FACTORS INFLUENCING MARK-UP SIZE DECISION OF MEDIUM AND LARGE SIZE CONTRACTORS IN PAKISTAN

by

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DEDICATED

TO

MY PARENTS

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ABSTRACT

The construction industry in Pakistan is dominated by a competitive business environment. The pressure on the contractor profit margin has further increased after a prolonged and continuous recession in this sector which has made the competition to get work more intense. Mark-up is the amount added over the cost estimate to cover head office overhead, contingencies or uncertainties and profit. The magnitude of this amount is largely determined based on a subjective criteria derived from experience and judgment. At the time of bidding the contractor must decide the amount of markup that will help him win the job and at the same time will maximize his profit. Any difference between the amount of the winning bid and the next lowest bid is a loss of profit. There are many factors that influence the decision of the contractors on the right amount of markup. These factors can be attributed to client, consultant, project characteristics, tendering situation and overall economy. Identifying the optimum mark-up for a project that will help in winning the tender while at the same time maximizing the profit (i.e. reducing the difference between the lowest and the next lowest bid) is a difficult job.

This research examines the factors that contractors perceive to be important when they are considering the size of their bid-markup and determines the current state of practice in determining the optimum mark-up size. The research hypothesis is that the contractor size would have a significant bearing on the factors that would influence the bid mark-up decisions. Fifty four potential factors in seven different categories i.e. project characteristics, project documentation, company characteristics, tendering situation, economic situation, client characteristics and consultant characteristics were identified through literature review. A questionnaire was designed which comprises three parts; part A solicits information regarding the respondent and the firm, part B solicits information on the current practices in mark-up size decision and part C presents 51 identified factors on a five point likert scale. A pilot study was conducted that involved six local contractors to establish the adequacy and appropriateness of the identified factors in the construction industry. The questionnaire was modified based on the results of the pilot study. The final questionnaire consisted of 51 factors identified as appropriate to the construction industry. A survey was conducted through random sampling by selecting 150 construction contractors out of a population of 900 registered

contractors with Pakistan Engineering Council having allowed financial limit exceeding 250 million rupees.

Analysis of data collected from 54 construction contractors showed that the process of mark-up size decision is highly subjective in nature based on experience and judgment of the executive management of a company. Analysis indicated that use of bidding strategy models and computer based models to assess the competitive situation were extinct. Lack of knowledge and complexity of models were the major reasons reported for not using of bidding strategy models in the construction industry. The results showed that contractor size had a significant impact on their attitude towards bid mark-up decision-making. Factors relating to project characteristics and client characteristics category are ranked among the top ten that influenced the mark-up size decision of medium and large size contractors. Project cash flow, size of the project and need for works were among the most important factors influencing mark-up. When deciding the size of the mark-up large contractors tend to be more concerned about the size of the project whereas medium-size contractors were more concerned about the project cash flow.

The results showed that client characteristics were among the top rated categories that influence the mark-up size decision. Payment record of client is rated among top ten by medium and large size contractors. Clients should consider improving their payment record and ensuring a good cash flow on their projects to get lower bids. The results can be used by contractors entering into the construction industry of Pakistan to better decide on their mark-ups. The identified factors can help contractors to prepare more competitive bids and secure more profit. These results can also be used by consultants at the pre-tender stage to forecast possible responses to invitation to bid.

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LIST OF ABBREVIATIONS

GoP	Government of Pakistan
SBP	State Bank of Pakistan
PEC	Pakistan Engineering Council
USA	United States of America
UK	United Kingdom
SPSS	Statistical Package for Social Sciences
ANOVA	Analysis of Variance
RII	Relative Importance Index
CI	Construction Industry

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Chapter 1

INTRODUCTION

1.1 Study Background

Construction industry is a unique industry. Unlike other industries that are product based, the project based environment makes it a lot more risky. The success of a project is based on a number of factors that are affected by the regional and economic environment which is hard to foresee and control. Labour and material prices are changing all the time. Availability of the resources and the characteristics of the principle parties involved (client, consultant and the contractor) also impact the industry. These and all other types of risks/uncertainties are catered for in the contract documents but still are largely out of control hence resulting in claims, disputes and huge losses. The risks are carried by all the principal parties involved, i.e the client, the consultant and the contractor.

The most common form of bidding is competitive bidding and is an integral part of the construction industry. In private sector, the owners or clients may choose to award the project through negotiated contracts or any other method but in the public sector, it is mandatory to award the project or the contract on competitive basis. The purpose of this is to promote healthy competition to ensure low bids on projects and to ensure proper use of public money. According to Morris (1988), most of the local state and federal governments in US award their projects through competitive bidding.

Bidding in construction is characterized by two unique and interrelated stages, cost estimation and tendering (McCaffer and Baldwin, 1986). The first stage is executed after obtaining the bidding documents. It is defined as calculating the expected cost of construction. This includes calculating the direct and indirect cost of construction. After the cost estimate is prepared, the final price of the contract is established. This is the second stage and is called tendering. The process of converting the cost estimate in to a tender involves a subjective assessment of a number of factors such as possibility of errors in an estimate and other risks involved in making such an investment.

Most of the construction contracts in Pakistan are awarded through competitive bidding.. Farooqui *et.al*., (2008), contended that 100% of the projects in the public or private sector were awarded to the lowest bidder in competitive bidding. 78% of the projects were procured through fixed unit price contracts without escalation, as shown in Table 1.1. This approach transfers most of the risks on the contractor. The competitive bidding environment is driven by lowest cost mentality (Dulaimi and Hong, 2002). In times of tough economic conditions, this approach makes the competition very intense.

Table 1.1: Project Delivery System Profile in Pakistan

Question No.	Delivery System Component	Percentage Projects Delivered
1	Project deliver method (Design-Bid-Build)	100%
2	Project procurement method? (Low bid)	100%
3	Project bidding strategy (Open competitive bidding)	100%
4	Type of contract-	
	Fixed unit price	78%
	Fixed lump-sum price	12%
	Fixed price plus escalation	8%
5	Project execution approach-	
	Normal track	68%
	Fast track (Multi prime contracting)	32%

(Source: Farooqui et.al, 2008)

The pressures of competitiveness in the construction industry are probably more intense than in any other industry (Park, 1972). Competitive bidding is essential for winning of a construction project. Every winning project contributes a significant portion to the company's turnover and improves the financial performance of a company. Accuracy of estimates is crucial for successful contracting business. Over estimates lead to an inflated tender price that result in loss of business opportunity. An underestimate results in winning a loss oriented business.

Mochtar (2002), suggested that the construction industry is characterized by extreme competitive forces and generally lower profit margins. The success of the contractor is dependent on the profit earned from the completed jobs. In other words, if

profit is a measure of success, increasing the profit can increase the success of a contractor. But on the other hand due to competitive bidding this will result in fewer jobs won and hence will result in a loss. Increasing the potential profit will lower the probability of winning a job and vice versa.

The objective of every contractor is to submit a bid that enables him to end as a lowest bidder while ensuring that he does not ends too low. The bidding process advocates the need for a sound knowledge of bidding strategies and the ability to prepare a stable and accurate estimate of project costs (Akintola Akintoye, 1998). Therefore, given the intense competition the survival of the contractor is possible only if can optimize his profits and at the same time become successful at bidding. This entails a sound knowledge of the factors that affect the dynamics of competitive bidding.

1.2 Research Significance

The usual practice by the contractors while preparing their bids is to calculate the cost of the project that includes the labour, material, equipment, subcontract work and the site overheads. These costs will be almost same for all the other contractors as these depend on the specifications and requirements of the client. Then on this calculated cost the contractors add a percentage or allowance for overheads (general/head office), contingencies and profit. This percentage or allowance is called mark-up. It is this allowance that establishes the lowest bidder on a project. Consequently the contractor must make a trade off between the probability of winning, the mark-up and being the lowest bidder for the job (Abdul Hadi, 1991).

Determining the right amount of profit on a job that will help the contractor in winning under competitive bidding and ensuring that all other calculated costs will remain within the limits is the only way to ensure success of the contractor. But how to determine this right amount? Unlike calculating the labour, material equipment and other quantifiable and associated costs for the direct work, calculating the right amount of mark-up is not an easy job. According to Tah *et.al* (2004), such decisions are based on experience and judgment of the management and involve assessment of a number of qualitative factors that cannot be easily quantified for analysis.

Establishing the adequate amount of markup on a project is a difficult undertaking. It is so because the contractor has to select a markup that will enable him to win the project and at the same time allow him to earn a handsome profit. According to

Odusote and Fellows (1992), the decision of arriving at a suitable markup value involves analysis of factors such as the current workload, other competitors bidding for the job, market conditions and a number of other factors.

A number of quantitative competitive bidding strategy models have been developed for application in the construction industry which will be discussed in the subsequent chapters. However, these models are not being utilized by the contractors on a large scale (Ahmad and Minkarah, 1988). Researchers contend that markup decision is based on intuition, experience and judgment (Fayek, 1998; Xu and Tiong, 2001). Moselhi *et al*. (1993), Li (1996) and Love (1999) also declared the same behavior of contractors while making bidding decisions. Akintoye (2000) argued that the markup is set at a value that is low enough to win the job and in line with the strategic goals of the contractor organization. Tools such as artificial neural networks have been proposed in order to develop a bidding strategy model for bid mark-up estimation (Moselhi *et al*., 1991, 1993; Li and Love, 1999). Establishing a sound knowledge of factors influencing mark-up decisions is imperative in determining the optimum mark-up for the projects. The present study has focused on determining the key factors influencing the mark-up size decisions of medium and large size contractors in Pakistan.

1.3 Research Objectives

The core objective of this research is to determine the 'Factors influencing the bid mark-up decision of the medium and large size construction contractors in Pakistan'. The sub-objectives of this study are:

1. To determine the current state of practice of construction contractors in mark-up size decision to record how such decision are made and to establish a benchmark for future studies on this topic.
2. To determine the use of existing bidding strategy models in the construction industry and the problems associated with them to enable an understanding of the role of such models in the construction industry.
3. To record the differences in perception of medium and large size contractors towards the factors influencing their mark-up szie decisions. The identification of these factors will enable us to carry out further research to develop a bidding strategy model for the local construction industry.

1.4 Scope and Limitation

The scope of this study is limited to the construction industry of Pakistan. Construction contracting organizations situated in Punjab and Federal capital area form the research population. However since almost all of these firms operate in all the regions of Pakistan, the results of the research can be generalized to the entire country.

The scope of this research is limited to medium and large size contractors which are registered as category C3 or above with Pakistan Engineering Council (PEC). Construction firms with a financial limit below 250 million rupees (as determined by PEC Bylaws) are not a part of the study population.

Furthermore, the study is focused on the competitive bidding with emphasis on traditional project delivery method of design, bid and build (DBB) which is most common in our country (farooqui *et.al*., 2008).

1.5 Organization of Thesis

The thesis is organized in five chapters with chapter 1 covering an introduction to mark-up, its significance in competitive bidding and the research objectives. Chapter 2 covers the literature review. Chapter 3 covers literature on bidding strategy models. Chapter 4 covers methodology used in the research and chapter 5 covers results and analysis. The final chapter, Chapter 6 presents the conclusions and recommendations.

1.6 Summary

The most commonly employed method of procurement in Pakistan's construction industry is open competitive bidding. This chapter presented the importance of mark-up in the competitive system and the problems that are faced by the contractors in making the decision on its size while bidding. The objective of this study is to bench mark the practices of contractors in mark-up size decision or estimation and to determine the underlying factors that influence this key decision to enable a better understanding and develop a strategy for the local construction industry.

Chapter 2

BIDDING SYSTEM AND MARK-UP

2.1 Introduction

Any business is in business to make a suitable profit which is imperative to its survival and growth. This however is possible only if the organization has adequate amount of work at hand at all times. In the construction industry, mostly the only way to obtain work is through competitive bidding. In construction industry, bidding is generally the most popular form for contractors to get the opportunity to render services (Ahmed and Minkarah 1987, De Neufville and Smith 1994). In Pakistan, like in most other countries of the world, it is mandated by law that construction contracts for public work projects be procured using a competitive sealed bidding process and awarded using a low-bid system. In this system, the contractors submits their bids in response to the tender documents prepared by the government agency involved or a private consultancy hired to prepare the project documents and except under special given conditions, the contractor with the lowest bid is awarded the contract. (Farooqui *et.al*., 2008)

The tender price submitted by the contractor basically consists of two different types of costs, direct cost and the indirect cost. Direct costs are those costs which can be attributed to a particular work item whereas indirect cost are those which can not be directly attributed to a particular work item or an identifiable piece of work in a projects work breakdown structure, such as the salary of a project manager. Even tough the definition of both the costs is very clear, it is often difficult to make a distinction between these costs. The direct cost consist of labor, plant, material and subcontractor costs and the indirect costs consist of site overheads, general overheads, profit and allowances for risk. Indirect costs without the site overheads are generally termed as **markup**. (Tah *et. al*, 1992)

2.2 Type of Bidding Systems

There are a basically two ways through which a contractor secures a job, competitive bidding and negotiated contracts.

1. In negotiated contracts, the owner/client directly approaches a particular contractor for negotiation of terms & conditions, price and subsequent award of contract. This method of procuring services may be due to good reputation of a particular firm on similar projects or due to good relationship with the client on past projects. Since there is no competition involved, the amount of the markup added over the based estimate is solely determined by the negotiation skills of both the parties involved in the process.

2. In competitive bidding however, the situation is different. In this framework, the client invites firms to compete for a particular project either openly or selectively based on any pre-qualification criteria that is deemed necessary by the client. The bid evaluation criterion is either based on the lowest bid or the average bid method. This method promotes intense competition as it encourages lower bids.

While preparing a bid for a job the contractor has to make an estimate of the cost and commit resources, such as cost of obtaining tender documents, estimating man hours and other indirect costs. All this effort and commitment of resources may be at a loss if a contractor is unable to secure a job.

This study is an attempt to identify the factors affecting the markup size decision.

2.3 Mark-Up and Its Components

As stated earlier, a bid price consists of two different types of costs, the direct cost and the indirect cost. The practice and the method involved in calculating the direct cost is quiet similar between the firms. The reason being that all of these firms have access to the similar resources. They are using same type of equipment, they have access to same labor, they procure materials from similar vendors and subcontractors and they have somewhat similar supervisory abilities. There is even a circulation of managerial staff between the firms. Hence the variation in the competitor bids is largely attributable to the selected mark-ups by various firms selected to achieve their own objectives (Tah *et. al*, 1992).

A bid price consists of a cost estimate (labor, material, equipment, subcontract work and other direct costs) and markup, where mark-up consists of components such as general overhead, contingency and profit etc. The markup is established so that it will

enable the contractor to win the project and meets the strategic goals of the company (Akintoye, 1998).

On competitively bid projects, mark-up is added after the completion of estimating process to account for head office overheads, contingency and profit. Regarding contingency as a separate component of mark-up is a matter of management philosophy.

The profit added in the mark-up is the minimum acceptable return on the investment that the contractor is expecting from the project. This rate of return is a function of risk and greater the risk, greater the rate of return or profit. Weather higher risk is translated into higher profit margin or is accommodated as a contingency amount is based on the company policy.

The percentage of mark-up may range from 5 percent to more than 20 percent and represents the amount of money that influences the contractors chances of winning and making a reasonable profit. Selecting an optimum value of markup is based on analysis of various factors. These factors may include but are not limited to size of the project, its location, the inherent complexity, degree of safety and hazard involved, other competitors bidding for the job, economic conditions, behavior of clients in making payments and a number of other factors.

The contractor is required to get into a contract with the owner that has been specifically drafted to protect the client and/or his agents. In order to protect the owner and his agents from any liabilities arriving from the construction process, the contractor is forced to accept these liabilities through certain terms and conditions that are not rightfully in the contractor's domain and may be out of the contractor's control. For example, provisions of indemnity of the client exist in certain contracts that absolve the client of damages resulting from delays caused by their own negligence. It is not uncommon that contractors are made to accept full responsibility of unknown conditions.

Hence the mark-up figure adopted for the project must take into account the risks created by such contracts or conditions. By adding the markup to the project cost, the estimator establishes the project or the bid price. This price will be submitted to the owner in an effort to win the contract. For competitively bid projects, it may be useful to calculate the bid cost and bid price separately. It is often useful to determine the difference between the two and weather the mark-up will meet the company considerations or not. Project bid price is usually determined by looking at current

market conditions. Based on this method it is easier to establish the value of service that is being provided rather than the cost of the service (Clough and Sears, 1994).

Decision to arrive at a suitable mark-up value is difficult and complex as many factors need to be considered that are complex and uncertain. Moreover, the relationship between these is complex and dynamic (Min Liu *et.al.*, 2002).

2.3.1 General / Home / Head Office Overhead

These costs include the rent of office building, salaries of the employed staff, utilities, stationary expenses, cars, office furniture and fixtures and legal and other costs. The head office overhead cost usually ranges from 2 to 8 percent of the annual business volume of a contractor. An allowance for such indirect cost/expense must be included in the cost estimate of each new project. All companies have a head office to administer their business functions. These office act as business support departments and their cost cannot be charged to any specific project. Hence this cost is included as a percentage of the total cost of the project. The method by which this allowance is applied to the project may vary depending upon the preferences and policies of a company (Clough and Sears, 1994).

2.3.2 Contingency

The contingency sum is added to an estimate to cater for uncertainties associated with a project. (Stephen, David, 2000).

Contingency has been defined as:

"An amount of money or time (or other resources) added to the base estimated amount to (1) achieve a specific confidence level, or (2) allow for changes that experience shows will likely be required" (AACE 2000: 28)

*"*The amount of money or time needed above the estimate to reduce the risk of overruns of project objectives to a level acceptable to the organization" (PMI 2000: 199)

Contingency is generally defined as the source of funding for unexpected events. Contingencies are included in construction budgets to help conduct financially successful projects. The complexity associated with a project, the performance of the parties with respect to their responsibilities under a contract, issues related to project funding, and schedule variances make it very difficult to forecast exact project cost from the

budgeting perspective. Hence a certain amount of flexibility is provided in a project budget to account for such uncertainties. (Budgeting owner's construction contingency, Arditi *et. al*, 2007).

Main purpose of any business is to make money by accepting certain risks (Construction contracts: Law & Management By John Murdoch, Will Hughes). Contingency sum is usually applied on the base estimate in the form of a percentage to provide an allowance for unexpected events. Construction and development is a risky endeavor and is full of risks. The basic idea is to perform an analysis to determine the expected or probable cost of occurrence of an unwanted event. This is better than performing no analysis at all. These are then added to the project budget as items that may possibly incur a cost. This makes the budget more representative and realistic (Stephen, David, 2000).

Risks for which contingencies are applied in the contracts may be related to physical working conditions, delay and disputes, direction and supervision issues, damage and injury to persons and property, external factors and payment law and arbitration (Abrahamson 1984, Bunni 1985).

2.3.3 Allowance for Profit

The amount of profit represents the minimum acceptable rate of return on contractor's investment. Profit is more linked with risk and uncertainty. Typically, more risky business ventures call for more profit. Therefore in construction industry, earning good profit is synonymous to taking big risks.

2.4 Difficulty in Determining the Mark-Up Size

Establishing the right amount of markup far a project is an important and essential stage of tendering as this directly affects the chances of winning. This amount which is usually added as a percentage of the project cost is determined based on the subject judgment of the executive management of a company (Tah *et.al*., 1994). Determining the optimum size of markup is a challenging job as the relationship between the dependent factors is dynamic and complex (Li H, 1996). Usually executive management is involved in determining the optimum size of markup but in some companies cost estimators are also involved in this decision process.(Min Liu et.al, 2004)

Akintoye argued that different factors influence cost estimating and tendering (Akintoye, 2000). In total 24 factors were identified as influencing cost estimation. Seven factors were finalized based on factor analysis. These factors in descending order of their importance are project complexity, technological requirement, project information, project team requirement, contract requirement, project duration and market requirement. Akintoye (2000), found out that the contractors had similar perception regarding the importance of these factors irrespective of their size.

2.5 Factors Affecting the Mark-Up Size decision

Studies regarding bidding practices were conducted in USA, UK, Saudi Arabia, Australia and Canada by Ahmad and Minkarah (1998), Shash (1993), Sash and Abdul Hadi (1993), Fayek *et .al* (2008), and Dulaimi and Hong (2002) respectively. Dulaimi and Hong (2002), found out that contractors who are financially strong are influenced more by the nature of the project while contractors who are relatively less financially capable are affected more by the financial situation of their firms while making bidding decisions.

Min Liu *et.al*(2004) contended that factors that affect the markup size were perceived differently by those contractors that were more successful than the others.

Ahmad and Minkarah (1988) studied 31 factors influencing the markup size decision of large size contractors in USA. Shash and Abdul-Hadi (1992) studied 37 factors classified in to five broad categories after developing on the factors given by Ahmad and Minkarah (1988) .

Shash (1993) after building on the research of Ahmad and Minkarah (1988) identified 55 factors influencing the contractor's markup decisions in UK. revised the questionnaire by Ahmad and Minkarah (1988) and identifying 55 potential factors affecting in tendering decisions by top UK contractors. The top ten factors identified in this research were degree of difficulty, risk involved owing to the nature of the work, current work load, need for work, contract conditions, anticipated value of liquidated damages, owner/promoter client identity, past profit in similar projects, completeness of the documents and the project size.

Dulaimi and Hong (2002) studied the perception of the contractors in Singapore by evaluating 40 factors influencing the contractors bidding decisions.

Recently, Min Liu et.al (2004) suggested 52 factors grouped in to seven broad categories influencing the contractor mark-up size decision in Singapore.

The factors identified by Min Liu et. (2004) are adopted for this study and modified as per the local conditions in construction industry through a pilot study. Table 3.1 shows a listing of all the categories and associated factors adopted for this study.

Table 3.1: Factors Affecting Contractors Mark-Up Size Decision

Factors Affecting Contractors Mark-up Size Decision			
	Project Characteristics	27	Portion of work subcontracted
1	Size of Project		**Tendering Situation**
2	Duration of Project	28	Required bond capacity
3	Location of Project	29	Size of Bid bond
4	Project Cash Flow	30	Number of bidders
5	Degree of Difficulty / Project Complexity	31	Time allowed to submit bids
6	Potential for Disputes	32	Identity of competitors
7	Type of equipment required	33	Prequalification/Compliance requirements
8	Strategic value of project	34	Tendering document price
9	Past Profit in Similar Jobs	35	Tendering procedure
10	Degree of Safety (Terrorism/other threats)	36	Time of tendering (Season)
	Project Documentation	37	Competitiveness of other bidders
11	Type of Contractual Arrangement		**Economic Situation**
12	Design Quality	38	Overall economy (Availability of work)
13	Presence of Owners special requirements	39	Availability of labor
14	Contract conditions used (Strict/Flexible)	40	Availability of equipment
15	Size of Liquidated Damages	41	Quality of available labor
16	Completeness of Tender documents	42	Risk of fluctuation in material prices
	Company Characteristics	43	Availability of other projects for tendering
17	Current work load	44	Risk of fluctuation in labor prices
18	Need for work		**Client Characteristics**
19	Contractor involvement in design phase	45	Payment record of client
20	Availability of cash to carry out the work	46	Size of Client
21	Availability of skilled workers	47	Type of client (Public/Private)

Factors Affecting Contractors Mark-up Size Decision			
22	Availability of qualified Site management staff	48	Relationship and past experience with client
23	Size of Head office overhead	49	Possibility of getting future work from client
24	Availability of Reliable Subcontractors		**Consultant Characteristics**
25	Uncertainty in cost estimates	50	Relationship with consultant
26	Experience in similar projects	51	Character of consultant (Strictness)

2.5.1 Project Characteristics

According to Min Liu *et.al* (2004), project characteristics includes all factors that describe the project such as size, duration, location, project cash flow, degree of difficulty, potential for disputes, type of equipment required, strategic value of the project, past profit in similar jobs and degree of safety and terrorism.

Contractor are highly affected by the size of the project. Larger the size of the project the more it will contribute towards annual business volume and longer its duration. Larger projects also contribute positively towards cashflows. (Shash and Abdul-Hadi, 1992).

The duration of the project is also an important factor. Two projects of similar value but different duration will have different profit margins. Logically the project with larger duration should have more profit margin due to time value of money. (Adrian, 1982). Longer duration projects will also keep the contractor's resources busy such as equipment and labour. (Shash and Abdul-Hadi, 1992).

The location of the project is also a very important factor. A contractor who is located away from a project location will be at a disadvantage as compared to a contractor who is located close to the project. The reason being that the contractors in the business area will have good working relations with the material suppliers and they do not have to mobilize their resources (equipment and labor) to the construction site. Whole on the other hand the contractor located far away will have to reflect the cost of mobilization in his bid. (Shash and Abdul-Hadi, 1992).

Cash flow plays a very important role in a contractors business. It is important that the contractor periodically receives the payments so that he can pay his salaried staff

and cover his periodic overheads. Similarly this cash flow will also support the contractor in continuing his project work. Money is also needed to bid for other projects. (Shash and Abdul-Hadi, 1992).

Degree of difficulty associated with a job is also an important factor in considering markup size. In a study conducted by Min liu et.al (2004) project complexity was rated at secong highest in project characteristics by contractors that are more successful at winning jobs. A project with a higher level of complexity will be more risky. High risk projects mean higher markups. If the complexity of the project requires more technical and managerial input, contractors may consider either employing or hiring consultants to undertake some of the technical and managerial functions. In such situation, contractors will determine the high mark-up size in his bid price. (Kwakye, 1994).

The equipment required for a project may have a significant bearing on the project's markup. For a contractor who owns a large number of equipment, a project that can bring his equipment in usable condition is feasible and he may trade higher markup for putting his equipment in revenue generating mode (Shashand Abdul-Hadi, 1992).

Another consideration to determine the mark-up size is the past profit in similar job. By considering past profit rates, the contractor may be able to formulate his desired future profit rate. (Adrian, 1982). That means that the contractor can determine the best and optimum mark-up size which maximize the possible profit and at competitive level.

Besides, the degree of safety and hazard risk also need to be considered in determination of mark-up size. According to Smith (1986), the greater the degree of risk and uncertainty involved in the job, the greater the profit margin that will be expected by the management. Thus, contractors have heavier weightage on the markup size decision in the highest risk of safety and hazards.

Moreover, identity of client and professional advisers of project also need to be considered in the determination of a mark-up size. If the contractor has had previous dealings with the client and client's professional advisers, then he or she may be in a better position to predict the level of risks that may confront him or her. If experience has shown that the client does not pay promptly and client's professional advisers are noted for the late issue of project information or disruptive variations, the contractor may decide to increase the project overhead costs in his mark-up size in order to mitigate this risk. (Kwakye, 1994).

2.5.2 Project Documentation

According to Min liu *et.al* (2004), the project documentation's category constitutes all factors and characteristics of the bidding documents such as type of contract, design quality, owner special requirements, contract conditions used (strict/flexible), size of liquidated damages, completeness of tender documents.

In project documentation, type of contract plays an important role in making bidding decisions. According Shash and Abdul-Hadi (1992), the lump sum and the unit price's contracts are usually used in competitive bidding. These types of contracts do not accommodate changes very easily. In these contracts most of the construction risk is transferred from the owner to the contractor. (Shash and Abdul-Hadi., 1992). Therefore, contractors are deciding to increase the contingencies costs in their mark-up size in order to mitigate these risks and uncertainties.

The risks involved in investment also need to consider in mark-up size decision. After the contractual and construction risks assessed, the contractors are expects to be rewarded for accepting such risks with a reasonable return and mark-up size. Generally, the greater the degree of risk and uncertainty involved in the project, the greater the profit margin that will be expected by the management. As a conclusion, where an element of risk is attached to an investment, it follows that a higher rate of return would be required to make it worthwhile.

2.5.3 Company Characteristics

Company characteristics include factors relevant to the company such as current work load, need for work, contractor involvement in the design phase, availability of required cash, availability work force and the site management staff, size of head office overhead, availability of reliable subcontractors, uncertainty in cost estimate, experience in similar jobs, portion subcontracted to others (Min Liu *et. al*, 2004).

Factors such as the current work load and the need for work are related to each other. In times of depression when work is not available in the market, current work load is less and the need for work is a dominating factor in determining the markup size. It is opposite if the work is available in the market in large amount (Shash and Abdul-Hadi,1992).

Availability of cash to carry out work is also an important factor. For a contractor who has the sum of money to carry out the work, the markup established is purely with consideration of profit required and the value of investment. But for a contractor who does not have the required money to carry out the work, he will have to take a loan from a bank. In this way the markup established for a job is also reflecting the interest fee which reduces the contractors' profit margin and may also fix assets of the contractor with the bank (Shash and Abdul-Hadi, 1992).

The availability of qualified staff does not seems to be an important factor as far as medium and large size contractors are concerned. Qualified staff is automatically attracted towards these firms in pursuing good salary and other benefits but small size contractors are highly affected by availability of qualified staff as they cannot offer such benefits. This may cause small size contractors to recognize this shortage of qualified staff in markup size on projects (Shash and Abdul-Hadi, 1993). Establishing good business relations may also be considered by the contractor at the time of setting markup (Shash and Abdul-Hadi, 1992).

The experience of the contractor for a particular may allow him to foresee the risks involved more clearly and plan in a better way thus allowing him to bid a job with relatively lower markup as compared to a less experienced contractor(Shash and Abdul-Hadi, 1992).

2.5.4 Tendering Situation

According to Min Liu et.al (2004), tendering situation includes all factors operating in the awarding of contract. This category includes factors such as required bond capacity, size of bid bond, number of bidders, time allowed to submit bids, identity of competitors, prequalification requirements, tendering documents price, tendering procedure, time of tendering (season) and competition.

Number, identity and competitiveness of bidders are important factors that must be considered in competitive bidding. According to Adrian (1982), the lowest bidder prices decreases as the number of competitors on a project increases. In such competitive situation, contractors need to minimize his or her mark-up size so that the chances being lowest bidder are maximized.

The required bond capacity for a project is also an important factor. Bonds are usually in form of a bank guarantee. The contractor needs to freeze an equivalent amount

of money with the bank until the project is complete to release that amount. This obviously reduces the cash available with the contractor to carry out the work. Hence it is an important factor in deciding the markup size (Shash and Abdul-Hadi, 1992).

The cost of bidding documents may be an important factor. For large projects the cost of the bidding documents may be sizeable and hence it must be recovered from the project. This is reflected by adjusting the mark size. For small projects this factor may have no value (Shash and Abdul-Hadi, 1993).

The pre-qualification requirement is a very good indicator of what type of contractors will be bidding for the job. This information can allow the contractor to identify beforehand the contractors bidding alongside him hence enabling him to set a markup value best suited for the situation (Shash and Abdul-Hadi, 1993).

Time allowed for submitting a bid is very important as in most of the cases this time is less. This causes higher uncertainties in the estimates and these uncertainties are translated into higher markups on jobs (Shash and Abdul-Hadi, 1993).

2.5.5 Economic Situation

Min Liu et.al (2004) stated that the economic situation's category involves all economic indicators that may operate on the project. Indicators such as overall economy (availability of work), availability of labor/equipment, quality of available labor, risk of fluctuation in material and labor prices are the elements of this category.

The overall economy is imperative in determining the mark-up size. A study of the economic indicators will enable the contractor to forecast whether the economy is heading toward a boom or recession. If the indications are that recession is imminent, which may slow down construction activities, then the contractor would price vigilantly to win the contract. In such case, determination to win means lower percentage mark-up and hence reduced profit margin. (Kwakye, 1994).

According to Shash and Abdul-Hadi (1992), the availability of the labor force is a small contributor to mark-up size decision. A contractor may either use his own labor or may get labor from other contractors who have free labor due to no work at hand.

2.5.6 Client Characteristics

According to Min Liu et.al (2004), this category includes all the factors that relate to the behavior/role of the client. This category includes factors such as size of client, payment record of client, type of client organization (public/private), relationship and past experience with client and the possibility of getting future work from client.

2.5.7 Consultant Characteristics

Min Liu et.al (2004) stated that relationship of the contractor with the consultant and the character of the consultant (strictness) may also play an important role in deciding the level of markup to be kept in the bid.

Consultants that are strict may cause work to delay and demand rework that will result in an increase in cost to the contractor. This may lead to contractor increasing markup and vice versa.

2.6 Summary

Competitive bidding is the most popular form of project procurement method used in different countries of the world. Hence deciding on an optimum amount of mark-up is imperative. The components of the mark-up comprise of head office overheads, contingencies and profit. In total 54 factors have been identified and presented under seven different categories of project characteristics, project documentation, company characteristics, tendering situation, economic situation, client characteristics and consultant characteristics.

Chapter 3

BIDDING STRATEGY MODELS

3.1 Introduction

As evident from the previous chapters, the amount of markup added over the base estimate depends upon the analysis of a number of factors. This shows the need for development of representative models to aid the contractors in making this decision. However this would require identification and understanding of these factors as a prerequisite (Ali A. Sash, 1991). The bidding process emphasizes the need for a sound knowledge of bidding strategies and the ability to prepare a stable and accurate estimate of project costs. . (Akintola Akintoye, 1998)

Over the years, numbers of bidding strategy models have been created for application in the construction industry (Friedman, 1956; Gates, 1967; Morin and Clough, 1969; Park, 1979). This entire chapter is devoted to the discussion of the bidding models that exist in literature.

Unlike the construction industry the competition in other industries is on selling nearly the same product or services. The prices of these commodities are determined by the analysis of supply and demand. In the construction industry, the suppliers/contractors are not selling the same product. Different contractors will adopt different methods of achieving the same objective (the finished product/project) which can significantly influence the bid price. Since the price of a project is determined by competitive bidding, the effort to develop bidding strategy models has mainly focused on competitive forces.

3.2 Friedman's Competitive Bidding Strategy

3.2.1 Bidding Strategy Objective

Friedman is considered the father of the competitive bidding strategy models. He suggested that a construction contractor may have several objectives while bidding. Some of these may be to maximize the total expected profit, minimize the total expected losses or to win a project even at a loss. These objectives are however dependent on the situation of a firm and hence varies (Friedman, 1956). In order to develop the model, Friedman chose the first objective as the basis of his model. The reason provided was

that it is one of the most common objectives for all the contractors and that it was easier to model. A company which has a number of resources that are idle may choose to bid for a project even at a loss so as to keep the resources busy and to minimize the loss in such tough times.

3.2.2 Bias of Estimated Cost

A cost estimate for a project is only an approximation of the expected costs that will be incurred in the future to realize the completion of a project. The actual cost after the completion can be quite different. Taking this fact into account Friedman developed a method to offset the effects of this bias between the estimated and the actual cost. The difference between the estimated cost C and the actual cost is called as bias of an estimated cost C'. Based on the estimated and actual cost data of the previous projects for a company, Friedman developed an equation to estimate this bias as given by equation 3-1 (Friedman, 1956)

$$C' = C \int Sh(S)dS \qquad \text{Eq. (3-1)}$$

S = Ratio of estimated cost to the actual costs (past projects)

h(S) d(S) = Probability that this ratio is between S and S+dS

This method can be used to offset the effects of bias of the estimated cost in the long term.

3.2.3 Expected Profit

Friedman gave an equation to calculate the total expected profit which is the product of probability of winning P(x) and the difference of bid price 'x' and the bias C'. The expected profit for the project, E(x), is given by Equation 3-2 (Friedman, 1956).

$$E(x) = P(x)(x - C') \qquad \text{Eq. (3-2)}$$

3.2.4 Probability of Winning

In order to determine the probability of winning P(x), Friedman devised a method in which a continuous probability distribution developed by calculation the ratio of the competitors bid to the contractors cost for all the projects in which a particular

competitor was faced in the past. This off course has to be done for all the competitors separately if the analysis is to extend over more than one competitor. In this way the bidding behaviors of other competitors can be studied. A contractor knows his cost C for the project. He can select any value of bid 'x' and determine the chances of winning by calculating area under the curve greater than the ratio x/c just calculated as shown in Figure 3-1. If the number of competitors are greater than one than the probability of winning against each competitor can be calculated in the similar manner and multiplied to determine the chances of winning against all. This however is only possible if the bidding behavior of competitors are not influenced by the knowledge of the others participating in the bidding.

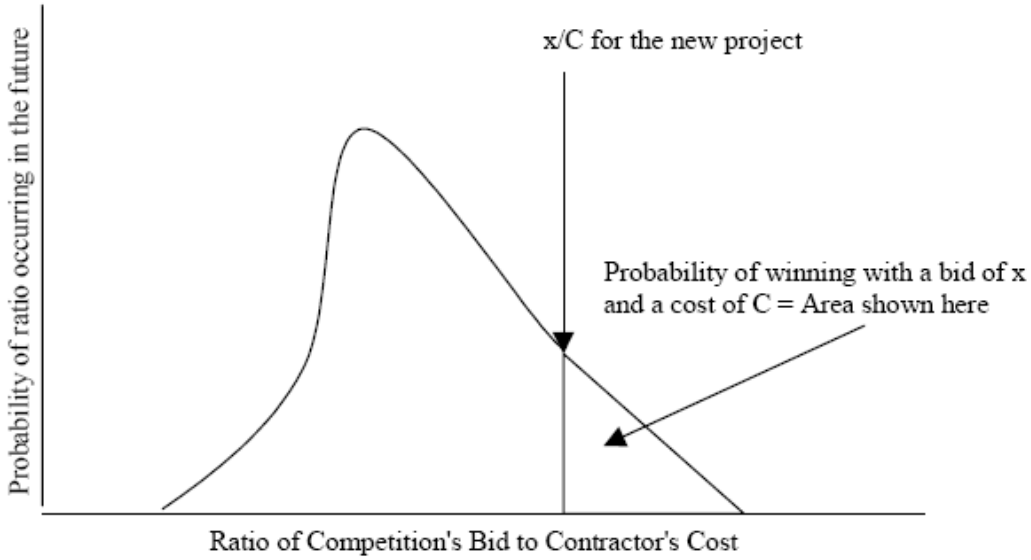

Figure 3.1: Friedman's Method of Determining the Probability of Winning

If all the competitors that are participating in the bid of a future project are not known than an average bidder idea may be used as introduced by Friedman. The probability distribution for an average bidder f(r) is determined by plotting the bid to cost ratios of all the projects on a single grid. Hence it is a combination of all the bidders. A curve fitted to this data can be used to determine the probability of winning against an average competitor. Such data is better approximated by a gamma distribution, so Friedman gave Equation 3-3 for $f(r)$,

$$f(r) = \left(\frac{a^{b+1}}{b!}\right) r^b e^{-ar} \qquad \text{Eq. (3-3)}$$

The chance that 'n' bidders will be appearing to bid on the project is represented by g(n), then the equation representing the probability of winning is shown in Equation 3-4, as given by Friedman.

$$P(x) = \sum_{k=0}^{\infty} g(n) \left[\int_{x/C}^{\infty} f(r)dr \right]^{n} \quad \text{Eq. (3-4)}$$

If the probability of number of bidders appearing for bidding can be represented by a positions distribution then g(n) is given by Equation 3-5.

$$g(n) = \boldsymbol{\lambda}^{\boldsymbol{n}} \boldsymbol{e}^{-\lambda} / \boldsymbol{n}! \quad \text{Eq. (3-5)}$$

3.2.5 Optimum Bid Determination

Friedman derived Equation 3-6 from Equations 3-3, 3-4, and 3-5, to give the total expected profit for any value of bid 'x'.

$$E.P. = (x - C')P(x) = (x - C')\exp[-\boldsymbol{\lambda}\left(\mathbf{1} - \sum_{\boldsymbol{i}=\mathbf{0}}^{\boldsymbol{b}} \left\{ \frac{\boldsymbol{ax}}{\boldsymbol{C}\ \}\ ^{\boldsymbol{i}}\boldsymbol{e}^{-\frac{\boldsymbol{ax}}{\boldsymbol{c}}}} \right)] \quad \text{Eq. (3-6)}$$

3.3 Gates Bidding Model

3.3.1 Bidding Strategy Objective

Marvin Gates presented his bidding strategy model in 1967. Like Friedmans model, this is also based on the objective of maximizing the total expected profits but with a number of differences in underlying assumptions. One of these is that the bidders bid independently for a project which is wrong as the bidders tend to be influenced by others participating for a project. Hence the probability of winning against 'n' competitors is not simply a product of winning against each one of them independently as assumed by Friedman. Gates discussed six different situations of bidding. In all of these situations Equation 3-7 is used to calculated the Expected Value for a bid amount P. The complication exists in determining the probability of winning.

$$\text{E.V} = (\text{p}) \text{ x P} \quad \text{Eq. (3-7)}$$

3.3.2 Lone-Bidder

In this situation the contractor is the only bidder for the project. It now lies on the experience and judgment of the contractor and knowledge about the client that will determine the total expected value. The contractor must calculate the probability of winning against different bid amount based on many factors that he is considering and select only that against which he is getting the highest expected value as calculated from Equation 3-7.

3.3.3 Two-Bidder Strategy

In this situation there is only one competitor with the contractor. The contractor must again calculate the probability of winning against different bid amounts that he is considering and select the one with the greatest expected value. However the lone or the two bidders situation are not popular in the real world.

3.3.4 Many-Bidders Strategy

Normally this situation is very common as more than two bidders are bidding on a project. Gates suggest treating all the bidders as the average bidders. The contractor analyses his bids by subtracting the ratio of lowest bid to his bid form one. A positive difference shown the percentage by which the contractors bid were higher than the lowest bid where as a negative percentage shows the amount by which the bid could have been raised and still won. This can be used to plot a cumulative distribution which can then be used to determine the probability of winning for different bid amounts. Afterwards Equation 3-7 can be used to determine the bid value that gives maximum expected value.

3.3.5 All-Bidders-Known Strategy

In this situation a contractor has detailed bidding information on past experiences with all the competitors bidding for a future project. Unlike many bidders strategy a distribution is plotted separately for each bidder and analyzed separately. Gates developed Equation 3-8 to determine the probability of winning against n competitors.

'Pa', 'Pb',…'Pn' are the probabilities of beating all the competitors participating in bidding.

$$(p) = \frac{1}{1+\frac{[1-(p_A)]}{(p_A)}+\frac{[1-(p_B)]}{(p_B)}+\frac{[1-(p_C)]}{(p_C)}+\cdots+\frac{[1-(p_n)]}{(p_n)}} \quad \text{Eq. (3-8)}$$

3.3.6 Least-Spread Strategy

The contractors while bidding competitively for projects are almost as concerned about being significantly lower as they are about entirely losing a project. The difference between the lowest and the second lowest bid (money left on the table) is the amount that the contractor could have added to his bid amount and still have won the project. After studying 400 cntracts Gates developed an equation to estimate the average difference which he called spread ΔBavg as given in Equation 3-9.

$$\Delta B_{avg} = 1.08C^{0.734} \quad \text{Eq. (3-9)}$$

Here 'C' represents the lowest bid. Gates relates the probability of winning with the amount added to a bid (additional amount) as shown in Equation 3-10. This allows the contractor to determine how adding a certain amount affects his chances of winning. In this equation, p is the probability of winning and P' is the amount added to the bid. The expected value can then be calculated after determining 'p' from Equation 3-7.

$$\frac{\mathbf{67}\boldsymbol{P'}}{\boldsymbol{\Delta B_{avg}}} = \mathbf{1} - (\boldsymbol{p}) \quad \text{Eq. (3-10)}$$

3.4 OPBID (Optimum Bid) Bidding Model

Researchers were developing computer based bidding models as early as 1969. The Optimum Bid (OPBID) is a software that uses Friedmans model to calculates the Optimum markup. The process of calculation is shown in the Figure 3.2 below (Morin and Clough, 1968).

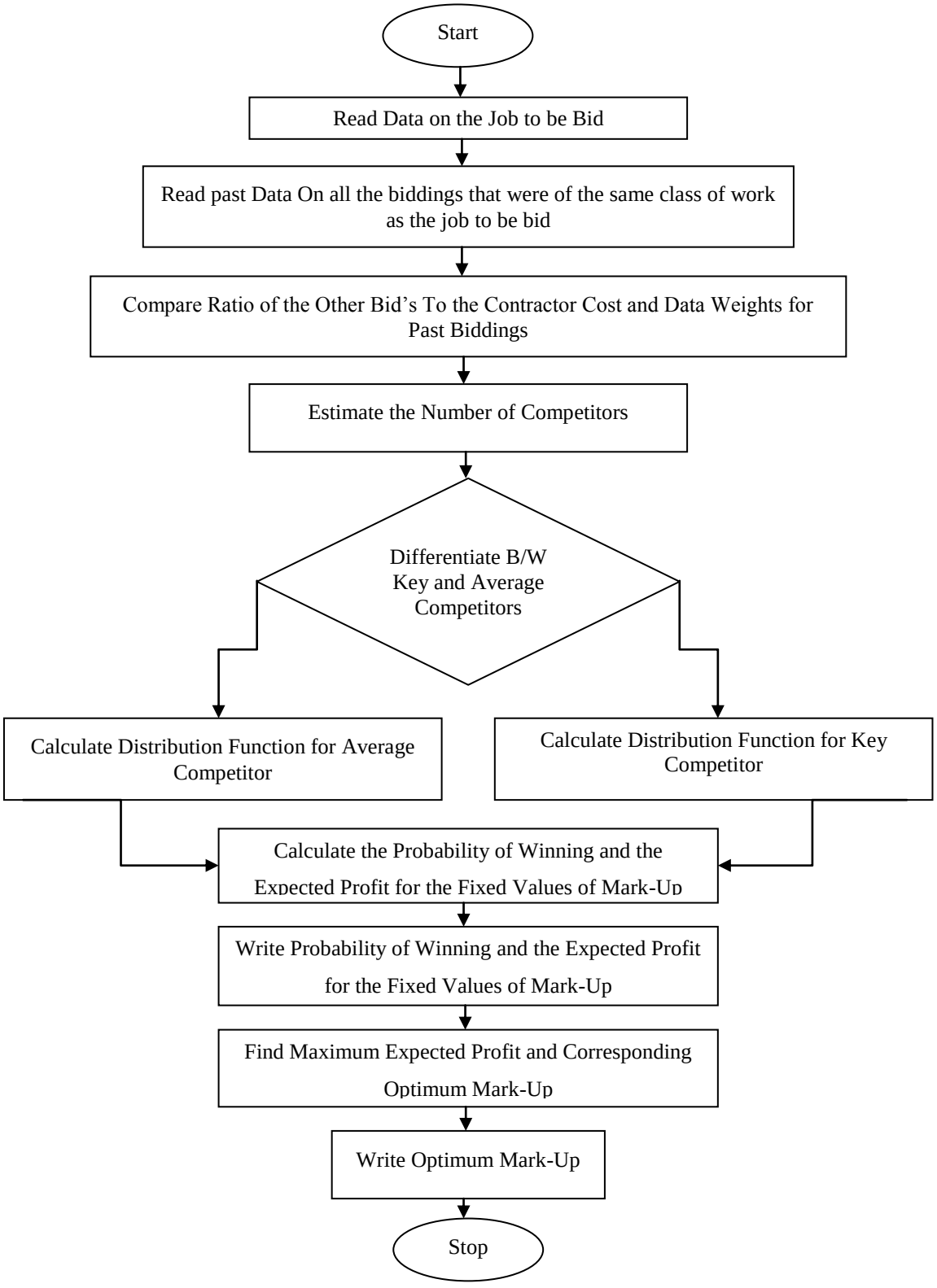

Figure 3.2: Summary Flow Chart for OPBID

The only added feature in this software over the Friedman's model is that it considers that contractors have different bidding patterns for different classes of work and that these patterns also change over time. Hence as new data is programmed into the software; it adapts to the new trends and gives these new trends more weight in subsequent calculations. Data on past bids such as the contractors estimated cost, the class of work and competitor's bids are input in the program by the contractor. When bidding for a project the contractors inputs his cost estimate and who else will bid on the job. OPBID upon performing the calculation produces optimum markup as output.

3.5 Combining the Models with Instinct

It may be quiet confusing to choose the correct bidding model for the contractor. Hence a method was established to determine the best model to be used (Shafferand Micheau, 1971). The contractor can also incorporate his instinct into this method and select the range of bids that he wants to analyze. This can be done using different models. Using the past data to analyze the bidding models efficiency, the contractor can determine which model gives the largest number of lowest bids. The model that turns out to be the best is then used to evaluate the future projects. Using the historical data the model that produces the highest second lowest bids with the highest profit margins is used to set the upper limit for the future projects. After the upper and lower bounds of bids is set, the contractor chooses a bid for the new project based on his instinct and the needed profits for the job.

3.6 LOMARK (Local Market) Bidding Model

As the name suggests this method is developed for application by small and medium sized contractors that exist in defined geographical bounds. Contractors existing in a local area are better aware of each other's strengths and weaknesses and have usually similar type of constraints. Hence the model is based on the assumption that this geographical confinement allows te contractors to better markup their bids (Wade and Harris 1976). This method is basically the same as the Friedman's model but for only known competitor. In this case the probability of winning is calculated by one minus the probability of loosing. An equation was developed to determine the probability that a contractor looses against more than one competitor as shown in Equation 3-13 (Wade

and Harris, 1976). The chances that contractor C will lose is determined by taking difference from one of the probability of winning using the Friedmann's method. The probability that another contractor would bid is fairly easy to determine i.e. by contacting the subcontractors.

$$\text{Prob(C loses)} = \text{Prob(C loses to C1, C2, C3)} * \text{Prob(C1, C2, C3 will bid)} \quad \text{Eq. (3-13)}$$

Where:

C = Contractor

C1, C2, C3 = Competitors

3.7 Carr's Bidding Model

3.7.1 Using Multiple Regression

In this method a number of independent variables are used to develop a relationship to determine a dependent variable. For the case of competitive bidding strategy models, relationship is developed between the dependent variable i.e. low bid to the contractors cost (LBC) and a number of independent variables that relate to project characteristics and other categories (Carr and Sandahl 1978). In order to develop such a model, the contractor first needs to identify a set of factors that will serve as independent variables. Then using data from past biddings, he can collect values for all the identified factors and develop a specific regression model. This equation can then be used to determine the optimum bid value for future projects. Since the market conditions change over time, the contractor would need to update this model every six months with new data. This equation can also be used to identify certain areas in which improvement can bring about good results. Factors with significantly large coefficient pf regression show that these factors have a significant bearing on the LBC ratio. Hence improving performance in these areas can benefit the contractor to become competitive.

3.7.2 General Bidding Model

Carr developed the first multiple regression model bidding strategy model for the construction industry (Carr 1982). Ratio of the competitors low bid to the contractors cost are calculated to establish a relation. However in order to do that certain assumptions must be validated, (1) The variance in the cost estimated of various bidders

is similar (2) Cost estimate variance is significantly greater than markup variance (3Markups are not large.

The probability that the lowest contractor will exceed the contractors bid to cost ratio can be determined through Equation 3-14. The equation incorporates the standard deviation between the cost estimates while MBC is the mean bid to cost ratio.

$$P(LBC_{ik} > b) = \int f[(x-1)/(\sigma/2)] \left[\int f\,[(y - MBC)/(\sigma/2)]dy\right]\sigma^{nk}dx \quad \text{Eq. (3-14)}$$

The basic objective is to maximize the total expected profit. Using different bid to cost ratios the influence on the probability of winning can be determined, [1 - P(LBCik>b)].

3.7.3 Impact of the Number of Bidders

While it is a well known fact that increasing the number of bidders can significantly influence the competition as contractors try to adjust their bids to these new conditions, Carr incorporated this into general bidding model (Carr 1983). This is done by changing the mean bid to cost ratio (MBC). Carr developed Equation 3-15 to show how this adjustment is done. In the Equation 3-15, MBC1 is for one competitor only where as MBCn is for n competitors.

$$MBC_n = MBC_1 - \Delta_n\sigma \quad \text{Eq.(3-15)}$$

Where:

σ = Standard deviation in the cost estimates

Δn = Competitors estimated adjustment in case of bidding against many competitors (more than 1)

3.7.4 Competitive Bidding and Opportunity Costs

When a contractor bids for a particular project and wins it, he is committing certain resources to it. This resource limitation also limits the ability of the contractor to bid for other projects. This is known as the opportunity costs. This maximizing the profit on project by project basis does not guarantee net profit maximization (Carr, 1987). The equation for expected value simply considers the bid amount and the probability of

winning. The contractor must also incorporate the effects of his resource limitation on the probability of winning. Carr developed Equation 3-16 to show how this limitation can be taken into consideration in profit calculations. Here 'x' is the number of winning projects, 'i' is the number of projects that are open to bid and 'j' represents those projects among 'i' for which the contractor is eligible due to his resource limitations. The probability of winning P(W) is calculated as the mean of the ratio of low bids to the contractors cost estimate for the past projects and is tabulated in tables given by Carr. Probability of loosing is given by P(L) which is obtained by subtracting P(W) from one.

$$P(x|i,j) = P(W) * P(x-1|i-1,j-1) + P(L) * P(x|i-1,j) \qquad \text{Eq.(3-16)}$$

3.8 Optimum Bid Approximation Model

This is a simple version of competitive bidding strategy model (Sugrue 1980). This model presents a standard equation that any contractor can use for any given situation thus eliminating the need to develop a multiple linear regression equation.

Sugrue developed Equation 3-17 form Friedmans and multiple regression models.

$$Y_1 = 0.5M + 0.627S + 0.5 \qquad \text{Eq. (3.17)}$$

Where:

M = Mean of bid/cost ratio for all the past projects

S = Standard Deviation of bid/cost ratio for all the past projects

Y1 = Optimum bid/cost ratio

3.9 Symmetry and State of Information

The amount of information available to a contractor directly affects the chances of winning. Ioannou (1988) investigated this by analyzing the contractor's chances of winning against n competitors in light of the amount of information available. The efficiency of a bidding model greatly increases with the level of information that a user has related to the bidding situation. Two different situations were considered. A contractor bidding for a project has an in depth view of the project and has much more information as compared to an impartial person so the contractor can significantly affect

the outcome. Therefore models that do not take into account the perspective and views of a competitor are inefficient as contended by Ioannou (Ioannou 1988).

3.10 Bids Considering Multiple Criteria

In real bidding situations the contractors need to consider and optimize a number of criteria. For example, a contractor might be considering retaining his work force, minimizing risks in addition to just maximizing the profit. To optimize multiple criteria many researchers have advised the use of analytical hierarchy process. This technique was developed by Satty in 1977 to select an option form a number of other options that better fulfills certain criteria (Seydel and Olsen, 1990). For a number of bidding options available to a contractor, the criteria are scored for each option. The option with the highest score is the best option. The main advantage of using analytical hierarchy process is that it allows the contractor to incorporate his sense and experience into the bid decision making.

3.11 Winning over Key Competitors

This model is similar to the gates bidding model. One main feature of this model is that it also takes into account the current workload of the key competitor thus enabling an analysis based on his constraints (Griffis 1992). The only difference is that there is only one known competitor, who is called the key competitor. One difficulty in using this model is that the contractor needs to collect a lot of data on the competitor to analyze the competition. Gates model is then used with this data to determine optimum bid. More than one key competitor can also be incorporated.

3.12 DBID

Methods to exploit the power of computers were being considered by researchers since 1980's. A software called DBID was developed, based on neural networks (Moselhi, et al. 1993). In this setup, artificial intelligence is used to train the network by executing a number of trials. This training establishes different relationships between the variables which can then be used to analyze future situations. This particular model was trained using past bidding data from USA and Canada.

The past data is very important since it contains the hidden characteristics and tendencies of the contractors while bidding.

3.13 Sequential Competitive Bidding

This model takes into account the fact that the contractors have limited resources such as equipment, labor and managerial time (Chen *et al*. 1994). This is incorporated in the model by considering the competitive bidding as a queuing system, as shown in Figure 3-3 (Chen et al. 1994 p. 1549). A project is not bid if sufficient resources are not available.

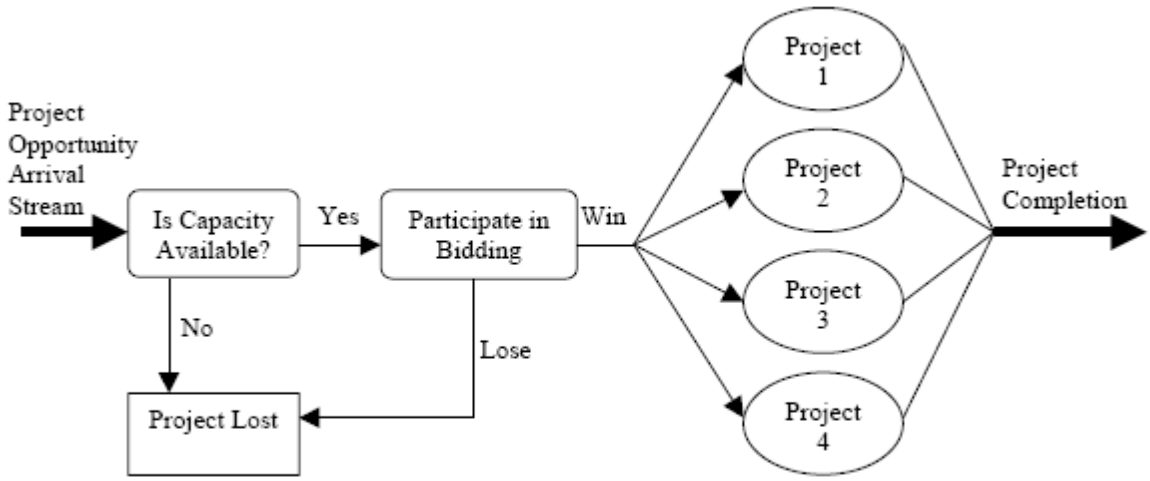

Figure 3.3: Queuing Model Representation of Flow of Limited Resources

This model has certain limitations i.e. it can only model one situation at a time. The goal of the model is to maximize the expected value over a series of projects. Equation 3-18 (Chen *et al*. 1994) shows how this expected value, E(V) is calculated for this model, where P(i) is the probability that i units of the limited resource are in use and k is the total number of units of the resource that is owned by the contractor. The conditional expected profit, is calculated using an extremely complicated equation.

$$E(V) = \sum_{i=0}^{k} E(V|i)P(i) \qquad \text{Eq.(3-18)}$$

3.14 Self-Explanatory Artificial Neural Networks

Artificial neural networks have now become a popular method to model varios situations (Li et al. 1999). The system however based on its training simply prints a

decision without giving any reason why it made such a decision. Users are typically not comfortable to use such a system that gives results without giving any reason.

Researchers tried to add a feature that would give reasons as well for the decisions made (Li et al. 1999).

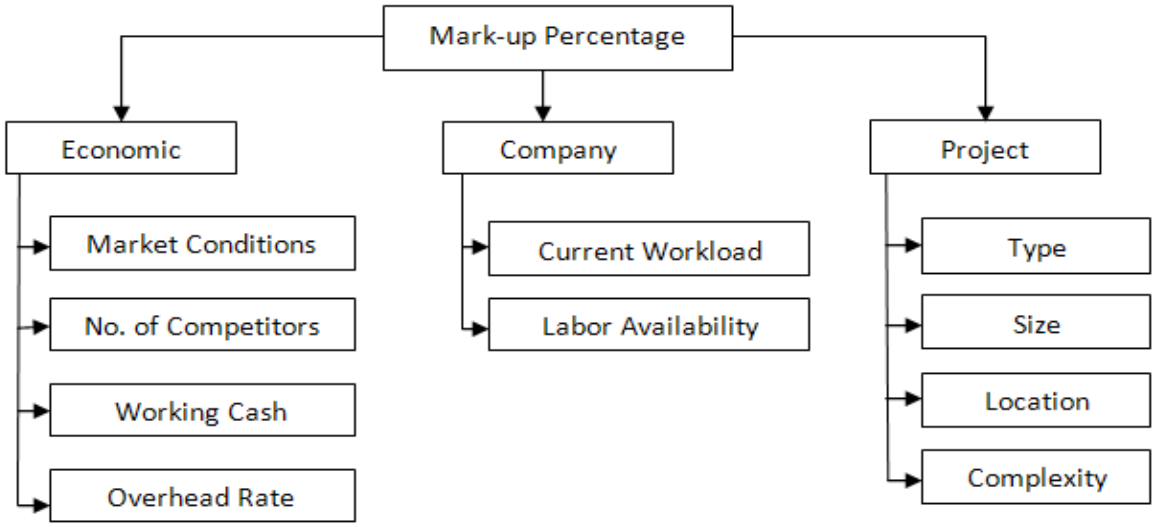

Figure 3.4: Hierarchical Structure of the Artificial Neural Network

3.15 Average-Bid Method Bidding Model

The method of awarding the bids based on the average method has grown in popularity. In 1993, a bidding model was established for bidding systems in which the bids are awarded using average method by Ioannou. Monte Carlo Simulation was used to model such a situation.

3.16 Use of Bidding Models

A survry wasw conducted in 1988 in USA which asked questions on the bidding methods of the contractors. Most of the contractors (80%) replied that they didn't use any statistical bidding strategy models (Ahamd and Minkarah 1988).

The survey also asked questions on the factors that influence the bid markup decisions. The results showed that degree of hazard, degree of difficulty, type of job, uncertainty in estimate, and historic profit, were among the top five factors. From these results it is evident that profit maximization is not the only criteria to maximize. The

contractors are not using the bidding strategy models either because they are unaware or because their concerns are not being addressed in these models.

3.17 Summary

A number of competitive bidding strategy models have been developed in literature however Friedman's, Gates', and Carr's models received most attention in our discussion as most of the other models are based on these methods. The two most significant hurdles are the lack of knowledge of these models and the ability to collect such large amount of data for analysis.

Chapter 4

RESEARCH METHODOLOGY

4.1 Introduction

Research methodology refers to the principles and procedures of logical thought processes which are applied to a scientific investigation. Methods concern the techniques which are available (for data collection, analysis, etc.) and those which are actually employed in a research project. Any management of a research project must address certain questions in making decisions over its execution. The questions involved are:

- What?
- Why?
- Where?
- When?
- How?
- Whom?
- How much?

This chapter describes the necessary steps required to carry out the research and to meet its key objectives. The chapter discusses about the research strategy, research design, the research population and sample, questionnaire design and its contents and the method of analysis used for this research.

4.2 Research Strategy

It can be defined as the method used to question the objectives of the research. There are two types of research strategies, quantitative and qualitative. In quantitative research, techniques are used to obtain data and facts from the field that are quantitative in nature and are then used to develop relationships between these facts and how it compares to past research. Certain quantitative methods are used to analyze this data and conclusion are made in light of the results obtained and the literature (*Fellows et.al.*, 2008).

Qualitative research strategy is employed to understand subjective concepts such as believes, ideas and perceptions and opinions of individuals or group of people. The

data so obtained is usually unstructured and is much more difficult to analyze and process as compared to quantitative techniques. Open ended questionnaires and interviews are usual modes of data gathering techniques in this strategy.

In this research, closed ended questionnaires are used as the primary instrument to gather perceptions of the contractors to the factors influencing markup size decision.

4.3 Research Design

It can be defined as the step wise procedure adopted to answer the research problem/questions. It is about stating the way in which the researcher accomplishes the research objectives (Fellows *et.al*., 2008).

This research study consists of six (6) phases. The first phase entails an extensive literature review relating to the factors influencing markup size decisions of construction contractors. Studies on similar topic have been conducted in Singapore, Malaysia, USA, UK, Canada and Saudi Arabia. The sources for this review consist of international and local research journal/publications, books, international & local professional bodies and associations of tendering & cost estimation and internet in general.

The second phase consists of development of the questionnaire instrument for this research. The contents of the questionnaire are derived from researches carried out on similar topics both locally & internationally as mentioned previously.

The third phase consists of a pilot study of the questionnaire instrument. This entails the modification of the questionnaire instrument in light of the expert recommendations received from the construction contractors and consultants operating in Pakistan. The purpose of this phase is to establish the adequacy and appropriateness of the questionnaire based on expert reviews. A total of six (6) interviews were conducted out of which five (5) interviews were with renowned large size contractors operating in Lahore and Islamabad and one(1) reputed consultant in Islamabad. Professionals from education industry also participated in the pilot study including one assistant professor from NED University Karachi. Fifty four factors influencing contractors bid mark-up decision were identified form the literature review. During the pilot study some factors were deemed unnecessary and removed while some were replaced with others. In the end, fifty one (51) factors were identified for the main survey.

The fourth phase consists of collecting data from the field. The data collection was done through the distribution of the questionnaire to the target sample through mails, emails and personal interviews.

The fifth phase involves the analysis of the collected data. This analysis includes ranking of the factors to establish the most important factors and the tests of hypothesis to establish the objective of the thesis. The analysis was done using MS Excel 2007 and SPSS v17.0.

The sixth and the last phase of the research documents conclusions and recommendations based on the findings of the research. The research methodology adopted is shown in Figure 4.1.

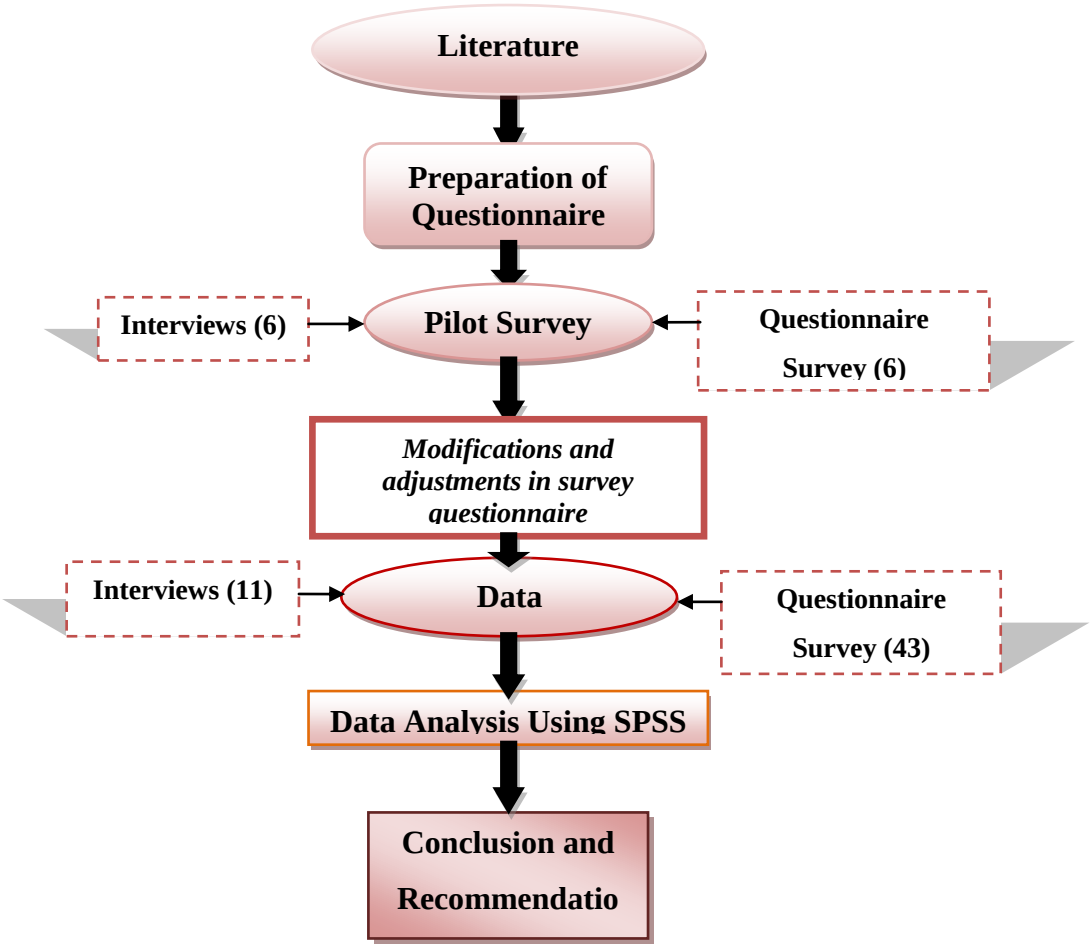

Figure 4.1: Research Methodology

4.4 Research Population and Sample Size

In statistics there are a number of methods to sample a population. The primary purpose is to target a representative sample in the population so that the results obtained can be relied upon. Random sampling is possible only there is too much variation in the target population and it can be grouped. Other methods of sampling include systematic sampling; stratified sampling and cluster sampling.

Various categories of the construction firms as defined by the Pakistan engineering council along with the financial limit of each category are shown in Table 4.1. It is evident from the table that category C4, C5 and C6 firms have a very small financial limit and usually work as sub-contractors. Hence these small construction contracting organizations were taken out of the scope of this research.

Table 4.1: Construction Contractor Categorization

PEC Category	Financial Limit of Each Category	Respondents Frequency	Respondents Percentage	Cumulative Percentage	Number of Registered Firms (5 jan, 2012)
C-A	No financial limit	09	13.33	13.33	63
C-B	2000 Million	04	8.88	22.21	75
C-1	1000 Million	12	25.56	47.77	130
C-2	500 Million	15	28.88	76.65	199
C-3	250 Million	16	23.33	100	433
C-4	100 Million	-	-	-	
C-5	30 Million	-	-	-	
C-6	15 Million	-	-	-	
Total	-	54	100	100	900

Since the research targeted only medium and large size contractors in Pakistan, the research sample was restricted to only those firms that are registered with Pakistan Engineering Council (PEC) as category C3 and above. Category C3 firms are eligible to bid for construction jobs worth 250 million rupees and above. Firms below this category were neglected as they usually work on very small jobs or as petty contractors. Besides,

the study of perception of small size contractors in deciding the markup size is out of the scope of this research.

The total number of contractors registered with PEC in Punjab and Federal Capital as of January 5, 2012 are 900 up to category C3. This research study excludes the PEC categories C4 to C6 as these companies are too small and are incapable of taking complete scope of jobs. These categories usually work as subcontractors on various projects and cannot bid for whole of the works.

Acceptable sample sizes for various populations with different sampling errors for 95% confidence level are given in Table 4.2.

Table 4.2: True Sample Size

Completed sample sizes needed for various population sizes and characteristics at three levels of precision.								
Sample sizes for 90% confidence level								
Population Size	**±15%**		**±10%**		**±5%**		**±3%**	
	Sampling Error		**Sampling Error**		**Sampling Error**		**Sampling Error**	
	50/50 split	80/20 split	50/50 split	80/20 split	50/50 split	80/20 split	50/50 split	80/20 split
100	23	16	36	26	73	63	88	83
200	26	18	44	30	115	93	158	141
400	28	18	49	33	161	121	261	218
600	29	19	51	34	186	134	333	266
800	29	19	52	34	201	142	387	300
1,000	29	19	53	34	212	147	428	324
2,000	29	19	54	35	237	159	544	386
4,000	30	19	55	35	252	165	630	427
6,000	30	19	55	35	257	167	664	443
8,000	30	19	55	35	260	169	683	451
10,000	30	19	55	35	262	169	695	456

(Source: Dillman, 2000)

These sample sizes can also be calculated using the formula given in Equation 4-1.

$$n = \frac{0.25N}{(N-1)\sigma^2+0.25} \qquad \text{Eq. (4-1)}$$

Where,

n = sample size

σ = Standard Deviation (For a sampling error of 10% and a confidence level of 90%, we have $0.1 = 1.64\sigma$, $\sigma = 0.0609$)

N = Total population = 900

A confidence interval of 0.2 was introduced by Ling et.al., (2004), hence a value of 0.1 is acceptable for sample size determination. Substituting the values of the variables the following sample size is introduced, **n = 52**. This sample size is also verified by the sample size calculator tool hosted at Australian bureau of statistics (National Statistical Service) web-site. Due to the limitation of the resources and time, random sampling of the population is undertaken and responses received for the analysis and conclusions.

4.5 Questionnaire Design

The questionnaire for this study is designed based on the information extracted from the studies conducted by Min Liu et.al 2004, Dulaimi et.al 2002, Ali A.Shash 1992, Ahmad & Minkarah 1988, abdul hadi 1990 and Tey kim hai 2009.

The questionnaire consists of three (3) parts/sections. Section A solicits general information about the respondent and the firm. It asks questions such as name, qualification, years of experience in construction and in setting mark-ups about the respondent. Questions regarding name of the firm, PEC registration category, average annual turnover, percentage of work obtained through competitive bidding, percentage of work subcontracted, regions in which the firm is operating or has operated, types of contracts usually signed, and some data regarding past successful bids are also included in this section. Section B of the questionnaire solicits information regarding practices used to determine the markup size, use of bidding strategy models and computer models and the perception of the contractors regarding the problems associated with low usage of such models. Section C provides the respondents with 51 identified factors on a 5-

point likert scale. These factors are categorized into consultant characteristics, project characteristics, economic situation, company characteristics, client characteristics, project documentation, and tendering situation. The questionnaire along with the cover letter is attached as annexure B and C respectively.

4.6 Data Measurement

The rating of factors given by the respondents for markup size decision is used to rank the factors so as to obtain the construction industry's (contractors only) perspective of the main factors affecting the markup size decision . Participants of the questionnaire survey rated the factors with respect to their significance on a Likert scale ranging from 1 to 5, where 1 = Unimportant, 2 = Less Important, 3 = moderately important, 4 = Important and 5 = Very Important.

4.7 Statistical Terminologies

The statistical terminologies used in this research are adopted from Choudhry and Kamal (2008) and are explained below:-

4.7.1 Hypothesis Testing and Statistical Hypothesis

This comes in the subject area of statistical inference. In this, data gathered from the sample is used to test certain assumptions or statements made at the start of the research. Such a statement that may or may not be true is called statistical hypothesis.

4.7.2 Null Hypothesis and Alternative Hypothesis

A null hypothesis is a statement that is assumed to be true and is to be tested for validity. It is denoted by Ho. If the data gathered shows that the statement is false than another hypothesis is drawn that is rejects the null hypothesis and is called the alternate hypothesis which is denoted by Ha.

4.7.3 Significance Level and Test of Significance

It is the limiting value of probability that is used to determine whether a hypothesis is true or not.

4.8 Methods of Analysis

The data is analyzed using MS excel and SPSS-18 with the application of frequency analysis, reliability analysis, normality test and non-parametric Manny Witney U test.

4.8.1 Relative Importance Index (RII)

The data was analyzed and ranked using the 'relative importance index' as used by Kometa *et.al,* (1994). RII was calculated for each factor available in the questionnaire by transforming the scale and giving weightage to the scale. This was then used to determine the ranks of each factor. Equation 4-2 shows how RII was calculated:

$$Relativeimportanceindex(RII) = \sum w/(A * N) \qquad \text{Eq. 4-2}$$

Where,

w = weighting given to each factor by the respondents and ranges from 1 to 5 where '1' is 'not important' and '5' is 'extremely important'

A = highest weight (i.e. 5 in this case)

N = total number of respondents (i.e. in this case 54)

4.8.2 Cronbach's Coefficient Alpha Method

It is used to determine the internal consistency or reliability of the data. It is most commonly used to check the reliability of scale when questions are asked on likert scale. If Cronbach's Coefficient Alpha value is higher than 0.7, this means that the data is acceptable for analysis whereas if its value is higher than 0.9, this means that the data is excellent for further analysis (Li, 2007).

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4.8.3 Test for Normality

Another important evaluation of the data is to test for normality of the data to check whether it is parametric or non parametric. For data sets with elements less than 2000 Shapiro-Wilk test is used to check for normality. The significance value should be greater than 0.05 that is non-significant. For data elements greater than 2000 Kolmogorov-Smirnov test is used. Shapiro-Wilk test is used for this study.

4.8.4 Mann-Whitney U-test

Non-parametric tests are basically used in order to overcome the underlying assumption of normality in parametric tests. Quite general assumptions regarding the population are used in these tests. A case in point is the Mann-Whitney U-test (Also known as the Mann-Whitney Wilcoxon (MWW) or Wilcoxon rank-sum test). Unlike its parametric counterpart, the t-test for two samples, this test does not assume that the difference between the samples is normally distributed, or that the variances of the two populations are equal. Thus when the validity of the assumptions of t-test are questionable, the Mann-Whitney test comes into play and hence has wider applicability.

4.9 Summary

In this research questionnaire survey is adopted as the main research instrument. The questionnaire consists of three sections. A total of 51 factors in seven categories are used to take the perception of contractors. Simple random sampling is employed at a margin of error of 10% resulting in a sample size of 52. Relative importance index and Mann Whitney U two independent sample tests are used to perform statistical analysis of the collected data.

Chapter 5

DATA ANALYSIS AND RESULTS

5.1 Introduction

This chapter presents the summary of the data collected through the questionnaire survey. The survey was targeted at the construction industry professionals who had prior experience in setting Mark-up on projects. Responses from professionals who had no experience in setting mark-up were treated as invalid. The collected data has been analyzed using MS Excel (2007) and SPSS (17).

For a sample size of 90, conservatively a total of 150 firms were randomly selected from the PEC population database and the survey questionnaire was sent to the firms. The modes of questionnaire delivery and response solicitation included emails, face to face interviews and personal contacts. A total of 65 responses were received out of which 54 valid responses were obtained. This amounts to a response rate of 43.3%.
The Respondents are categorized into medium and large size contractors based on their PEC financial category. All contractors of financial category C1 and above are treated as large size contractors due to high correlation in their responses and category C2 and C3 are treated as medium size contractor firms again due to high correlation in their responses.

5.2 General Information about the Respondents and the Firm

In this section general questions were asked to identify the characteristics of the respondent and the firm to develop a profile of both.

5.2.1 Respondent Characteristics

This section provides the data obtained from Section A of the questionnaire. Not all the questions were answered by the all the respondents in this section. Therefore the presentation is based on the collected data only.

Most of the respondents are functioning as project managers in different companies and are B.Sc/BE Engineers (Civil). Respondents to this survey are mostly civil engineers. This second highest proportion of responses comes from the qualification category of others. A detailed breakup of the qualification of the respondents is given

Table 5.1. The same is shown in Figure 5.1 as well. It is interesting to note that the ownership of the company does not necessarily lie with construction specific academically qualified people in Pakistan's construction industry. It is not necessary that the owners are having engineering or a management degree.

Table 5.1: Qualification of Respondents

Qualification	Number of Respondents	Percentage	Cumulative Percentage
B.Sc/BE Engineering	27	50.00	50.00
MS Engineering	3	05.60	55.60
MBA	5	09.30	64.90
Others	19	35.20	100.00
Total	54	100%	100%

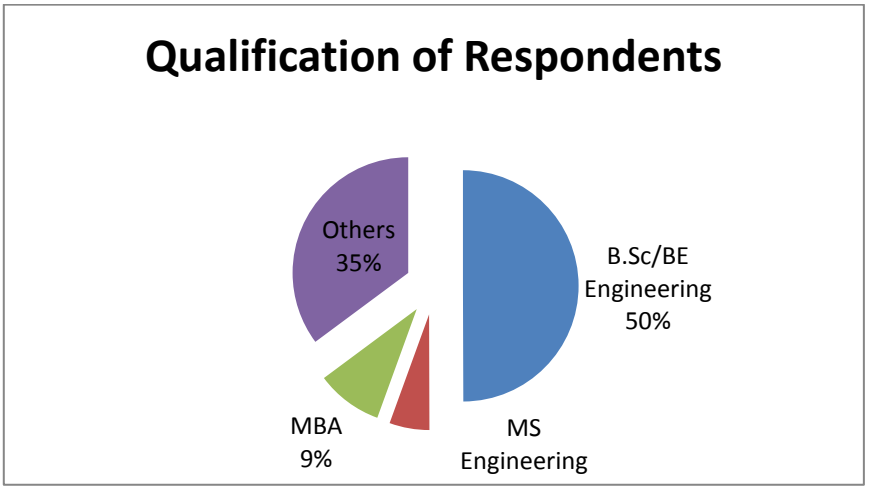

Figure 5.1: Qualification of Respondents

Respondents were asked about their title or position at their companies. Majority of the respondents to the survey hold a key position in their firms. They are either the owners or senior managers from contracts, proposals or business development departments of their companies. Since all of these professionals have an input to the mark-up size decision process, a valid response can be obtained from them.

The title of the respondents at their respective firm or companies is given in Table 5.2. The same is shown in Figure 5.2 as well. Senior and experienced project managers are often involved in the final meeting before bidding where important decisions regarding final markup adjustments are made.

Table 5.2: Title/Position of Respondents at Their Respective Firms

Title / Position	Number of Respondents
General Manager / Director / Senior Manager	32
Project Manager / Professional	22

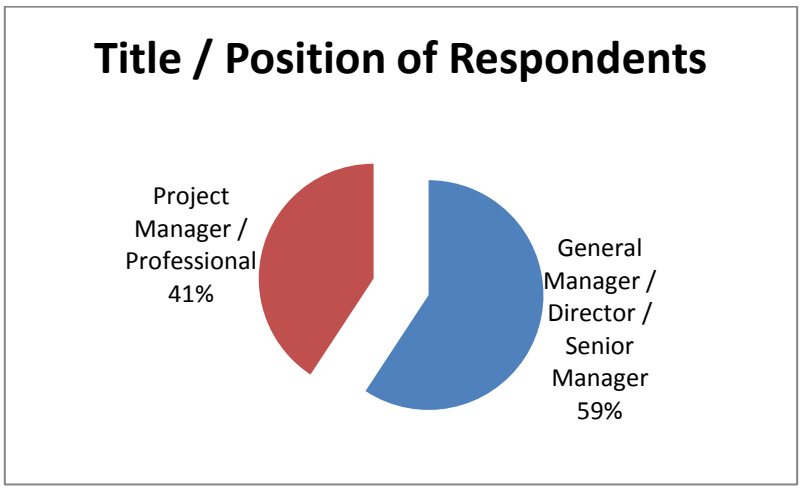

Figure 5.2: Title / Position of Respondents at Their Respective Firms

Respondents were asked to provide their experience in the construction industry. The experience of the individuals/respondents to the survey was very varied ranging from 1-5 years to more than 20 years in the construction industry as shown in Table 5.3.

Table 5.3: Experience of Respondents in Construction

Experience (years)	Number of Respondents
1-5	2
6-10	20
11-15	8
16-20	11
20+	13

Respondent distribution is shown in Figure 5.3 based on the years of experience in the construction industry. This shows that very experienced professionals from the field have responded to the survey.

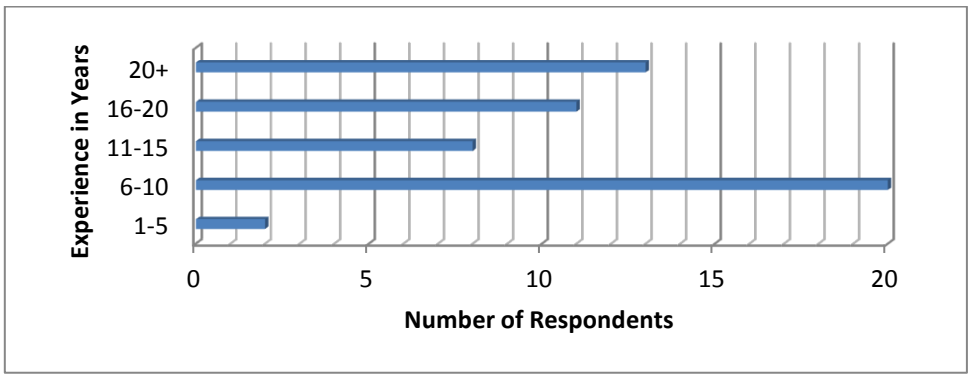

Figure 5.3: Experience of Respondents in Construction

Respondents were also asked about their experience in setting mark-up on the projects. The breakup is given in Table 5.4. It shows that majority of the respondents have an experience in access of sixteen (16) years. This is the case because the survey specifically targeted the executive management of the companies that were contacted for the survey. The results are also produced in Figure 5.4.

Table 5.4: Experience of Respondents in Setting Mark-Up

Experience No. of Projects	Number
1-5	4
6-10	9
11-15	10
16-20	16
20+	15

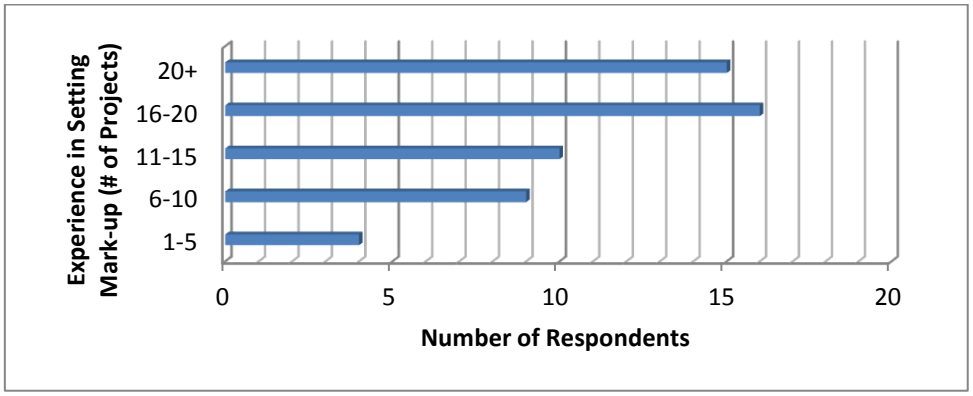

Figure 5.4: Experience of Respondents in Setting Mark-up

5.2.2 Company Characteristics

Out of 150 firms that were initially contacted, a total of 65 responses were received out of which 54 valid responses were obtained. This amounts to a response rate of 36%.

A detailed breakup of the responses obtained from different contractor categories in given in Table 5.5. It can be seen that majority of respondents belong to category C2 and C3 contractors. Out of the total valid responses, 57.4% are form medium size contractors and 42.6% of the responses are form large size contractors. Figure 5.5 above shows the categories of construction firms that responded to the survey.

Table 5.5: Respondent Characteristics

PEC Category	Financial Limit of Each Category	Respondents Frequency	Respondents Percentage	Cumulative Percentage
C-A	No financial limit	9	16.67	13.33
C-B	2000 Million	4	7.4	22.21
C-1	1000 Million	12	22.22	47.77
C-2	500 Million	15	27.77	76.65
C-3	250 Million	16	29.63	100
Total	-	54	100%	-

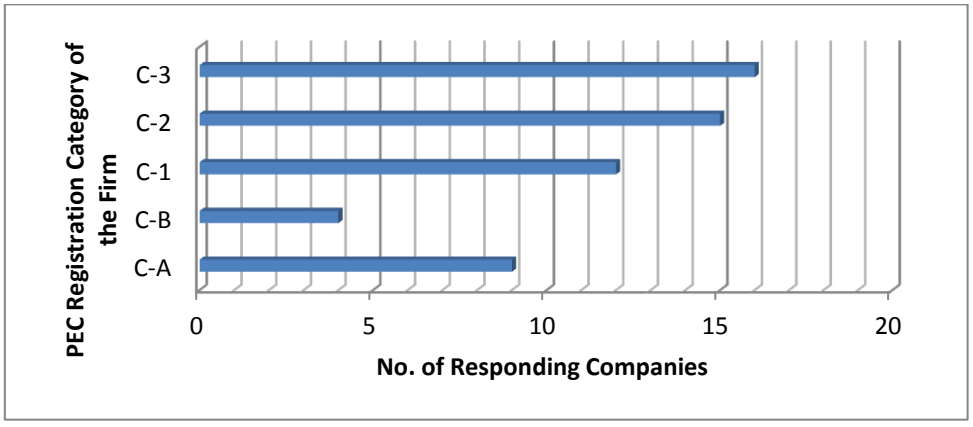

Figure 5.5: Respondent Characteristics

The respondents were asked about the average annual turnover of their companies. Only 13 out of 54 firms responded to this question. Many firms guard this information as sensitive and confidential. Same response restriction / limitation was

recorded in a survey conducted by Dulaimi et.al, 2002 in Singapore. Table 5.6 shows the data gathered on this question. The data gathered may be limited but it clearly advocates that a study based on annual turnover should be conducted as there is a significant variation in the annual turnover.

Table 5.6: Average Annual Turnover of Responding Companies

Average Annual Turnover (Million Rupees)	Number of Firms
11500	1
10500	1
3000	1
750	3
105	1
500	2
400	1
200	2
100	1

The respondents were asked about their average bid winning frequency. Exclusively all the contractors responded to this question by stating that the winning rate is between **5%-15%** i.e out of every 100 bids submitted by a contractor, 5-15 are won.

The respondents were asked about the percentage of work that they obtain through competitive bidding. Table 5.7 populates the results to this question. Majority of the respondents indicated that they get most of the work, greater than three quarter, through competitive bidding.

Table 5.7: Percentage of Work Obtained Through Competitive Bidding

Percentage	Number
Under 25%	5
26%-50%	7
51%-75%	6
+76%	36

The respondents were also asked of the percentage of work subcontracted on average on a particular project.

Table 5.8 populates the answers to this question. It is clear that the contractors subcontract a significant portion of their work.

Table 5.8: Percentage of Work Sub-Contracted

Percentage	Number
Under 25%	7
26%-50%	8
51%-75%	24
+76%	15

The respondents were asked about the type of contract usually signed by them. 93% of the respondents responded that they entered only into unit rate contracts whereas only 7% entered into both the unit rate and lump sum contracts.

The respondents were asked whether they usually preferred public / private sector projects. 73% of the respondents replied that they usually took public sector projects. 25% of the respondents said that they took both public and private sector projects. Only 2% of the respondents took private sector projects only. This shows that government is a big player in the construction industry of Pakistan. Furthermore, in the interviews it was revealed by many contractors that they are more interested in working with public sector clients rather than private sector client. The main reason for this sense of insecurity was reported to be the high chances of a private client going into default.

The respondents were asked what types of projects were usually taken by them. A detailed breakup is given in Table 5.9. It is evident that most of the contractors perform more than one type of job.

Table 5.9: Type of Construction Specialization of the Firms

Type of Project	Number of Respondents
a) Building Construction (Residential, commercial, etc..)	15
b) Engineering Construction (Heavy / Infrastructure)	07
c) Industrial Construction	02
Both (a) and (b)	15
Both (b) and (c)	03
Both (a) and (c)	0
All of the above	12

Respondents were asked about the region in which they operate. Most of the contractors that responded to this survey have worked in more than one region in Pakistan. There are a very few contractors that continue to work in only one region/province as shown in the Table 5.10.

Table 5.10: Region(s) of Operation of the Contractors

Region/Province	Number
KPK	2
Punjab	11
Punjab, KPK, AJK	8
Punjab, Sindh	6
Punjab, AJK	3
Punjab, Balochistan, Sindh, KPK	10
ALL	14

The respondents were also asked to provide data on the projects that they had won as the lowest bidder and the percentage difference between their bid and the 2nd lowest bid on the same project. Not all the respondents replied to this question. However the data that was collected on 19 projects is shown in Table 5.11 below.

Table 5.11: Money Left on the Table on Various Projects

Total cost of winning bid	Difference b/w next lowest and lowest	Percentage Difference	Total cost of winning bid	Difference b/w next lowest and lowest	Percentage Difference
Million Rupees	Million Rupees	%	Million Rupees	Million Rupees	%
10	0.3	3	461	30	6.51
12	0.32	2.67	510	15	2.94
22	0.7	3.18	598	6	1
108	5	4.63	599	49	8.18
110	6	5.45	710	30	4.23
120	1.2	1	718.5	99.48	13.85
124	2.5	2.02	892	6	0.67
195	2	1.03	965	29	3.01
210	20	9.52	985	24	2.44
218	9	4.13	1640	49.2	3
339.4	16.72	4.93	2194	362.8	16.54

The same is plotted in Figure 5.5 to indicate the level of scatter or variance associated with subjective decisions in mark-up size decision. It can be seen from the figure that the variance is maximum when the project cost is below 400 million rupees. However since there is only little data available to plot this scatter diagram, this deduction cannot be established for a fact.

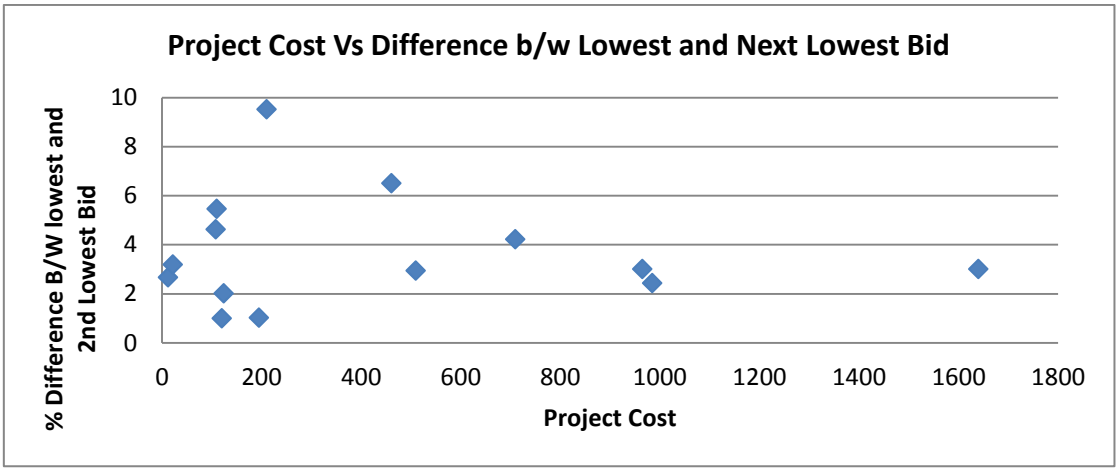

Figure 5.5: Money Left on the Table on Various Projects

5.2 Current Practices in Contractor Mark-Up Size Decision

Respondents were asked to declare the components of their mark-up. As explained previously in Ch 2, the components of mark-up i.e Overheads, Contingencies and profit are more a matter of company policy and philosophy rather than a strict rule or definition. Table 5.12 shows the response of the companies in relation to their definition of mark-up. The table shows the majority of the respondents consider overheads (head office), contingencies and profit as the components of their mark-up.

Table 5.12: Mark-Up Composition

Components of Mark-up	No. of Respondents
Overhead, Contingencies & Profit	45
Overhead & Profit	9
Contingencies & Profit	0
Profit Only	0

Respondents were asked how they determine their mark-up size against a number of options on a 5-point Lickert Scale ranging from Strongly Disagree to Strongly Agree. Table 5.13 tabulates the responses of the respondents.

Table 5.13: Method of Determining/Deciding Mark-up

Mode of Mark-Up Size Determination	Rank
Experience	1
Judgment	2
Market Survey	3
Documented Past Records of Biddings	4

It can be seen that the Mark-up amount is decided largely based on Experience and Judgment. Market survey plays a very important role in determining mark-up as prices of materials are always changing and this risk factor has a huge bearing on the mark-up size.

Respondents were asked what type of information was recorded and documented from past biddings. All contractors responded that information regarding the competitors who attend the bid, their bid price, total number of competitors and own bid price is kept documented for future reference and analysis.

Respondents were asked if they use any computer software or any qualitative or statistical model to assess their bidding situation. All the contractors unanimously responded "No" to this question as shown in Figure 5.6.

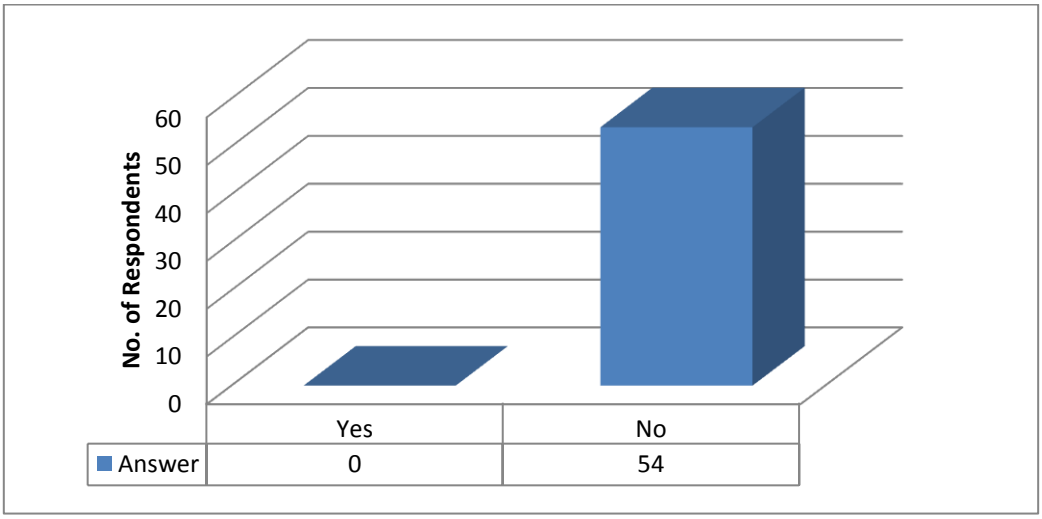

Figure 5.6: Use of Computer Software to Assess the Bidding Situation

A number of bidding models exist in literature. When asked whether any of those are used, the answer was “No”. Table 5.14 tabulates the results.

Table 5.14: Usage of Bidding Strategy Models in Local Industry

Model Name	No. of Respondents
Friedman Model	-
Bids Considering Multiple Criteria	-
Gates Model	-
Winning Over Key Competitors	-
OPBID	-
LOMARK (Low Markup Model)	-
Sequential Competitive Bidding	-
DBID	-
Average Bid Method Bidding Model	-
Carr’s Bidding Model	-
Self Explanatory Artificial Neural Networks	-
Optimum Bid Approximation Model	-

Respondents were also asked the reason for not using any of the bidding models that are found in the literature. 91% of the respondents replied that they are unaware of any such models whereas the remaining 9% of the respondents replied that these models are complex and inefficient to be used. Table 5.15 tabulates the results to this question.

Table 5.15: Issues with Bidding Strategy Models

Issues with the Bidding Models	Rank
No Knowledge about the Bidding Models	1
Complexity of Bidding Models	2
Inefficiency of Bidding Models	3

5.3 Factors Affecting the Contractors Mark-up Size Decision

Respondents were asked to evaluate the factors on a scale of 1 to 5. Based on the level of importance given by each respondent relative importance index was calculated

and a rank order was given to the factors as presented in Appendix 1. The results were obtained through SPSS program.

The top ten factors identified by all the contractors as the most influential in their bid markup decision were Project Cash Flow, Size of Project, Need for work, Location of Project, Degree of Difficulty / Project Complexity, Overall economy (Availability of work), Payment record of client, Degree of Safety (Terrorism/other threats), Availability of cash to carry out the work and Identity of competitors as tabulated in Table 5.16.

Out of these ten top rated factors, 5 belong to project characteristics group (Project Cash Flow, Size of Project, Location of Project, Degree of Safety (Terrorism/other threats), Degree of Difficulty / Project Complexity) and 2 belong to company characteristics (Need for work, Availability of cash to carry out the work). None of the top ten factors belong to the category of project documentation and consultant characteristics factor category.

Table 5.16: Factors Affecting Mark-Up Size Decision

Factors	Importance Index	Ranking
Project Cash Flow	91.11	1
Size of Project	90.00	2
Need for work	86.67	3
Location of Project	85.56	4
Degree of Difficulty / Project Complexity	84.44	5
Overall economy (Availability of work)	84.44	6
Payment record of client	82.22	7
Availability of cash to carry out the work	78.89	8
Degree of Safety (Terrorism/other threats)	78.89	9
Identity of competitors	78.89	10

5.3.1 Overall Ranking Category Wise

The overall ranking of seven factor categories is shown in Table 5.17. Project characteristics and client characteristics are the highest ranking categories that influence the mark-up size decision of contractors in Pakistan.

Table 5.17: Factors Affecting Mark-Up Size Decision - Category Wise

Factor Categories	Importance Index (%)	Rank
Project Characteristics	75.9	1
Client Characteristics	74.2	2
Company Characteristics	69.2	3
Economic Situation	68.9	4
Project Documentation	67.2	5
Consultant Characteristics	66.1	6
Tendering Situation	61.1	7

From the results given above, it can be inferred that factors related to project characteristics are the most significant contributors that influence the mark size decision. The top six ranking factors in the project characteristics are Project Cash Flow, Size of Project, Location of Project, Degree of Difficulty / Project Complexity, Degree of Safety (Terrorism/other threats) and Duration of Project. Factors relating to client characteristics are the 2nd most significant contributors that influence the markup size. The most important factor in this category is Payment record of client. Factors related to company characteristics are the 3rd most significant contributors that influence the markup size decision. The top three factors in this category are Need for work, Availability of cash to carry out the work and Size of Head office overhead.

5.4 Attitude of the Medium-Size Contractors

The top 10 factors identified here were: Project Cash Flow, Need for work, Availability of cash to carry out the work, Size of Project, Overall economy (Availability

of work), Location of Project, Degree of Difficulty / Project Complexity, Payment record of client, Degree of Safety (Terrorism/other threats) and Risk of fluctuation in material prices as shown in the Table 5.18 below.

Table 5.18: Top Ten (10) Factors Affecting Medium Size Contractors

Factor	Importance Index (%)	Rank
Project Cash Flow	95	1
Need for work	92.5	2
Availability of cash to carry out the work	92.5	3
Size of Project	90	4
Overall economy (Availability of work)	90	5
Location of Project	87.5	6
Degree of Difficulty / Project Complexity	86.5	7
Payment record of client	83.7	8
Degree of Safety (Terrorism/other threats)	83.3	9
Risk of fluctuation in material prices	83	10

The results in Table 5 show that project and company characteristics category has achieved significant importance. Factors such as the project cash flow, need for work, availability of cash to carry out the work and size of the project were ranked higher.

Medium-size contractors also placed a higher emphasis on need for work and project cash flow, due to low turnover and limited funds to sustain without doing any work.

Payment record of client ranked at 9 shows that medium size contractors have limited financial capacity and need payments on time to continue to function profitably.

Medium sized contractors are mostly involved in building construction work. Escalation on certain materials and labor is covered by the contract however there are many materials (especially those that are required for finishing works such as wood, paint, tiles, marbles, fittings) for which the contractor much foresee any change in prices for a project that may go 2 to 3 years in the future and adjust as contingency in the bid. This may have caused them to rate Risk of fluctuation in material prices as the tenth highest factor influencing their bid markup decision.

5.5 Attitude of the Large-Size Contractors

The top 10 factors (Table 5.19) identified here were: Size of Project, Project Cash Flow, Identity of competitors, Location of Project, Need for work, Degree of Difficulty / Project Complexity, Overall economy (Availability of work), Payment record of client, Competitiveness of other bidders and required bond capacity.

The category of project characteristics seems to be the most influential as most of the top ten factors come from it. This may be due to that fact that large size contractors are involved in more complex projects. Size of the project has obtained highest importance as this allows large contractors to earn good profits, sustain their annual overheads and contributes positively towards their annual business volume.

Project cash flow is marked as the second highest factor as opposed to the ranking of medium sized contractors who placed it at highest level of importance. It may be argued that the large size contractors have enough financial resources to cope with this issue in a better way as compared to the medium sized contractors who have a limited working capital. The results have been tabulated in Table 5.19 below.

Table 5.19: Top Ten (10) Factors Affecting Large Size Contractors

Factor	Importance Index (%)	Rank
Size of Project	90	1
Project Cash Flow	88	2
Identity of competitors	88	3
Location of Project	84	4
Need for work	82	5
Degree of Difficulty / Project Complexity	82	6
Overall economy (Availability of work)	80	7
Payment record of client	78	8
Degree of Safety (Terrorism/other threats)	78	9
Required bond capacity	74	10

The second most important category influencing large contractors' bid mark-up decisions is 'Tendering situation'. Under this category, factors such as identity of

competitors, competitiveness of other bidders and the required bond capacity for a project were given higher importance. These factors are likely to influence the profitability of works as well as the capacity to take on additional work.

Number of the bidders and the identity of the bidders gives valuable information regarding the amount of mark-up to put in the cost estimate. In the interviews conducted during this survey, the contractors revealed that when they are invited to bid for a project, sometimes relatively small contractors are also bidding for those jobs. Due to their small overhead structure, these contractors are in a better position to win the bid. Hence identity of the competitor is also important from this point of view.

Most of the clients require that the contractor provide bank guarantee for a performance bond. This puts a lot of pressure for large size projects on the contractors.

5.6 Statistical Analysis

5.6.1 Reliability of the Sample (Cronbach's Coefficient Alpha Method)

It is most commonly used to check the reliability of scale when questions are asked on likert scale. If Cronbach's Coefficient Alpha value is higher than 0.7, this means that the data is acceptable for analysis whereas if its value is higher than 0.9, this means that the data is excellent for further analysis (Li, 2007). For the collected data, its value is calculated as 0.966 using SPSS, as given in Table 5.20. Its higher value indicates that the data is consistent and reliable for further analysis.

Table 5.20: SPSS Output for Cronbach's Coefficient Alpha

<table>
<tr><td colspan="4">Case Processing Summary</td><td rowspan="2">Cronbach's Alpha</td><td rowspan="2">0.966</td></tr>
<tr><td colspan="2"></td><td>N</td><td>%</td></tr>
<tr><td rowspan="3">Cases</td><td>Valid</td><td>54</td><td>100.0</td><td rowspan="3">Number of Items</td><td rowspan="3">51</td></tr>
<tr><td>Excluded[a]</td><td>0</td><td>.0</td></tr>
<tr><td>Total</td><td>54</td><td>100.0</td></tr>
<tr><td colspan="4">a. Listwise deletion based on all variables in the procedure.</td></tr>
</table>

5.6.2 Normality Test

It is performed to know whether the data is normally distributed or not, i.e. is the data parametric or non-parametric in nature. Significance values found are 0.000 which is less than 0.05. (significance value should be larger than 0.05 for the data to be sufficiently normal). Hence the data cannot be utilized using normal parametric statistical techniques such as the two independent sample t-test.

Since data is not normally distributed and non parametric tests are required for further analysis. Table 5.21 shows the data regarding test of normality by Shapiro Wilk test.

Table 5.21: SPSS Output for Normality Test

Shapiro-Wilk Test								
Factors	**Statistic**	**Sig.**	**Factors**	**Statistic**	**Sig.**	**Factors**	**Statistic**	**Sig.**
FAC_1	0.695	0	FAC_18	0.757	0	FAC_35	0.846	0
FAC_2	0.848	0	FAC_19	0.822	0	FAC_36	0.834	0
FAC_3	0.753	0	FAC_20	0.785	0	FAC_37	0.853	0
FAC_4	0.686	0	FAC_21	0.836	0	FAC_38	0.74	0
FAC_5	0.733	0	FAC_22	0.85	0	FAC_39	0.835	0
FAC_6	0.882	0	FAC_23	0.853	0	FAC_40	0.882	0
FAC_7	0.846	0	FAC_24	0.879	0	FAC_41	0.87	0
FAC_8	0.902	0	FAC_25	0.853	0	FAC_42	0.816	0
FAC_9	0.899	0	FAC_26	0.775	0	FAC_43	0.881	0
FAC_10	0.798	0	FAC_27	0.911	0	FAC_44	0.877	0
FAC_11	0.838	0	FAC_28	0.846	0	FAC_45	0.76	0
FAC_12	0.888	0	FAC_29	0.853	0	FAC_46	0.853	0
FAC_13	0.861	0	FAC_30	0.871	0	FAC_47	0.872	0
FAC_14	0.878	0	FAC_31	0.879	0	FAC_48	0.885	0
FAC_15	0.838	0	FAC_32	0.797	0	FAC_49	0.845	0
FAC_16	0.884	0	FAC_33	0.854	0	FAC_50	0.871	0
FAC_17	0.903	0	FAC_34	0.705	0	FAC_51	0.858	0

5.6.3 Mann–Whitney – Two Independent Sample Tests

The normality test showed that the data is not normally distributed. Hence Mann Whitney test is performed because it is a non parametric test. This test will determine if the two groups of contractors the medium and the large size have any significant difference in their perception towards the factors influencing the markup size decision. SPSS was used to perform this test. The research null hypothesis states that the means of the two categories of contractors are the same, and the alternative hypothesis states that they are not the same. A significance level of 95% was used. If p is less than 0.05 (significance value), then we reject the null hypothesis otherwise we accept it.

Null hypothesis H0: μL = μM (No significant difference in the perception of two groups)

Alternative hypothesis Ha: μL $\neq\mu$M (Significant difference in the perception of two groups)

Here μL and μM are the means for large and medium contractors, respectively.

5.7 Medium and Large Size Contractor's Attitudes - Differences

The previous section highlighted the level of importance the two groups of contractors have attached to the different factors in considering their bid mark-up decision. A hypothesis was set up to test whether both groups of contractors varied significantly in their attitudes toward these factors. The factors that contributed significantly to the differences between the two groups of contractors in evaluating their bid markup decision are discussed under seven categories.

5.7.1 Project Characteristics

Under this category as shown in Table 5.22, duration of project, location of project, project cash flow, past profit in similar jobs and Degree of safety (Terrorism/other threats) have a p-value less than 0.05 indicating that the large and medium size contractors see these factors as significantly different in influencing their mark-up size decision.

The mean rank of all the significant factors for medium size contractors is larger than the large size contractors. Medium size contractors are much more sensitive to

location of project, project cash flow and the degree of safety on their projects due to their limited infrastructure and financial resources.

Table 5.22: Project Characteristics Category

Project Characteristics	Mean Rank		P-value
	Large Contractor	Medium Contractor	*(2-tailed)*
Size of Project	45.25	45.81	0.907
Duration of Project	37	56.13	**0**
Location of Project	40.25	52.06	**0.019**
Project Cash Flow	40	52.38	**0.009**
Degree of Difficulty / Project Complexity	45	46.13	0.822
Potential for Disputes	41.25	50.81	0.071
Type of equipment required	43.75	47.69	0.451
Strategic value of project	49.5	40.5	0.093
Past Profit in Similar Jobs	38.5	54.25	**0.003**
Degree of Safety (Terrorism/other threats)	39.25	53.31	**0.007**

5.7.2 Project Documentation

Under this category, there is no factor that is perceived significantly different in the contractor's markup size decision. The p-value for all the factors is greater than 0.05. Hence none of the factor in this category is perceived significantly different in this category between the two study groups. Table 5.23 tabulates the results.

Table 5.23: Project Documentation Category

Project Documentation	Mean Rank		P-value
	Large Contractor	Medium Contractor	*(2-tailed)*
Type of Contractual Arrangement	42.25	49.56	0.165
Design Quality	42.5	49.25	0.209

Project Documentation	Mean Rank		P-value
	Large Contractor	Medium Contractor	*(2-tailed)*
Presence of Owners special requirements	42.5	49.25	0.198
Contract conditions used (Strict/Flexible)	45.5	45.5	1
Size of Liquidated Damages	47.25	43.31	0.449
Completeness of Tender documents	42	49.88	0.145

5.7.3 Company Characteristics

Under this category, current workload, need for work, availability of cash to carry out the work, availability of skilled workers, availability of qualified site management staff and availability of reliable subcontractors have a p-value less than 0.05 indicating that the large and medium size contractors see these factors as significantly different in influencing their mark-up size decision.

Projects executed by medium sized contractors are comparatively of smaller duration, thereby necessitating winning of more work at relatively short intervals as compared to large size contractors to keep the business running.

Large contractors have a number of projects in the chain. Some are at their starting or middle phase while others are nearing completion.

This may have caused the large contractors to rank availability of manpower issues lower than the medium size contracts. These results have been tabulated in Table 5.24.

Table 5.24: Company Characteristics Category

Company Characteristics	Mean Rank		P-value
	Large Contractor	Medium Contractor	*(2-tailed)*
Current work load	39.5	53	**0.012**
Need for work	38.75	53.94	**0.003**
Contractor involvement in design phase	41	51.13	0.051

Company Characteristics	Mean Rank		P-value
	Large Contractor	Medium Contractor	*(2-tailed)*
Availability of cash to carry out the work	34	59.88	**0**
Availability of skilled workers	38.25	54.56	**0.002**
Availability of qualified Site management staff	40.5	51.75	**0.036**
Size of Head office overhead	41.25	50.81	0.07
Availability of Reliable Subcontractors	39.75	52.69	**0.016**
Uncertainty in cost estimates	43.25	48.31	0.342
Experience in similar projects	44.5	46.75	0.643
Portion of work subcontracted	42	49.88	0.143

As evident from the results of the survey shown previously, a significant portion of the work is subcontracted by most of the contractors. Availability of reliable subcontractors to execute the work as per specification and within the quality standards therefore has a significant bearing on the markup size decision. Medium sized contractors are mostly involved in building construction which requires a number of specialty trades. Moreover for works executed in remote areas or in the Kashmir region, finding reliable subcontractors in the locality can be a key issue.

5.7.4 Tendering Situation

Under this category as shown in Table 5.25, identity of the competitors and the competitiveness of other bidders is perceived significantly important by large contractors as opposed to the medium sized contractors.

Table 5.25: Tendering Situation Category

Tendering Situation	Mean Rank		P-value
	Large Contractor	Medium Contractor	*(2-tailed)*
Required bond capacity	44.75	46.44	0.751
Size of Bid bond	43	48.63	0.292

Tendering Situation	Mean Rank		P-value
	Large Contractor	Medium Contractor	*(2-tailed)*
Number of bidders	45.5	45.5	1
Time allowed to submit bids	42.25	49.56	0.172
Identity of competitors	54.75	33.94	**0**
Prequalification/Compliance requirements	43.5	48	0.397
Tendering document price	47.75	42.69	0.308
Tendering procedure	45	46.13	0.832
Time of tendering (Season)	46.5	44.25	0.671
Competitiveness of other bidders	50	39.88	**0.047**

Given the current economic situation of our country, winning big works can be a difficult job. Large contractors are only interested in jobs that match their structure to sustain their overheads and match profit aspirations to keep the business running. Due to low availability of work in the w\market, competition is much more intense for large contractors as compared to medium sized contractors.

5.7.5 Economic Situation

Under this category, availability of equipment, risk of fluctuation in material prices and availability of other projects for tendering have a p-value less than 0.05 indicating that the large and medium size contractors see these factors as significantly different in influencing their mark-up size decision.

Large contractors usually have a big pool of heavy equipment in their ownership as opposed to the medium size contractors. Renting of necessary equipment increases the net cost to the contractors. These results have been tabulated in Table 5.26 below.

Table 5.26: Economic Situation Category

Economic Situation	Mean Rank		P-value
	Large Contractor	Medium Contractor	*(2-tailed)*
Overall economy (Availability of work)	39.5	53	**0.008**
Availability of labor	42.25	49.56	0.163

Economic Situation	Mean Rank		P-value
	Large Contractor	Medium Contractor	*(2-tailed)*
Availability of equipment	38.75	53.94	**0.005**
Quality of available labor	41.5	50.5	0.091
Risk of fluctuation in material prices	37.25	55.81	**0**
Availability of other projects for tendering	38.5	54.25	**0.003**
Risk of fluctuation in labor prices	43	48.63	0.298

Given the current economic situation inflation is a very serious issue in our country. This poses a serious risk to contractors that are not able to obtain good deals under bulk buying strategies due to their limited financial capacity.

5.7.6 Client Characteristics

Under this category, all the factors are perceived significantly more important by medium sized contractors. This is in line with the findings of many international researches that indicate client characteristics to be the most important in influencing the behavior of medium of small and medium size contractors in bidding.

The client characteristics ranked by the respondents are tabulated in Table 5.27 below.

Table 5.27: Client Characteristics Category

Client Characteristics	Mean Rank		P-value
	Large Contractor	Medium Contractor	*(2-tailed)*
Payment record of client	41.25	50.81	**0.036**
Size of Client	40.75	51.44	**0.045**
Type of client (Public/Private)	40.25	52.06	**0.026**
Relationship and past experience with client	40.75	51.44	**0.047**
Possibility of getting future work from client	35.75	57.69	**0**

5.7.7 Consultant Characteristics

Under this category s shown in Table 5.28, character of consultant (strictness) is ranked significantly more important by medium size contractors as opposed to large size contractors.

Table 5.28: Consultant Characteristics Category

Consultant Characteristics	Mean Rank		P-value
	Large Contractor	Medium Contractor	*(2-tailed)*
Relationship with consultant	47.25	43.31	0.462
Character of consultant (Strictness)	39.25	53.31	**0.009**

5.8 Summary

This chapter presents the analysis of the data collected through the questionnaire survey of 54 construction contractors. The results indicate that the contractors are not using any statistical or computer bidding model to aid in mark-up size decision. Moreover, there is a significant difference in the factors that are perceived important by different study groups. Large size contractors are more concerned about the size of the project whereas the medium size contractors are more concerned about their company financial situation.

Chapter 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Review of Research Objectives

The core objective of this research is to determine the 'Factors influencing the bid mark-up decision of the medium and large size construction contractors in Pakistan'. The sub-objectives of this study are:

a. To determine the current state of practice of construction contractors in mark-up size decision to record how such decision are made and to establish a benchmark for future studies on this topic.
b. To determine the use of existing bidding strategy models in the construction industry and the problems associated with them to enable an understanding of the role of such models in the construction industry.
c. To record the differences in perception of medium and large size contractors towards the factors influencing their bid mark-up decisions. The identification of these factors will enable us to carry out further research to develop a bidding strategy model for the local construction industry.

Data was collected from the responses of 54 individual respondents/construction contractors. The data was analyzed using different techniques to meet the objectives of the research. The analysis has highlighted major factors contributing to the contractors mark-up size decisions. These identified factors can be used to aid the contractors in decision making while they are bidding on future projects.

6.2 Conclusions

Following conclusions are drawn based on the analysis of the data.

a) Majority of the construction contractors (PEC category C3 and above) operating in Pakistan, build mark-up on their cost estimates to cover for contingency, general overheads and profit.
b) The decision making in setting mark-up on projects is based on a number of factors that are subjective and qualitative in nature.

c) The decision to set mark-up on cost estimates is based exclusively on experience and judgment of the senior / executive management. Use of computer models or any analysis to assess the competition is extinct.

d) Main reason for no application of bidding strategy models in construction industry of Pakistan is the lack of knowledge of such models in the industry.

e) The top ten factors identified by all the contractors/respondents to the survey as the most influential in their bid mark-up decision are

   a. Project Cash Flow
   b. Size of Project
   c. Need for work
   d. Location of Project
   e. Degree of Difficulty / Project Complexity
   f. Overall economy (Availability of work)
   g. Payment record of client
   h. Degree of Safety (Terrorism/other threats)
   i. Availability of cash to carry out the work
   j. Identity of competitors.

f) The top three ranked categories by all the respondents / contractors are

   a. Project Characteristics
   b. Client Characteristics
   c. Company Characteristics

g) The contractors operating in Pakistan show high sensitivity to factors such as cash flow payments and economic conditions. This is true for both of the study groups.

h) Large size contractors see project cash flow as the second most important factor as opposed to medium size contractors. For them, size of the project is the most important factor. It is logical as big structure of such companies require big projects to finance their expenditures and overheads.

i) Large size contractors see project complexity as more important than medium size contractors.

j) Need for work is ranked at 2 by medium and 5 by large size contractors. Small duration of jobs taken by medium size contractors may explain this difference.

k) Large size contractors have indicated that they are highly affected by competitiveness of other bidders (Ranked # 3). Interviews have revealed that this

competitiveness comes from low overheads of medium size contractors that are participating in bidding alongside the large size contractors.

l) Large size contractors are also affected more by the location of the project as the projects they take are usually in areas far from their area of operation or nearby developed areas.

m) Degree of safety (terrorism and other threats) has been ranked at 8th by medium size contractors. If clients cannot provide a safe climate at their project sites, this may result in inflated bids by the contractors.

n) Degree of difficulty / Project complexity has been marked in top 10 factors by both study groups. It is an impetus for consultants or the designers to pay attention towards constructability issues as far as possible as this may result in identifying feasible options that may help lower mark-up on the bids received.

o) Risk of fluctuation in material prices is ranked at 10 by both the study groups.

p) Project cash flow and payment record of client are the highest ranking factors of both groups. Clients should pay considerable attention towards their payment scheme as this may significantly affect mark-up amount on project.

q) Large contracts require large amount of money to be paid as performance bond. Its has been ranked 10th by large contractors. Typically 10% of the project cost is paid up and fixed in a bank account for the period of construction plus the defect liability period. Most of the interviews revealed that majority of the clients demand Bank guarantee. Contractors contend that if an insurance guarantee is allowed, they can use that money to bid and do more work. The opportunity cost associated with a bank guarantee is too much which must be ultimately paid by the client. This results in inflated bids.

r) Location of project has been ranked among the top 10 factors by both the study groups. It is important as the contractors have to mobilize and consider other factors such as procurement of material, labor and equipment from adjoining areas.

s) Risk of fluctuation in material prices in marked 10th by medium size contractors. Medium size contractors are mostly involved in building construction. Escalation is only paid on a few materials. This makes the work a lot more risky and hence this risk is transferred to the client in shape of inflated mark-up.

6.3 Recommendations for the Industry and Further Research

The study has successfully achieved its objectives in highlighting the main factors that influence the contractor's mark-up size decision and the current state of practice of determining the mark-up size on various projects. Following recommendations are made to the academics and the industry to make the results of this research more useful,

a) The factors identified can be used to develop a bidding strategy model for the local industry that will help the contractors as a decision support tool while making important mark-up related decisions.
b) The author suggests the use of artificial neural networks (ANN) for modeling as it is better for modeling the non-linearity of the subject data.
c) The results of the study can be utilized by the clients to improve themselves in areas that are under their control (payments and project cash flow) to realize cheaper (lower mark up) and more successful projects.
d) The results can be used by consultants at the pre tender stage to forecast possible responses to ITB based on these factors.
e) The results can be used by new contractors entering into the construction industry of Pakistan to better decide on their mark-ups.
f) For the contractors already operating in Pakistan, the results can help them to submit even more competitive bids to enable winning of the tenders.

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APPENDIX-I

Factor Ranking by Respondents

Table A.1: Factors Affecting Mark-Up Size Decision of Contractors

SR#	FACTORS	OVERALL RANKING		MEDIUM		LARGE	
		Importance Index %	Rank	Importance Index %	Rank	Importance Index %	Rank
1	**Project Characteristics**		**1**		**2**		**1**
1.1	Size of Project	90.0	2	90	4	90	1
1.2	Duration of Project	75.6	11	85	11	68	19
1.3	Location of Project	85.6	4	87.5	6	84	4
1.4	Project Cash Flow	91.1	1	95	1	88	2
1.5	Degree of Difficulty / Project Complexity	84.4	5	87.5	7	82	6
1.6	Potential for Disputes	65.6	33	72.5	27	60	37
1.7	Type of equipment required	63.3	37	65	39	62	34
1.8	Strategic value of project	67.8	26	62.5	44	72	14
1.9	Past Profit in Similar Jobs	56.7	47	65	43	50	48
1.10	Degree of Safety (Terrorism/other threats)	78.9	9	87.5	9	78	9
2	**Project Documentation**		**5**		**6**		**3**
2.1	Type of Contractual Arrangement	75.6	12	80	13	72	12
2.2	Design Quality	63.3	38	67.5	36	60	38
2.3	Presence of Owners special requirements	66.7	31	70	31	64	28
2.4	Contract conditions used (Strict/Flexible)	67.8	27	67.5	35	68	21
2.5	Size of Liquidated Damages	62.2	41	60	46	64	30
2.6	Completeness of Tender documents	67.8	28	72.5	26	64	27
3	**Company Characteristics**		**3**		**4**		**4**
3.1	Current work load	60.0	44	67.5	38	54	46
3.2	Need for work	86.7	3	92.5	2	82	5
3.3	Contractor involvement in	62.2	42	65	40	60	40

SR#	FACTORS	OVERALL RANKING		MEDIUM		LARGE	
		Importance Index %	Rank	Importance Index %	Rank	Importance Index %	Rank
	design phase						
3.4	Availability of cash to carry out the work	78.9	8	92.5	3	68	18
3.5	Availability of skilled workers	70.0	23	80	16	62	32
3.6	Availability of qualified Site management staff	68.9	25	75	23	64	26
3.7	Size of Head office overhead	73.3	16	77.5	18	70	15
3.8	Availability of Reliable Subcontractors	64.4	35	72.5	28	58	41
3.9	Uncertainty in cost estimates	61.1	43	65	41	58	42
3.10	Experience in similar projects	72.2	18	72.5	25	72	13
3.11	Portion of work subcontracted	63.3	39	67.5	37	60	39
4	**Tendering Situation**		**7**		**7**		**7**
4.1	Required bond capacity	75.6	13	77.5	17	74	10
4.2	Size of Bid bond	72.2	19	75	22	70	16
4.3	Number of bidders	70.0	24	70	30	70	17
4.4	Time allowed to submit bids	55.6	48	60	48	52	47
4.5	Identity of competitors	78.9	10	67.5	34	88	3
4.6	Prequalification/Compliance requirements	57.8	46	60	47	56	45
4.7	Tendering document price	34.4	51	32.5	51	36	51
4.8	Tendering procedure	44.4	50	45	49	44	50
4.9	Time of tendering (Season)	46.7	49	42.5	50	50	49
4.10	Competitiveness of other bidders	75.6	14	72.5	24	72	11
5	**Economic Situation**		**4**		**3**		**5**

SR#	FACTORS	OVERALL RANKING		MEDIUM		LARGE	
		Importance Index %	Rank	Importance Index %	Rank	Importance Index %	Rank
5.1	Overall economy (Availability of work)	84.4	6	90	5	80	7
5.2	Availability of labor	65.6	34	70	33	62	33
5.3	Availability of equipment	63.3	40	72.5	29	56	43
5.4	Quality of available labor	60.0	45	65	42	56	44
5.5	Risk of fluctuation in material prices	74.4	15	87.5	10	64	25
5.6	Availability of other projects for tendering	67.8	29	77.5	20	60	35
5.7	Risk of fluctuation in labor prices	66.7	32	70	32	64	29
6	**Client Characteristics**		**2**		**1**		**2**
6.1	Payment record of client	82.2	7	87.5	8	78	8
6.2	Size of Client	72.2	20	80	15	66	22
6.3	Type of client (Public/Private)	73.3	17	80	14	68	20
6.4	Relationship and past experience with client	71.1	22	77.5	19	66	23
6.5	Possibility of getting future work from client	72.2	21	85	12	62	31
7	**Consultant Characteristics**		**6**		**5**		**6**
7.1	Relationship with consultant	64.4	36	62.5	45	66	24
7.2	Character of consultant (Strictness)	67.8	30	77.5	21	60	36

APPENDIX-II

Covering letter

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING(SCEE)

SURVEY QUESTIONNAIRE

To: _____

Subject: **FACTORS INFLUENCING MARK-UP SIZE DECISION OF MEDIUM AND LARGE SIZE CONTRACTORS IN PAKISTAN**

My name is Khawaja Mateen Mazher and i am a student of Masters Program (Construction Engineering & Management) at NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY (NUST) Islamabad, Pakistan. I am currently conducting a research to determine the factors that affect the contractor's markup size decision in Pakistan. The research will attempt to determine the differences in perception of large and medium sized construction contracting firms in Pakistan. Markup is the amount added over the base estimate to cover head office overhead, contingencies / uncertainties and profit.

At the time of bidding the contractor must decide the amount of markup that will help them win the job and at the same time will maximize their profit. Any difference between the amount of the winning bid and the next lowest bid is a loss of profit. There are many factors that influence the decision of the contractors on the right amount of markup. These factors can be attributed to client, consultant, project characteristics and overall economy.

The purpose of the research is to determine the **factors** that affect the markup size decision of contractors. This research also attempts to determine the methods used to judge competition in the market. There are many strategic bidding models in literature. These are based on statistics. The questionnaire attempts to determine if these are used in our local industry.

The Questionnaire is best suited to be filled by the personnel from business development / proposals and the executive management of the company. Project managers and individuals who have experience in setting markups can also provide a valid response.

Your cooperation and participation is highly anticipated.

Yours sincerely,

KHAWAJA MATEEN MAZHER
Post Graduate Student of Construction Engineering and Management
Email:khmateenmazher@gmail.com
Contact: 03345088443

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Professor and Head
Department of Construction Engineering and Management
National Institute of Transportation
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Sector H-12, NUST, Islamabad.

APPENDIX-III

Questionnaire

National University of Sciences and Technology, Islamabad

QUESTIONNAIRE-SURVEY FORM

Subject: Factors Influencing Mark-up Size Decision of Medium and Large Size Contractors in Pakistan

General Information about the Respondent& the Firm *(All the details will be kept confidential)*	
Personal Information:	
1. Name **(Optional):**	
2. Qualification **(Optional):**	
3. Title/Position in the Company:	☐ General Manager / Director / Senior Manager ☐ Project manager / Professional
4. Experience in Construction Industry (years):	1. 1-5 2. 6-10 3. 11-15 4. 16-20 5. 20+
5. Experience in setting Markup/Margin (Number of Projects):	1. 1-5 2. 6-10 3. 11-15 4. 16-20 5. 20+
Company Information:	
6. Name of the company **(Optional)**:	
7. PEC Category of the firm:	1. CA 2. CB 3. C1 4. C2 5. C3
8. Number of years since established:	1. 1-5 2. 6-10 3. 11-15 4. 16-20 5. 20+
9. Average Annual Turnover (Millions of Rs.)	_____ to _____Million Rupees
10. Average Bid Winning Frequency (Out of every 10 bids)	
11. Percentage of work obtained through competitive bidding:	☐ Under 25 % ☐ 26-50% ☐ 51-75% ☐ 76-100%
12. Percentage of Work Subcontracted	☐ Under 25 % ☐ 26-50%

	☐ 51-75% ☐ 76-100%
13. Type of Contract Usually Signed:	☐ Unit Rate ☐ Lump Sum ☐ Cost Plus
14. Type of the Projects Usually Taken:	☐ Public ☐ Private
15. Type of Projects usually Executed: (Check all that apply)	☐ Building Construction (Residential, Commercial, etc) ☐ Engineering Construction (Heavy/Infrastructure) ☐ Industrial Construction
16. Regions In which Projects have been executed by you (Check all that apply)	☐ Punjab ☐ Sindh ☐ Balochistan ☐ Khyber Pakhtoon Khwa (KPK) ☐ Azad Jamu Kashmir (AJK)
17. Difference Between Your bid and the next lowest Bid on projects **WON** by your company. (Please provide this information for at most last two projects)	Type of Project: (Building / Infrastructure/Industrial) – Check one that applies. Difference between your bid and the next lowest bid: _____ Rs Type of Project : (Building / Infrastructure/Industrial) – Check one that applies Difference between your bid and the next lowest bid: _____ Rs

Part B: Current Practices In Contractor's Markup Size Decision

18. What are the components of your markup/margin? Check all that apply.

- ☐ Overhead Cost (General/Home Office Overhead)
- ☐ Contingencies Cost (Risk Allocation)
- ☐ Profit

19. What kind of information from past bid/tender openings is recorded? Check all that apply.

- ☐ Number of contractors who participate in bidding
- ☐ Name of each contractor
- ☐ Bid price submitted by each contractor
- ☐ Own bid price along with cost estimate
- ☐ None of the above

20. Is any computer software used to assess the bidding situation?

- ☐ Yes
- ☐ No

21. Does your company employ any bidding model(s) (Quantitative/Qualitative) to help decide on mark-up size?

- ☐ Yes
- ☐ No

22. If the answer is YES than, which of the following models are used, check all that apply:

Friedman Model	☐
Gates Model	☐
OPBID	☐
LOMARK (Low Markup Model)	☐
DBID	☐
Carr's Bidding Model	☐
Optimum Bid Approximation Model	☐
Bids Considering Multiple Criteria	☐
Winning Over Key Competitors	☐
Sequential Competitive Bidding	☐
Average Bid Method Bidding Model	☐

Self Explanatory Artificial Neural Networks	□
Custom Made In-house Statistical Model(s)	□

23. How your company Determine the Mark-Up/Margin Size?

Statements *Please encircle one box for each factor below to indicate your level of agreement*	**Strongly Disagree**	**Disagree**	**Somewhat Agree**	**Agree**	**Strongly Agree**
Experience	1	2	3	4	5
Market Survey	1	2	3	4	5
Judgment	1	2	3	4	5
Documented Past Records of Biddings	1	2	3	4	5
Others (Please Specify): _____	1	2	3	4	5

24. What do you think is the reason for lack of use of bidding model in assisting the contractors in mark-up size decision?

Statements *Please encircle one box for each factor below to indicate your level of agreement*	**Strongly Disagree**	**Disagree**	**Somewhat Agree**	**Agree**	**Strongly Agree**
No knowledge about the bidding models / Unawareness	1	2	3	4	5
Complexity of bidding models	1	2	3	4	5
Inefficiency of the bidding models	1	2	3	4	5
Others (Please Specify): _____	1	2	3	4	5

Part C: Factors Affecting Contractors Mark-up Size Decision

	Statements *Please encircle one box for each factor below to indicate your level of agreement*	**Un important**	**Less Important**	**Moderate**	**Important**	**Very Important**
Project Characteristics						
01	Size of Project	1	2	3	4	5
02	Duration of Project	1	2	3	4	5
03	Location of Project	1	2	3	4	5
04	Project Cash Flow	1	2	3	4	5
06	Degree of Difficulty / Project Complexity	1	2	3	4	5
07	Potential for Disputes	1	2	3	4	5
08	Type of equipment required	1	2	3	4	5
09	Strategic Value of Project	1	2	3	4	5
10	Past Profit in Similar Jobs	1	2	3	4	5
11	Degree of Safety	1	2	3	4	5
Project Documentation						
01	Type of Contractual Arrangement / work procurement method	1	2	3	4	5
02	Design Quality	1	2	3	4	5
03	Presence of Owners special requirements	1	2	3	4	5
04	Type of contract conditions used	1	2	3	4	5
05	Size of Liquidated Damages	1	2	3	4	5
06	Completeness of Tender documents	1	2	3	4	5
Company Characteristics						
01	Current work load	1	2	3	4	5
02	Need for work	1	2	3	4	5
03	Contractor involvement in design phase	1	2	3	4	5
04	Availability of cash to carry out the work	1	2	3	4	5
05	Availability of skilled workers	1	2	3	4	5
06	Availability of qualified Site management staff	1	2	3	4	5
07	Size of Head office overhead	1	2	3	4	5
08	Availability of reliable subcontractors	1	2	3	4	5
09	Uncertainty in cost estimates	1	2	3	4	5
10	Experience in similar projects	1	2	3	4	5
11	Portion of work subcontracted	1	2	3	4	5
Tendering Situation						
01	Required bond capacity	1	2	3	4	5
02	Size of Bid bond	1	2	3	4	5

Statements *Please encircle one box for each factor below to indicate your level of agreement*		**Un important**	**Less Important**	**Moderate**	**Important**	**Very Important**
03	Number of bidders	1	2	3	4	5
04	Time allowed to submit bids	1	2	3	4	5
05	Identity of competitors	1	2	3	4	5
06	Prequalification requirements	1	2	3	4	5
07	Tendering document price	1	2	3	4	5
08	Tendering procedure	1	2	3	4	5
09	Time of tendering (Season)	1	2	3	4	5
10	Competitiveness of other bidders	1	2	3	4	5
Economic Situation						
01	Overall economy (Availability of work)	1	2	3	4	5
02	Availability of labor	1	2	3	4	5
03	Availability of equipment	1	2	3	4	5
04	Quality of available labor	1	2	3	4	5
05	Risk of fluctuation in material prices	1	2	3	4	5
06	Availability of other projects for tendering	1	2	3	4	5
07	Risk of fluctuation in labor prices	1	2	3	4	5
Client Characteristics						
01	Payment record of client	1	2	3	4	5
02	Size of Client	1	2	3	4	5
03	Type of client (Public/Private)	1	2	3	4	5
04	Relationship and past experience with client	1	2	3	4	5
05	Possibility of getting future work from client	1	2	3	4	5
Consultant Characteristics						
01	Relationship with consultant	1	2	3	4	5
02	Character of consultant (Strictness)	1	2	3	4	5