Difference Between Ranks (d)	
	Contractors	Consultants	d	d ²
BA1	24.5	19	5.5	30.25
BA2	28	25	3	9
BA3	24.5	17	7.5	56.25
BA4	19.5	21	1.5	2.25
BA5	5	5	0	0
BA6	8	15	7	49
BA7	23	17	6	36
BA8	27	17	10	100
BA9	26	21	5	25
BA10	6	10.5	3	9
BB1	1	1	0	0
BB2	7	10.5	3.25	12.25
BB3	16.5	10.5	6	36
BB4	10	10.5	0.5	0.25
BB5	19.5	23.5	4	16
BB6	14.5	23.5	9	81
BB7	18	27	9	81
BC1	4	2.5	1.5	2.25
BC2	12	5	7	49
BC3	9	5	4	16
BC4	21	27	6	36
BC5	11	7	4	16
BC6	13	27	14	196
BC7	29	29	0	0
BD1	3	8	5	25
BD2	2	2.5	0.5	0.25
BD3	16.5	21	4.5	20.25
BD4	14.5	13.5	1	1
BD5	22	13.5	8.5	72.25

d² = 977.25

about concluding that a correlation exists between both parties (contractors and consultants) on the agreement on severity of the factors affecting the accuracy of the estimated costs after examining a sample size of only 47 of them. Specifically, the following question is formulated. Is the sample evidence enough to reject the following hypothesis?

$$H_0 = \rho = 0 \quad (5.2)$$

This null hypothesis states that contractors and consultants do not agree on the importance index rank of the factors affecting the accuracy of cost estimate and that they differ in their responses.

To test the hypothesis of (5-2), we must identify the appropriate sampling distribution. The t distribution, shown in Fig. 5.6, is the sampling distribution for this test, since the sample (n) is small, the standard deviation (E) is unknown (and is being estimated by the sample standard deviation(s)) and the population can be assumed to be approximately normally distributed.

Two degree of freedom are lost because two population parameters are estimated by using sample values (Hanks-Peitsch-Dickson, 1984).

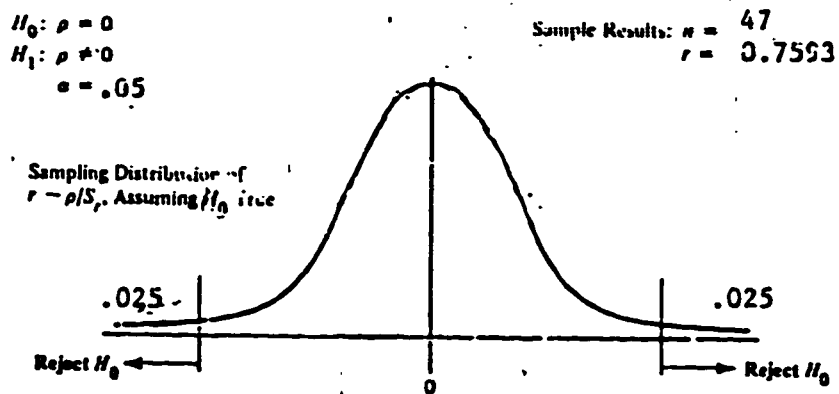


Figure (5-6)

The test statistic is as follows :

$$S_r = \frac{\sqrt{1 - r^2}}{\sqrt{n - 2}} \quad (5.3)$$

$$t = \frac{r - \rho}{s_r} \quad (5.4)$$

Where:

s_r = Standard error of the correlation coefficient

r_s = The sample Spearman correlation

n = the number of observations

ρ = the population correlation which has zero value as stated by the null hypothesis.

t = the t - statistic.

So,

$$s_r = \frac{\sqrt{1 - (0.7539)^2}}{\sqrt{47-2}}$$

$$= .0097$$

$$t_{cal} = \frac{0.7593}{0.097} = 6.1136$$

$t_{table} = 1.96$ (from t table for $\alpha = 0.05$, $d_f = n-2 = 45$ and a two-sided test).

Decision Rule:

Since 6.113 is greater than 1.96, we can reject H_0 at the .05 level of significance.

Conclusion:

We concluded that contractors and consultants agree on the importance index rank of the factors affecting the accuracy of a cost estimate.

The mean rank of the concerned factors for all parties is illustrated in Table 5.20.

5.5 Other Factors Affecting the Estimated Costs

The respondents were asked to add other factors that they thought were important but were not listed in the questionnaire . Some of the factors they mentioned are : (1) security requirements, (2) skilled national labor; (3) block visa, (4) purpose of the building, (5) previous experience of owner in work; (6) time between bid submittal and actual award of contract; (7) material used; (8) retention monies; (9) performance guarantees; and (10) advance payment.

CHAPTER 6

SUMMARY AND RECOMMENDATIONS

6.1 Summary

This section first presents a summary of the study, followed by a summary of the results.

6.1.1 Summary of the Study

This research study served two purposes relevant to large buildings : detailed contractors estimates. The first purpose was to investigate the estimating process. The second objective was to determine the factors that affect the accuracy of Saudi contractor estimate.

These objectives were achieved through two interdependent phases. The first phase included an intensive literature review. This phase was necessary to investigate the process by which a contractor estimate is prepared. It was important to identify potential factors that affect the accuracy of costs estimate. The literature review helped in identifying 29 potential factors which are grouped into four categories. These categories are finance, construction parties, construction items and environment.

The second phase included the necessary steps in collecting all the required information. A questionnaire was sent to 34 contractors and 15 consulting offices in the Eastern Province of Saudi Arabia. All the 34

contractors but only 13 consultant offices participated in the survey.

6.1.2 Summary of the Results

This section presents the results that was obtained from this research:

1. Contractors and consultants generally agree on the severity of factors affecting the estimated costs.
2. The financing division is the most influential factor on the accuracy of cost estimates.
3. Previous experience of contract is given the highest rank of all the 29 factors. This result was expected, and this might be due to the unavailability of qualified professional estimators.
4. Progress payments have a very strong effect on the accuracy of the estimated costs. The result of the survey shows that progress payments are not estimated well, which results in project delay, claims, disputes and other contractual problems.
5. The type and size of contract and its content, the contract period, labor and equipment required and the content of specification are major factors in the construction items division which cause violation of the estimated costs.

6. The social and cultural impact, the level and number of competitors, together with the laborers' nationality, are cited to be the most common environmental factors affecting the estimated costs.
7. The majority of construction contractors suffer a great deal from lack of information and coordination between the government agencies.
8. Computers can offer real advantages to the contractor by speeding up the estimating process considerably and by eliminating computational errors.
9. Historical production records are the only reliable reference of information to assess the preparation of estimated costs.
10. Most of the uncertainty in the cost items was considered by adjusting mark-up.

6.2 Recommendations

6.2.1 General Recommendations

The following recommendations are the most important ones in the opinion of the author.

1. Owners should know their needs and if they will be able to satisfy them with their financial ability in order to reduce

payment problems.

2. Estimates based on updated price information should be considered in order to come up with a reasonable offer.
3. There should be a price information center to enable contractors, if there is a change in the costs of certain items, to come up with the best estimates.
4. Experience of contractors should be given high priority in the prequalification procedure.
5. Close coordination and communication between contractor and owners and among various government agencies with standard procedures, permits and codes is strongly recommended to improve management and control problems.
6. It is the responsibility of contractors to come up with a clear plan and strategy before starting a project. Early project planning and scheduling of labor, equipment and cash, combined with a good bidding strategy, will help to obtain sufficient work at a proper price.

6.2.2 Recommendations for Further Study

1. It is suggested that the boundaries of such a study should be widened to include all Saudi Arabia.
2. This study is limited to public projects; it is suggested that

the same research be conducted for private projects.

3. Since the owner's opinion about the factors affecting estimated costs was not covered in this research, it is suggested that a similar study be conducted to determine his opinion.
4. The same study might be conducted to analyze previous actual completed contracts.
5. The scope of this study is limited to building contractors. Further studies might be conducted in the other construction sectors.
6. A study could be performed to investigate financial problems associated with payments and other important factors affecting the estimated costs and to develop methods for calculating such costs.
7. A study could be performed to investigate the computer's ability in making many changes within the estimate sheet without spending too much time and with a high degree of accuracy.
8. The same study might be conducted to include the other factors affecting the estimated cost that were important but were not listed in the questionnaire and mentioned by the respondents.

APPENDIX
QUESTIONNAIRE

- 1. ARABIC FORM**
- 2. ENGLISH FORM**

Ministry of Higher Education

King Fahd University of Petroleum & Minerals

DHAHRAN 31261, SAUDI ARABIA



وزارة التعليم العالي

جامعة الملك فهد للبترول والمعادن

الظهران ٣١٢٦١ المملكة العربية السعودية

السادة /

السلام عليكم ورحمة الله وبركاته .

نفيدكم أن قسم هندسة وإدارة التشييد بكلية تماميم البيئه بجامعة الملك فهد للبترول والمعادن بالظهران يقوم بأعداد بحث دراسي علمي عن العوامل المؤثرة على صحة تقدير التكاليف الانشائية للمباني الفخمة في السعودية حيث أن العربي من هذه الدراسة هو توضيح ومعرفة طبيعة تأثير تلك العوامل على صحة ودقة تقدير وتأمين التكاليف الانشائية للمباني الفخمة في المملكة العربية السعودية وذلك من اجل الصالح العام

نأمل منكم المشاركة والاجابه على كافة الاسئلة وموافاتنا بالمعلومات الضرورية للعوامل المؤثرة التي تؤخذ في الاعتبار عند تقدير التكاليف للمشاريع المنفذه فنحن نؤمل منكم أو شركتكم الخاصه من أجل اعطائنا توضيح وافى عن الفوائد والمشاكل المترتب على تأثير تلك العوامل في تقدير التكاليف وذلك لمعرفة أهميتها وتقييمكم لتلك العوامل على المشاريع المنفذه والمزمع تنفيذها من قبلكم . . ونحن سوف نقوم بتجميع المعلومات من اغلب الشركات والمؤسسات في الاممكة أمثالكم في هذا المضمار .

نرجو منكم مراعاة الدقه والصبه والواقعيه حيث معلوم لدينا أن وقتكم ضروري ومفيد لكن مشاركتكم في هذا البحث ذو أهميه بالعهه لعمل هذه الدراسه كما أن الاجابه على الاسئله المرفقه في الاستبيان سوف تستغرق من وقتكم (١٥ - ١٠) دقيقه . . وهي تتكون من ثلاثه اجزاء كالتالى :-

الجزء الاول : معلومات عامه عن مؤسستكم أو شركتكم .

الجزء الثاني: العوامل المؤثرة على صحة تقدير التكاليف الانشائية في مشاريعكم المنفذه .


الجزء الثالث: معلومات عامه عن تقييمكم وآرائكم عن مدى تأثير تلك العوامل على تقدير تكاليف المشاريع .

نأمل منكم رد الجواب بسرعه قبل تاريخ ١٢/٢/١٤٠٩هـ مع شكرنا لكم بعمق ويمكنكم التفهه علينا وارجاع تلك الاستبيان في ظرف المعنون المرفق . . ولكم خالص ووافر تحياتنا .

المشرف العام


الدكتور/علي علي شياش

الباحث المشارك


المهندس/زيتون شديد الخالدي
٨٨٠٤٦١٠٤ (٠٢)

جامعة الملك فهد للبترول والمعادن
كلية الدراسة العليا
قسم هندسة وإدارة التشييد

استبيان

العوامل الرئيسية المؤثرة على صحة تقدير التكاليف الانشائية للمباني
الكبيرة في المملكة العربية السعودية .

الغرض

يهدف هذا الاستبيان الى معرفة العوامل الأكثر خطورة وحدثاً والمؤثرة على تقدير
التكاليف الانشائية للمباني الكبيرة وقد اختيرت المنطقة الشرقية لدراسة
تلك الحالة .

الهدف

عمل هذا الاستبيان لاجل الحصول على متطلبات تتعلق العوامل المؤثرة على صحة
تقدير التكاليف الانشائية للمباني الكبيرة . ان نتائج هذا الاستبيان سوف توضح
في بحثه لنيل درجة الماجستير. ويشمل هذا البحث على اجابة لجنة مختارة من
المقاولين والاستشاريين العاملين في المنطقة الشرقية من المملكة العربية السعودية
لهدف التقليل من حجم المخاطرة والتحكم في المشاكل المصاحبة لتقدير التكاليف
الانشائية .

تصميم / الاستبيان:

يحتوي هذا الاستبيان على ثلاثة اجزاء هي كالتالي:-

- (١) الجزء الاول : ا - (معلومات عامة) .
- (٢) الجزء الثاني: ب - (العوامل المؤثرة على صحة تقدير التكاليف الانشائية) .
- (٣) الجزء الثالث : ج - (تقييم تقدير التكاليف) .

وسنكون مقدرين اجابتم على هذا الاستبيان شاكرين لكم هذا التلطف بعمق .

الجزء الأول

الرجاء ملاءمة ما يلي :

اسم الشركة : ----- جنسيتها -----

العقر الرئيسي ----- عدد الفروع -----

عدد العاملين بالشركة ----- مقر الاثغال -----

مركز العمل الرئيسي -----

الرجاء الاجابة على الاستبيان الاتى بوضع علامة (✓) فى الجزء المناسب .

(١) ما هو مقدار رأس مال الشركة تقريبا بالريال السعودى ؟

- () اكثر من ٥٦ مليوناً
 () من ١٥ - ٢٤ مليوناً
 () من ٢٥ - ٥٥ مليوناً
 () من ٥ مليوناً او اقل

(٢) ما هو معدل حجم الاعمال المعطاة من قبلكم ؟

- () ١٩ % او اقل فى المشروع الواحد
 () من ٢٠ - ٤٩ % من المشروع الواحد
 () من ٥٠ - ٩٩ % من المشروع الواحد
 () جميع الاعمال (١٠٠ %)

(٣) ما هو معدل تكلفة المشروع الواحد بالريال السعودى

- ()
 ()

(٤) ما هو معدل مدى انجاز المشروع الواحد بالسنة ؟

- ()

(٥) ما هو مدته سنوات الخبرة فى مجال الانشاءات ؟

- () اقل من سنة
 () من ١ - ٥ سنوات
 () من ٥ - ١٠ سنوات
 () من ١٠ - ١٥ سنة
 () اكثر من ١٥ سنة

٦) كم عدد موظفي تقدير التكاليف في مؤسستكم ؟

() من ١-٢ () من ٣-٤ () ٥ او اكثر

٧) من يقرز تقدير العطاء النهائى للمشاريع ؟

() على مستوى الادارة (المالك او المدير العام)

() على مستوى مقدرى التكاليف (مهندس التكاليف او المشمن)

() غيرهم (اذكرهم)

٨) هل تستخدم برنامج حاسب آلى (كمبيوتر) لمساعدتكم فى سحة دقة تقدير التكاليف ؟

() نعم () لا

اذا كانت الاجابة بنعم اجب على السؤال التاسع واذا كانت (لا) اترك الاجابة على السؤال التاسع .

٩) الرجاء توضح ما يلى :

١) اسم البرنامج - - - - -

٢) الصانع - - - - -

٣) وقت تطبيق البرنامج - - - - -

١٠) هل تستخدم اى معلومات قديمة لمشاريع سابقة للمساعدة فى اعداد تقدير تكاليف المشاريع

() نعم () لا

اذا كانت الاجابة بنعم هل توضع فى الاعتبار انتاجية العامل او الالة عند تقدير التكاليف .

() نعم () لا

اذا كانت الاجابة (لا) ما هى الاسباب وراء الاخفاق فى عدم اعتبار الانتاجية ؟

() قلة معايير الانتاجية

() صعوبة التعامل معها

() تحتاج الى متخصصين

() اسباب اخرى ٠٠٠٠ (اذكرها)

الجزء الثاني

العوامل المؤثرة على صحة تقدير التكاليف للمشاريع
هذا الجزء من الاستبيان مسم للمعرفة مدى فعالية كل عامل من العوامل الاتية على صحة تقدير التكاليف المشاريع

اعمال المساندين				العوامل	
غير مؤثرة	تأثير بسيط جدا	تأثير بسيط	مؤثرة جدا		
				(1) البيئة	
				العوامل الداخلية	(1)
				العوامل الاجتماعية والعمارية	(2)
				العوامل المحيطة علمي العماء، مساندة	(3)
				القوانين الحكومية والشرائح الدينية	(4)
				موقع العمل	(5)
				مدى مستوى الناقد، ومدتهم	(6)
				جنسية العاملين	(7)
				قلة معايير الانتاجية في المملكة العربية السعودية	(8)
				قلة معايير التكاليف في المملكة العربية السعودية	(9)
				التقسيم الاقتصادي	(10)
				تأمل ذكر عوامل اخرى تعتقد انها مهمة ولم تذكر في الجدول	11 12 13 14

اعمال المصارف					المسؤول
غير مؤثر	تأثير بسيط جدا	تأثير بسيط	مؤثر	مؤثره جدا	
					جها شراء العمل (المالك، المقاول ، الاستشاري)
					(١) الخبرة السابقة في مجال العقد
					(٢) معرفة صاحب العمل والاستشاري
					(٣) المتطلبات الحكومية الاضافية
					(٤) عددي وجود المعلومات والتنسيق بين الجماعات الحكومية
					(٥) زيادة او التقليل في الضرائب غير متوقعة
					(٦) غرامة الخاضعة
					(٧) التغيير في القوانين والطرق والتصاريف المختلفة
					تأمل ذكر عوامل اخرى تعتقد انها مهم ولم تذكر في الجدول

اعمال المباني					المواد
مؤثره جدا	مؤثره	تأثير بسيط	تأثير بسيط جدا	ليس مؤثرا	
					(١) نوع وحجم المقعد وما يحتويه <u>مبنى القبة</u>
					(٢) متطلبات العمالة والمعدات
					(٣) محتويات العقد في تحكيم فصل النزاع
					(٤) محترقات . المواصفات
					(٥) المدى من الاعلان عن المناقمة الى تقديم العطاء
					(٧) قيمة تكاليف شراء عقود المناقمة تأمل ذكر عوامل اخرى تعتقد انها مهم ولم تذكر في الجدول
					٨ ٩ ١٠ ١١

اسماء المعينات					العوامل
مؤثره جدا	مؤثر	تأثير بسيط	تأثير بسيط جدا	غير مؤثر	
					١) المالية توفر الادارة المالية والنظم
					٢) دفع المستحقات
					٣) مخطط التنفيذ
					٤) طريق- المتبعة في التقدير للتكاليف
					٥) التفسير في العملات
					تأمل ذكر عوامل اخرى تعتقد انها مهم ولم تذكر في الجدول

الجزء الثالث

تقييم تقدير التكاليف

هذا الجزء من الاستبيان يتطلب تقييمكم عن الممارسه في تقدير التكاليف للمشاريع

- ١ - هل تفعون في الاعتبار عدم لثبوتية حجه كلفه العنصر الواحد ؟
 - أ - يؤخذ في الاعتبار بضره في عامل التصحيح أو الخطاء .
 - ب - يؤخذ في الاعتبار عند تعديل الربح .
 - ج - لا يؤخذ في الاعتبار .
 - د - أخرى اذكرها _____

- ٢ - كم مره يؤخذ في الاعتبار العوامل المؤثره على صحة تقدير التكاليف المذكوره في الجزء الثاني السابق ؟
 - أ - لس جميع العقود .
 - ب - لس ٥٠٪ أو أكثر من عقود المشاريع .
 - ج - لس اقل من ٥٠٪ من العقود .
 - د - لا يؤخذ أبدا .

٣ - هل أنت مرتاح من الطريقه التي تتبعها في تقدير التكاليف ؟

أ - نعم

ب - تقريبا

ج - لا

٤ - مامدى نجاح شركتكم في تطبيق العوامل المؤثره على صحة تقدير التكاليف ؟

أ - بنجاح جدا .

ب - بنجاح متوسط .

ج - غير ناجح .

إذا كانت الاجابه (غير ناجح) اذكر الاسباب التي تعتقدها وراء ذلك ؟

أ - إذا أخذت في الاعتبار سوف نخسر المناقصه .

ب - نحتاج الى متخصصين .

ج - غيرهم: اذكرهم _____

ملاحظات

إذا كانت لديك أية ملاحظات إضافية تساعدنا لفهم نظام وتقييم
شركتكم نأمل إضافة ذلك أسفله :

نشكركم على حسن تعاونكم •



Dear Respondent:

The Construction Engineering & Management Department of the College of Environmental Design at King Fahd University of Petroleum & Minerals is presently engaged in a study of the essential factors that affect the accuracy of the construction costs estimating in large buildings in Saudi Arabia.

The purpose of the study is to visualize the essential factors affecting the accuracy of cost estimating for large buildings.

We are asking you to participate by providing needed information related to the factors your firm is using and the degree of importance to your firm. We hold all data of individual firms in strict confidence. We know that there are numerous demands on your time. But your involvement is important in contributing to the study. The questionnaire will take less than 15 minutes of your valuable time.

The attached questionnaire consists of four sections. The first section seeks information about your firm. The second section seeks information related to the importance of the factors for cost estimating. The third section seeks your evaluation related to your firm's current practice regarding the cost estimate.

We shall, therefore, highly appreciate your kindness towards us in rendering the information as per our needs. Your contribution in this regard is highly appreciated.

Your immediate action will be highly appreciated. Please return your completed questionnaire in the enclosed self-addressed envelope not later than August 25th, 1989.

Thank you in anticipation for your co-operation.

Sincerely yours


DR. ALI A. SHASH, Ph.D.
STUDY DIRECTOR


ZAITOON S. ALKHALDI
RESEARCH ASSOCIATE

CONSTRUCTION FIRM'S QUESTIONNAIRE

PURPOSE

The objective of this questionnaire is to identify the most severe and frequent types of factors in the Eastern Province of Saudi Arabia that influence the construction costs estimate for large buildings.

SYNOPSIS

This questionnaire is prepared for certain requirements related to the factors affecting the accuracy of cost estimating for large buildings. The result of the questionnaire will be written in Master Degree research. This research contains a survey study among selected contractors and consultants in the Eastern Province of Saudi Arabia in order to reduce the possibility of risk and control the potential problem associated with the cost estimating.

DESIGN

This questionnaire contains three sections which will be considered in turn :

- Section (1) : Part A (Firm's information)
- Section (2) : Part B (Factors that influence the accuracy of your cost estimate)
- Section (3) : Part C (Firm's cost estimate evaluations)

We will be most grateful to you for answering this questionnaire and we are thankful to you for this act of kindness.

PART - AGENERAL FIRM'S INFORMATION

This section contains questions seeking information about your firm.

Please fill the following :

Company name: _____ Company Nationality: _____

Location of Main Office: _____ No. of Branches: _____

Total No. of Employees: _____ Region of operation: _____

Title or position of the Respondent: _____

Please answer the following questions by placing a check [] in the appropriate box :

1. What is the size of your firm in terms of Saudi Riyals volume of construction?

<input type="checkbox"/> (56,000,000 plus)	<input type="checkbox"/> (15,000,000-24,000,000)
<input type="checkbox"/> (25,000,000-55,000,000)	<input type="checkbox"/> (5,000,000-1,400,000 or less)

2. What is the average amount of work subcontracted on average job?

<input type="checkbox"/> 19% or less of one job.	<input type="checkbox"/> 50%-99% of one job.
<input type="checkbox"/> 20-49% of one job	<input type="checkbox"/> All of the job (100%)

3. What is the average job size in terms of Saudi Riyals of each project (SR: _____)	4. What is the average job duration of each project? (Years: _____)
---	--

5. How many years of working experience has your firm been in construction?

<input type="checkbox"/> Under 1 year	<input type="checkbox"/> 1 to 5 years
<input type="checkbox"/> 5 to 10 years	<input type="checkbox"/> 10 to 15 years <input type="checkbox"/> Over 15 years.

6. How many Estimators are working in your firm?

1 - 2 3 - 4 5 or more.

7. Who sets up the firm's tendering price?

At the management level (owner, manager)
 At the estimating level (cost engineers, estimator)
 Others: _____ (Please specify)

8. Do you use any computer program to assess the accuracy of your cost estimate?

Yes No

If yes, please answer question # 9. If no, please skip question 9.

9. Please indicate:

- a. The name of the package
- b. The manufacturer
- c. Time of installation

10. Do you use any historical data to assess the preparation of your cost estimate?

[1] Yes [2] No

If you choose [1], do you consider the productivity of labor and equipment in estimating the cost?

[1] Yes [2] No

If you choose [2], what do you think the reasons for failure of not considering the productivity?

- Lack of productivity standards.
 It is too complex to deal with.
 It needs specialists
 Other: _____ (Please specify).

PART - B

FACTORS THAT INFLUENCE THE ACCURACY OF YOUR COST ESTIMATE

This Section of the Questionnaire is designed to investigate how effective is each of the following factors on the accuracy of the cost estimate.

THE FACTORS	BUILDINGS WORKS		
	V. Major Effect	Minor Effect	No Effect
A. Environment			
1. Weather			
2. Social and Cultural Aspects			
3. Public Exposure of the Project			
4. Local Laws and Religious Customs			
5. Project Location			
6. Level of Competition and No. of Competitors			
7. Labor's Nationality			
8. Lack of Productivity Standards in Saudi Arabia			
9. Lack of cost indexes publication in Saudi Arabia			
10. Economic Unstability			
Please add other factors you think are important, but not listed here:			
11.			
12.			
13.			

BUILDINGS WORKS					
THE FACTORS	Very Major Effect	Major Effect	Minor Effect	Very Minor Effect	No Effect
2. <u>Construction Parties</u> (Owner, Contractor, Consultant)					
3. Previous Experience of Contract					
4. Knowledge of clients and consultants					
5. Government requirements					
6. Lack of information and coordination between Government and agencies					
7. Punitive damage					
8. Unforeseeable increase or decrease in certain taxes					
9. Unforeseen changes in local laws, procedures, permits or codes.					
Please add other factors you think are important but not listed here.					
10.					

THE FACTORS		BUILDINGS WORKS				
		Very Major Effect	Major Effect	Minor Effect	Very Minor Effect	No Effect
3.	Construction Items					
1.	Type and size of contract and its content. ..					
2.	Contract Period ..					
3.	Labor & Equipment Required ..					
4.	Content of Advertisement Clause ..					
5.	Content of Specification ..					
6.	Time Between Project Announcement and Bid Submittal ..					
7.	Price of the Bidding Document ..					
8.	Please add other factors you think are important but not listed here.					
9.						
10.						

THE FACTORS	BUILDING WORKS				
	Very Major Effect	Major Effect	Minor Effect	Very Minor Effect	No Effect
<u>2. Financing</u>					
1. Availability of Management Finance & Plans					
2. Payments					
3. Inflationary pressures					
4. Estimating method used					
5. Currency exchanges					
Please add other factors you think are important, but not listed here:					
6.					
7.					
8.					
9.					
10.					

PART - CFIRM'S COST ESTIMATE EVALUATION

This Section of Questionnaire seeks your evaluation on the Firm's current practice regarding the cost estimate

1. Do you consider the uncertainty in the cost item?
 - a. Considered by applying a correction factor
 - b. Considered by adjusting mark up
 - c. Not considered
 - d. Other: _____ (Please specify)

2. How frequent you consider all the factors influencing the accuracy of your cost estimate mentioned in Part B?
 - a. On all contracts
 - b. 50% or more of all projects
 - c. Less than 50% of all
 - d. Never

3. Are you comfortable about the way you make your cost estimate?
 - a. Yes
 - b. Somewhat
 - c. No

COMMENTS

Q. IF YOU HAVE ANY ADDITIONAL COMMENTS THAT WOULD HELP US TO UNDERSTAND YOUR FIRM'S IMPLEMENTATION AND EVALUATION, PLEASE ADD THESE BELOW :-

THANK YOU VERY MUCH FOR YOUR COOPERATION.

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