An Evaluation of Pakistan Engineering Council's (PEC) Price Adjustment Formula for Highway Construction Projects

A thesis submitted in partial fulfillment of

the requirements for the degree of

Master of Science

in

Construction Engineering and Management

Submitted By

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To Almighty Allah and

My beloved Parents

Muhammad Badar-ud-din Jahangir & Shamas Shaheen

ACKNOWLEDGEMENTS

For I must be kindheartedly thankful to Allah Almighty who bestowed me with a considerable opportunity to pursue my Master's degree and to undertake this research.

Next, I wish to extend my gratefulness and acknowledgment to Dr. Anwaar Ahmed who served as an advisor to this research. The development of this thesis is derivative of his inspiration, categorical advice, and undeniable academic and personal guidance. Thus, I express his advising services quintessential to the completion of this work. It would be unjust not to thank him for making me aware of my strengths and weaknesses and to expose my inert understandings to light during my stay at NIT, NUST.

I also take this opportunity to praise my committee members Dr. Muhammad Bilal Khurshid, Dr. Hamza Farooq Gabriel, and Dr. Jamaludin Thaheem for their valuable comments and advice through the course of this research.

I would also like to pay regards to my friends and colleagues who made the learning experience quite amazing during my stay at NUST: Sana Rafiq, Arooj Fatima and Muhammad Arslan Adil Chaudhary. Their contribution in this regard is highly appreciated.

Most Importantly, I would like to thank my parents and siblings Rabia Badar and Maryam Badar for their incredible personal, financial, and academic support. I owe a lot to my parents who brought and disciplined me into a responsible citizen. Throughout my educational career till date, their involvement, concern, forbearing, and understanding has been the prime support for me. Perhaps, my particular thanks to them would be too numerous to mention for all what they provided me with. Also, the support and motivation of Engineer Tabjeel Ashraf is highly acknowledged.

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LIST OF ACRONYMS

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
RII	Relative Importance Index
CI	Construction Industry
FBS	Federal Bureau of Statistics
CPI	Consumer Price Index
FIDIC	Federation Internationale des Ingenieurs Conseils (French)
POL	Petroleum, Oils and Lubricants
HSD	High Speed Diesel
PMI	Project Management Institute
IPC	Interim Payment Certificate
EPC	Escalation Payment Certificate
CEM	Price Escalation Model
PICC	Pakistan Institute of Price and Contracts

ABSTRACT

The construction and maintenance of our national highway infrastructure consumes significant quantities of materials that include asphalt concrete, Portland cement concrete, steel, and the fuel required for such activities. The price of major construction materials fluctuates during the period of a construction contract and price escalations frequently counterbalance the planned benefits of infrastructure projects to the community. Present research effort mainly focused on the prevalent price adjustment practices in construction industry of Pakistan. For this purpose Pakistan Engineers Council's (PEC) price adjustment formula, being used for contract price adjustment by highway construction industry in Pakistan has been studied. Also an effort has been made to compare PEC price adjustment formula with other similar practices and its implications in construction contracts and suitable measures to improve the formula. The interviews with professionals revealed that major components of PEC price adjustment formula that need revision are: minim elapsed period for escalation, minimum percentage for item weightage, weightage of fixed and adjustable portion of PEC formula, temporary works and sources of material prices. Price escalation factors were identified through comprehensive literature review and were validated through knowledge elicitation technique. Results indicated that price escalation was mainly responsible for project delays, low quality and price overburdens. Also, it was revealed that POL and steel are the items that are most susceptible to price fluctuation. Present study also developed a price escalation model for highway projects, in order to forecast escalation factors for different construction items such as cement, steel, bitumen and unskilled labour. Model has the capability to predict the project cost along with major price escalation factors. Model developed in present study can be used by highway industry in Pakistan for contract price adjustment resulting from fluctuation in prices of construction material and unskilled labour.

CHAPTER 1. INTRODUCTION

1.1 Background

Construction activities are considered as the back bone of economic and social growth of any country. Pakistan being a developing country is highly dependent upon infrastructural development for its economic growth in shape of implementation of major highway projects like motorways. Accurate estimation of effort, time and resources for successful completion of a project is a challenging task for project managers. In current economic environment price overrun has emerged as one of the major problems for the construction industry of Pakistan. Recent trends have revealed that the completion prices of most of the highway projects are unrealistically much higher than the original contract price.

Generally vast development projects have been tormented by cost and time overruns (Fly vbjerg et al. 2002). In an excess of cases, the final project cost has been higher than the value estimates prepared and released during initial planning, preliminary engineering, final design, or even at the start of construction. In most long-term projects, the owners/ clients/ employers account for escalation due to several reasons like general inflation, global market forces, skilled labour shortage, increased demand, material supply, natural disasters and Safety, code, or project certification requirements during estimation (Insurance, 2014).

As free market dynamics are not in control of any specific group of the society, the risk related to market rates is usually owned by the employer, fully or partially, to safeguard the contractor against unprecedented loss in business and to protect the interests of the project which usually faces major setback if such mechanism is not adopted.

The implications of contrasts between ahead of schedule task cost estimates and offer costs or the last cost of an undertaking can be huge. Over the time range between task start idea advancement and the fruition of development numerous elements might impact the last venture costs. Ventures can be conveyed on spending plan yet that requires a decent beginning gauge, an attention to elements that can bring about value heightening, and extend administration discipline (Shane S. J., 2009). On a basic level, development work is performed by pre-affirmed contract sum and contract understanding under a single amount contract. There might be a few changes in monetary conditions, for example, sharp variance of costs and on its premise development contracts are endorsed over the timeframe (Choi M., 2006).

Price acceleration is brought on by numerous components, for example, swelling, economic situations, and danger allotment conditions in the agreement, loan cost, and charges (Hanna and Blair, 1993). It represent a considerable piece of development cost, particularly in lengthy projects where the unpredictability and vulnerability is more important.

In the later past, a critical value instability of development materials and supplies, for example, black-top, fuel, concrete and steel has been watched. Under these circumstances it is truly a testing undertaking for temporary workers to plan sensible offers, in this manner making vulnerability for every one of the gatherings included in a development venture. As a rule, planned bidders can't acquire firm value cites from material suppliers for the length of time of the venture. To overcome the effect of price fluctuations, certain contract clauses have been devised by Pakistan Engineering Council (PEC). The main purpose of the price adjustment clauses is to allow the contractors and clients to revel in the benefit of price changes while the project is in construction phase. The purpose of price adjustment mechanism is to make needed price adjustments so that contractor is compensated for the escalated price. In reality this arrangement is being misused due to certain technical issues with current price adjustment formula.

1.2. Problem Statement

The construction and maintenance of our national highway infrastructure consumes significant quantities of materials that include asphalt concrete, Portland cement concrete, steel, and the fuel required for such activities. The price of these materials fluctuates during the period of a construction contract. Sometimes the price changes are volatile. In the past decade, petroleum products (e.g. liquid asphalt binder and fuel) and reinforcing steel experienced considerable swings in price over relatively short periods of time.

In such an uncontrolled monetary environment, instruments that reduce the money related danger to temporary workers and state organizations are critical. The most well-known component that has been embraced at most state offices is the usage of price adjustment clauses (PEC, 2009; Shane, 2009). Some agencies refer to these provisions as price escalation clauses. In Pakistan there has been no research effort in past related to contract price adjustment, however extensive research has been carried out at international level. Thus current situation demands development of an improved framework that can assist in dealing with price escalation formula in an equitable way.

1.3. Research Objectives

Price invades in large infrastructure projects have been very common in the past decades. Planning for price escalation for different scenarios is an important step in successful execution of any project. In order to address this key issue and other associated factors, the objective set forth for present research are:-

1. To critically analyze PEC's price adjustment formula.
2. To check efficiency of prevalent price adjustment mechanism through case study.
3. To highlight the draw backs of price adjustment formula and suggest improvements.
4. To formulate a frame work for price escalation factor prediction.

1.4. Overview of Research

To accomplish the research objectives, a detailed methodology was devised and the following research tasks were outlined:-

- Detailed literature review for the identification of critical factors which leads to project price escalation.
- Critical study of PEC's price adjustment formula in construction contracts and its application during bid evaluation process.
- Selection of typical road project.
- Development of indices for each item in project model.
- Development of 'Project Price Escalation Model' using Microsoft.
- Demonstration of proposed Framework through case study.

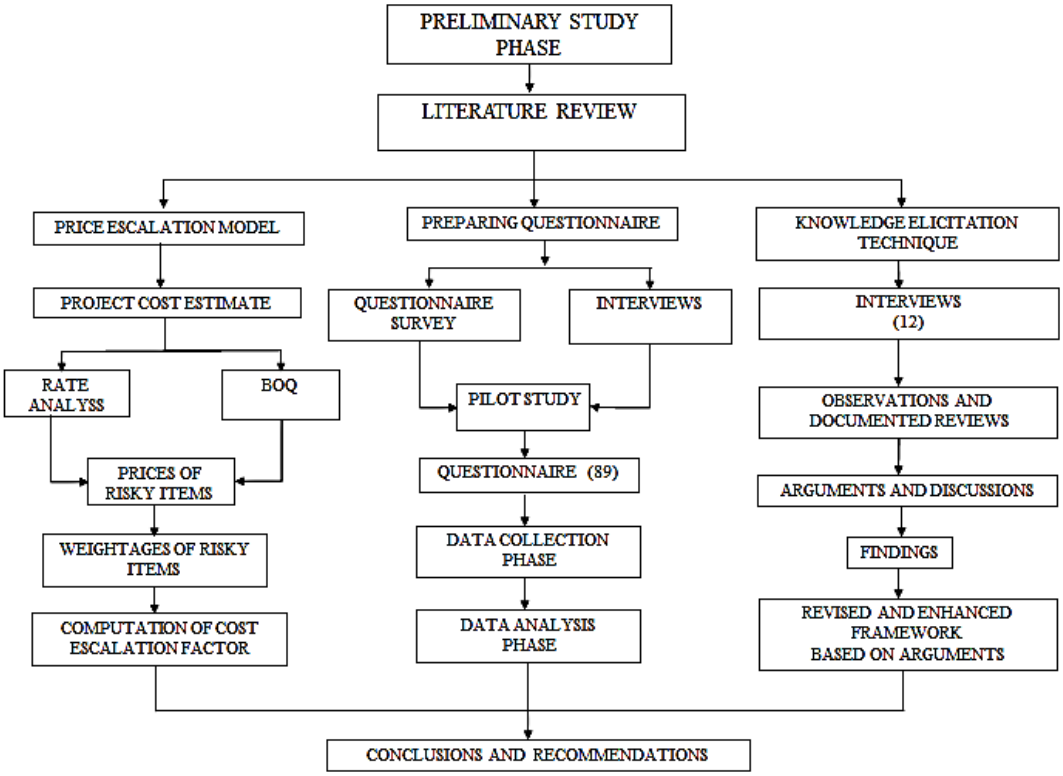


Figure 1 Demonstration of Framework

CHAPTER 2. LITERATURE REVIEW

2.1. Introduction

This chapter summarizes following topics project price estimation techniques, price contingency techniques, importance of sensitivity analysis, difference between traditional approach and analytical approach for project price contingency, simulations, concept of time line series and labour/ machine efficiencies. This chapter first examines the project price estimation techniques and contingency techniques. Bottom-up technique and traditional contingency approach are the most commonly used but developed countries are adopting advanced techniques and software for project price estimation and contingencies.

2.2. Price Fluctuation

Price fluctuation is generally defined as the rise or fall of price of goods, materials and services. A survey of the construction Industry (CI) showed that the building materials and labour component comprise 85% of construction prices (FBS, 2003).These two major components are highly sensitive against the price changes and slight changes in the prices of materials and labour effect the construction contracts considerably. Fluctuation in prices can occur in any market, i.e. in international markets, local market and/or in the labour rates which can affect a construction project severely. There can be many reasons for fluctuation in prices, the major ones in the Pakistani scenario being inflation, Increase in Petroleum, Oils and Lubricants (POL) prices, improper supply-chain-management, increase or decrease in demand of a certain item and overall economic and security conditions of the country (FBS, 2003; Insurance.n.d, 2014). Economists considers that major contributor towards price escalation is inflation (Merewitz, 1973; Merrow, 1988; Mansfield et al., 1994; Datta, 2002; NAP, 2002).

2.3. Inflation and Construction Industry

Inflation is a very important phenomenon especially in the framework of the construction industry, because the purchasing power of money rarely stays constant in most world economies. Over time the amount of materials and services that can be purchased with a fixed amount of money changes. Inflation causes the currency to lose the purchasing power. That is, with the inflation in prices we can purchase less with the same amount of money. Inflation makes future currency less valuable than present value (Newnon, Lavelle and

Eschenbach, 2002). A generalized relationship of factors in the construction trading and the national economy of a country is shown in Figure 2.

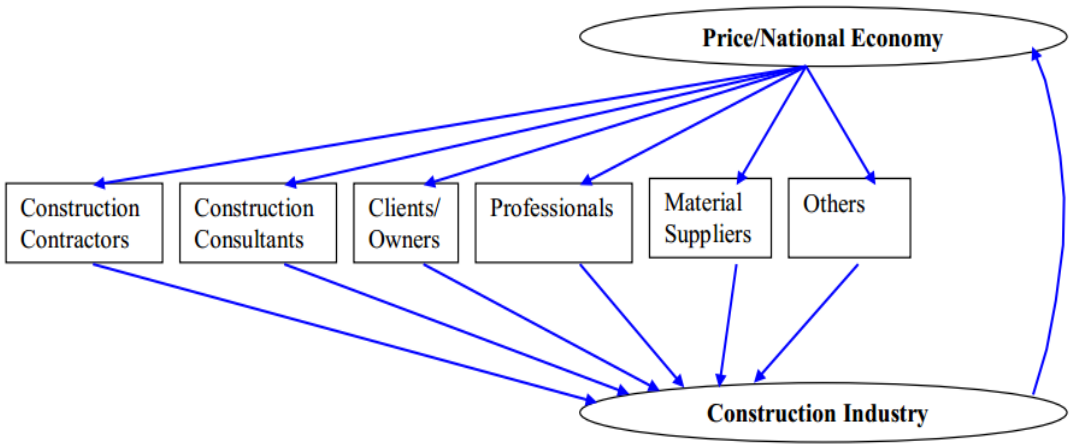


Figure 2 Relationship of factors of the Construction Industry and National Economy

Higher inflation rate is always correlated with increased price variation, which can lead to uncertainty about the future profitability of investment projects. It will, ultimately, lead to the reduced investment and economic growth. Moreover, inflation can interact with the tax system of the country to disturb borrowing and lending decisions. Firms may have to allocate more resources to dealing with the effects of inflation (Ayyoub,2011). Single digit inflation rate is always preferred for the better growth. Figure 3 shows the comparison of inflation rates for different countries for the period of 1961 to 2012.

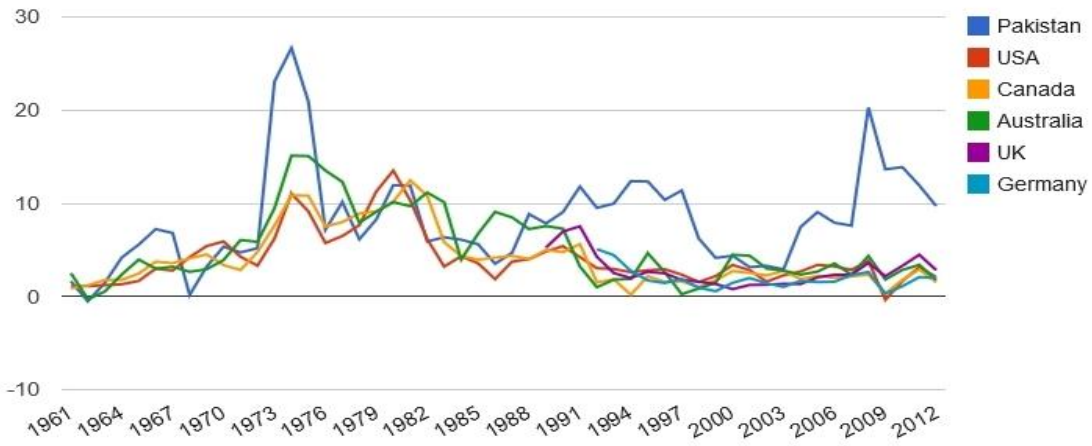


Figure 3 World Bank Comparison of inflation rates (1961 to 2012)

2.4 Inflation

Economists do not agree on all of the sources of inflation, but generally agree that the following factors influence the inflation, either in isolation or in combination.

Money Supply

The amount of money in our national economy is thought to have an effect on its purchasing power. If there is too much money in the system versus goods and services to purchase with that money, it tends to decrease the value of money. When there are fewer money in the system, they become more valuable. The Federal Reserve, through its influence on the money supply, seeks to increase the volume of money in the system at the same rate that the economy is growing (Newnon, Lavelle and Eschenbach, 2002).

Exchange Rates

Price rates may be adjusted to compensate for the relative strength or weakness of the money in the world market. As corporations' profits are weakened or eliminated in some markets due to exchange rates, prices may be raised in other markets to compensate (Newnon, Lavelle and Eschenbach, 2002).

Price-Push Inflation

It is the supply side inflation, in which producers of goods and services "push" their increasing operating prices along to the customer through higher prices. These operating prices include fabrication/manufacturing, marketing, and sales, among others (Newnon, Lavelle and Eschenbach, 2002).

Demand-Pull Inflation

This is demand side inflation, when customers spend freely on goods and services. Often "free spending" is at the expense of customer saving (Newnon, Lavelle and Eschenbach, 2002). As more and more people demand certain goods and services, the prices of those goods and services will rise (demand exceeding supply).

2.5 Previous Studies on Price Escalation in Construction Projects

Cost acceleration factors have been recorded in an extensive number of studies and coordinated to changes in cost of projects. Each factor presents a challenge to any organisation seeking to produce accurate project price estimates (Schexnayder et al. 2007).

This is a direct concept that the difference between "nominal" and "real" price escalation can lead to misperception. Nominal prices are the amounts without regard to time, whereas real prices are constant amounts. Thus, nominal price escalation includes inflation while real price escalation does not (Leavitt et al., 1993).

Datta (2002) in the India Infrastructure Report portrayed value heightening as a widespread issue in government projects. Schexnayder et al. (2003) and Merewitz (1973) endeavored to discover a percentage of the reasons that prompt value heightening and sorted them into two general gatherings: wild and controllable elements.

Different studies (Frimpong et al., 2003, Schexnayder et al., 2003; NAP, 2002; Datta, 2002; Mansfield et al., 1994; Merrow, 1988; and Merewitz, 1973) recognized value acceleration to be an aftereffect of issues, for example, poor contract administration, poor specialized exhibitions, delay in area procurement, startling issues in supply of crude materials, unlawful infringement ashore notwithstanding amid project usage, or because of inner issues in government associations.

Components that prompt value acceleration are said to incorporate among others: the extent of the task; project scope augmentation; swelling; time allotment to finish the undertaking; fragmentation of preparatory building and amount studies; designing vulnerabilities; exogenous postponements; complexities of managerial structures; and naiveté of regulatory work force (Merewitz, 1973). Value acceleration is further aggravated by variables, for example, project area, project conditions, ecological relief costs, suspension of works, strikes, poor coordination on location, expiry of offer, neighborhood government weights, political brokenness and transportation issues (Schexnayder et al., 2003 and NAP, 2002).

2.6 Summary of Factors that Lead to Price Escalation

Previous studies reveals that price escalation can be caused by:

Poor contract administration, poor specialized execution, land securing challenges; harsh climate (substantial rains and surges); changes or hazy administrative prerequisites; multifaceted nature of managerial structures; disturbance of administration progression; interruption of political congruity; building vulnerabilities; ecological insurance and moderation costs; unlawful infringement on undertaking destinations; unpractised authoritative staff; swelling; inadequate starting investigation of costs; absence of coordination on location;

absence of hierarchical limit or abilities; nearby government weights; new innovation necessities; project conditions; project area; wellbeing and wellbeing regulation; plan invades; scope changes; size of task; strikes; suspension of works; specialized difficulties; change of group desire; unexpected constructability issues; and unanticipated designing complexities.

2.7 Comparison of the Price Escalation Provisions in Major Countries and FIDIC

Table 1 Comparison of the Price Escalation Provisions

	Korea	Japan	FIDIC	The United States
Necessary conditions for price escalation	In case the adjustment rate for an index (or the categories of articles) increase or decrease by 3% or more	In case the fluctuation rate increases or decreases by 1.5% or more	The adjustment by basic prices or base index figure	Forecasting price change in advance and including it in cost estimates
Starting date of price change and minimum waiting period for escalation	90 days since the signing date of a contract	1 year since the signing date of a contract	28 days prior to bidding rate	-
Scope of adjustment by escalation	Adjust a entire contract amount reflected a price change	Adjust only the contract amount over 1.5% of fluctuation rate (contractor bears the loss up to 1.5%)	The difference in cost between the basic price (index) and the current price (index)	Increased cost due to delay arising from project owner's faults
Escalation for specified materials due to a sudden economic crisis	Possible as exceptional case	Possible (compensate for ¾ of losses)	Possible	Impossible in principle
Overheads and profits in escalation	Included	-	Excluded	-

(Choi. et al. 2006)

2.8 Factor Effecting Price Escalation

Factors that leads to price acceleration are said to incorporate following (Merewitz, 1973);

- length of time to complete the project;
- the size of the project;
- project scope change;
- inflation;
- uncertainties;
- delays;
- And administrative personnel expertise.

Other compounded factors are project site, project conditions, environmental mitigation, suspension of works due to strikes, poor coordination on site, bid expiry, local and political government pressures, and transportation problems (NAP, 2002 and Schexnayder et al., 2003).

Managing capital construction projects requires the coordination of a multitude of human, organizational, technical, and natural resources. Quite often, the engineering and construction

complexities of such projects are overshadowed by economic, societal, and political challenges (Shane et.al., 2009). Identifying the factors and causes of price overruns is a key step towards helping construction managers to either prevent a price overrun or apply the proper corrective actions to the problem. Majid (1998) claimed that there must be a systematic approach used by construction managers for identifying these factors in order to reduce their impacts.

The factors that affect the estimate in each project development phase are by nature internal and external. Factors that contribute to price escalation and are controllable by the agency/owner are internal, while factors existing outside the direct control of the agency/owner are classified as external (Shane et.al., 2009). As give in table.

Table 2 Construction Price Escalation Factors

External Factors	Internal Factors
• Local concerns and requirements • Effects of inflation • Scope changes • Scope creep • Market conditions • Unforeseen events • Unforeseen conditions	• Bias • Delivery/procurement approach • Project schedule changes • Engineering and construction complexities • Scope changes • Scope creep • Poor estimating • Inconsistent application of contingencies • Faulty execution • Ambiguous contract provisions • Contract document conflicts

Studies (Merewitz 1973, Merrow 1981, Merrow 1988, Mansfield 1994, Datta 2002, Schexnayder 2003, NAP 2003) identified price escalation to be a result of problems such as delay in land acquisition, unexpected problems in supply of raw materials, illegal encroachment on land even during project implementation, or due to internal problems in government organizations. It has further been noted that delays between the planning stage and actual implementation of especially large infrastructure projects is an ubiquitous problem resulting in price escalation and failure to meet the demands as the construction completion horizon is reached even before the completion of the project. Price Escalation and Its effects on Different projects in Zambia mentioned below (Projects progress report 2002, Projects progress report 2005);

2.9 Effects Of Price Fluctuation

The market price hike of construction materials and labor are a big hindrance towards the growth of the CI. The lack of availability and affordability, both in quantity and quality can lead the stakeholders of the construction projects into failure to complete their projects within acceptable limits of quality and time. In the absence of any compensation strategy, the major effects of price fluctuation can be (Abdo Abatemam 2006):

a. Delays or cancellation of projects
b. Reduced numbers of bidders
c. Poor quality
d. Loss in profits
e. Problems of the cash flow
f. Loss of interest of stakeholders in the project

2.10 How to Deal With Price Escalation

Much can happen to the economy and to the prices in general in the time it takes a project from start to become fruitful to its users. Under such circumstances the winning bidder who has overlooked likely-hood of price increase will not show much of the profit in his work. There will be continuous arguing, claim and perhaps even litigation before accounts are settled to say nothing of delays, careless work and other evidences to save last penny in contractor's prices. It is for this reason most contracts entered into for more than one year longer duration to carry escalation/price adjustment clause. An escalation clause can be defined as "An escalation clause is a clause in a contract that guarantees a change in the contract price once a particular factor beyond the control of either party results in an increase or decrease in the Contractor's prices" (Kinlan D. and Roukema D, 2011). A price escalation clause allows the parties to have an opportunity to plan for the uncertainty and allocate how, who and to what extent the additional prices will be absorbed. Thus future increase in prices for major price items is thus made employer's risk whereas the owner not only to get the benefit of saving themselves from getting a "reluctant to perform contractor" under the circumstances, but also get competitive and more reliable bid. In the absence of an adjustment clause the bidders will estimate and bid possible future price increases differently which may result in unrealistic prices. Moreover, it will make sure to estimate the future price increases being estimated not too high, which would otherwise result in higher bids.

2.11 Types of Escalation Clauses

Keeping in view the consistent and unpredictable trend of fluctuation in the prices of construction materials and labour, price adjustment clauses are being the part of the construction contracts to absorb the volatility of prices at the outset of a project and allow a certain degree of flexibility. These clauses must be tailored with care and should be thoughtfully drafted, specifically identifying the various building materials most at risk for price variation. This procedure also should recognize the price guide to be used to measure changes in price, and it should describe how often a price adjustment clause may be used during the project.

Three options can determine what triggers a price clause adjustment and when (Barthet P.C. and Wasserstein D., 2010):

2.11.1 Invoice method

In this system, the contractual worker gives documentation as receipt, buy bill or accreditation from its supplier to affirm the adjustments in the cost of any bought material. It must mirror the adjustment in the material cost from the season of marking the agreement to the time when genuine buy was made. On the premise of this archive, the temporary worker is paid the distinction between the rates of the material on the two dates. This was not well known due to inflow of various data of expanded/diminished rates from both sides.

2.11.2 Index method

While applying the record strategy, the expansion in the agreement cost is altered to a value list guide for a specific item and archived accordingly. This system permits the agreement to conform the list cost to local and nearby changes and conditions for real things, for example, steel, diesel fuel, concrete and black-top. The Index Method can frequently be a decent decision when a supplier is not ready to give an altered value offer until the real buy is made. The customer has the point of interest as the rates are observed by a free body.

2.11.3 Hybrid Method

Combining the invoice and the index methods, this method is centred on a “certified bid price” in which the contractor certifies its estimate of a specific material’s price based on its current supplier price or an index price listing. Should this certified bid price change by more than a pre-set percentage—such as 5 percent or 10 percent, positively or negatively—the contract would be adjusted accordingly.

2.12 Price Adjustment Formula

For the most part development undertakings, private or open, are completed over an entirely protracted range of time that might extend from a while to quite a while. Keeping in perspective the unstable way of costs of development materials and work, there is dependably a solid probability that the cost of work and materials will rise and fall intermittently in a capricious way, to a more noteworthy or lesser degree, amid the life of the task. Diverse gatherings included in the task attempt to manage this danger as far as moderation, consolidation or exchange contingent upon their demeanor towards the danger and their capacity to oversee it. In this manner there ought to be procurement for value variance for development contract and legitimate, exact and rapid system to recoup the genuine change which ought to be worthy to the all partners of the undertaking, and it ought not give any sort of undue support to any gathering.

To manage the expansion or diminishing in the costs of materials, work and administrations in development gets, the value alterations are polished universally. Development specialists, in this manner, thought it important to process the cost of agreements on present value, keeping adaptability at the procurement of Cost Adjustment for likely variances amid the cash of the project. The International Federation of Consulting Engineers (FIDIC) 1999 has acquainted a recipe with figure real piece of value climb acceleration hazard. The motivation behind bringing the recipe is to propose a uniform and reasonable system for managing the antagonistic impacts coming about because of the value variances, which ought to be worthy to all gatherings in all sort of circumstances. It is not to the greatest advantage of the proprietor to request that temporary workers cite firm costs with no procurement of value modification, particularly if there should be an occurrence of long haul contracts. In contract records having procurements for value changes, the customer is relied upon to get more aggressive offers from respectable gatherings and will need to meet the net varieties in cost as might really happen.

In Pakistan, Finance Division has given the rules and recipe for ascertaining value change through Office Memorandums, Pakistan open works office intermittently arranged charts for heightening for run of the mill Civil, Mechanical and Electrical projects for remuneration to the temporary workers (PEC, 2009).

CHAPTER 3. PRICE ESCALATION SYSTEM IN CONSTRUCTION INDUSTRY OF PAKISTAN

3.1 Introduction and Background

Construction project cost are high due to late completion times. (Choi. et al. 2006;Pickrell 1990, Flyvbjerg et al. 2003, Touran, Asce, & Lopez 2006, Kaliba 2010) Also, such construction projects are performed according to a pre confirmed contract amount and contract agreement in principle. Therefore, there is a strong probability that the price of labor and materials will rise and fall periodically, to a greater or lesser extent, during the life of the project. The amount included in any construction price estimate or construction price breakdown to account for escalation in construction prices is an important component of total Construction prices.

For this purposed one term need clarification i.e. Escalation. Websters dictionary defines the term escalate as "to gradually increase to raise and go up"

“Escalation in construction prices is the increase in the prices of any construction elements required for original contract works occurring during construction.”(Blair, Lye, & Campbell, 1993)

“Price escalation refers to the increase in the amount of money required to construct a road project over and above the original budgeted amount.” (Kaliba, Muya, & Mumba, 2009)

This chapter discusses the price escalation provision and common practices of price adjustment in CI of Pakistan through a case study approach on real time project. This study will investigate perceptions of price adjustment in CI of Pakistan, as well as implications of the said formula. Furthermore knowledge elicitation technique have also been provided to improve the price escalation system in a construction industry.

3.2 Study Framework

The methodology is divided into two stages. First stage consists of a pilot study which focuses on scope and usage of price adjustment formula in CI of Pakistan. Then framework moves towards case study research methodology through knowledge elicitation techniques. The case study is defined as “a research methodology based on interviews”. The justification for use of this methodology to investigate contemporary phenomena in different areas,

including, psychology, sociology, political science, history, anthropology, economics, management, has been recognized by many researchers (Eisenhardt, 1989; Perry, 1998; Dubois and Gadde, 2002; Halinen, and Tornroos, 2005). The case study research is concerned with describing real world phenomena rather than developing normative decision models. The case study approach is a highly appropriate method for investigating the dynamics of PEC price adjustment formula evolving in construction business.

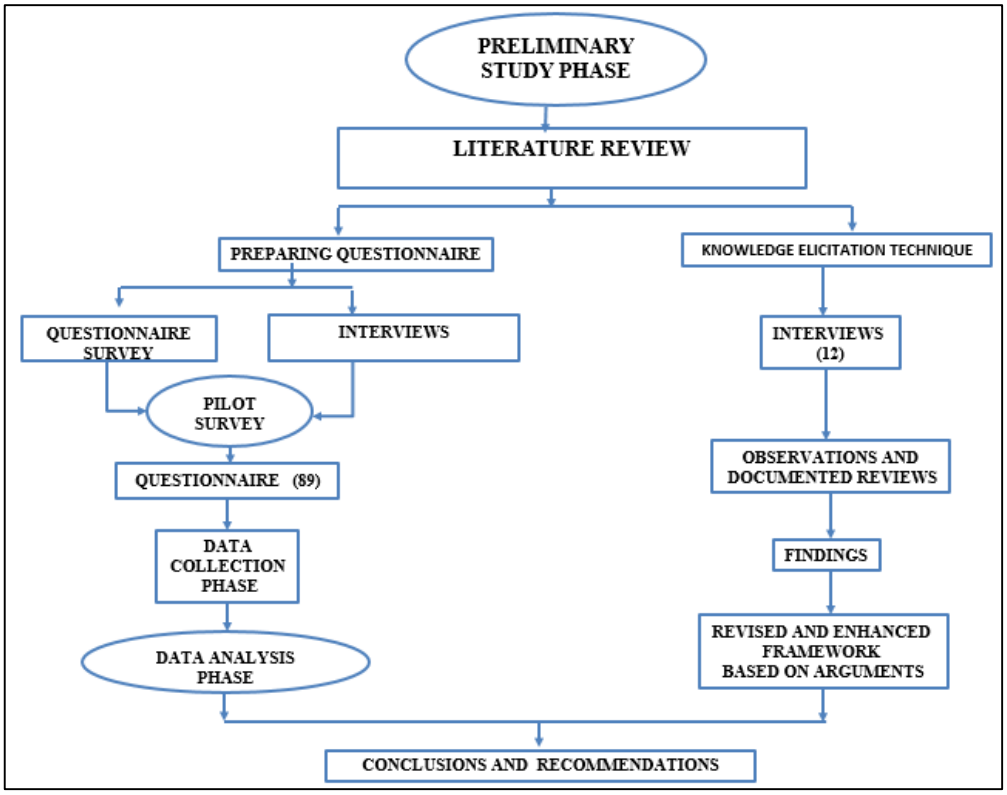


Figure 4 Frame work

3.3 Data Collection and Collation

The price fluctuation of construction materials in Pakistan has become very much unpredictable. Most of the contractors in CI, especially local contractors, are facing strong challenges during bid process due to the high uncertainty of predicting process of certain materials. The challenge gets even more severe not only as a result of the ever changing prices of materials but also the weak practices of price adjustment in CI of Pakistan. Having said that the research problem has been addressed that first we need to get an idea about the perception of price adjustment practices in CI. So, in order to understand the opinion of the stakeholders, a pilot survey was conducted through knowledge elicitation techniques (face to face meetings) with the professionals. The interview questionnaire consists of two parts, first part covers the pilot study which consists of 8 questions and covers common practices of price adjustment

clauses, familiarity with the formula, factors effecting escalation, vulnerable materials to price escalation, comparison of price adjustment formula with other price escalation techniques. Second part is the main body of the survey. It consists of joining experts on construction contracts and deducing the results that enable to formulate an approach to the escalation system in construction contracts. The first round of questions was done and certain arguing and discussion points were deduced from it and they were discussed and opinions were gathered to get a final decision.

The main purposes of interviews were to:

- To investigate the common practice of price adjustment
- To gain preliminary knowledge on general issues related to price adjustment practices
- To provide basis for developing and enhanced framework for price adjustment

3.4 Results and Discussions

3.4.1 Common Practices of Price Escalation Process

First question was designed to know that how many stakeholders are there in the field having proper knowledge of price escalation. The results are Figure 5. The results show only 41% of the respondents is often/always familiar with the escalation/de-escalation and the remaining 59% do not have frequent exposure to the escalation/de-escalation process.

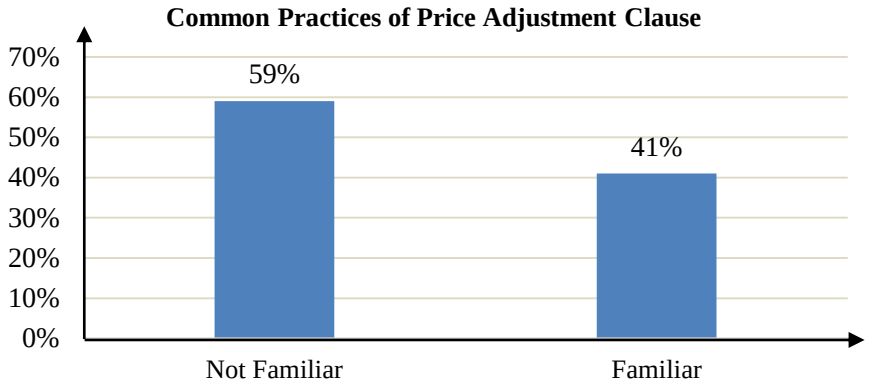


Figure 5 Common Practices of Price Adjustment Clause

3.4.2 Causes for Price Escalation in Construction Projects

The price escalation factors that lead to project price growth have been documented through a large number of studies (Anderson et al. 2006, Paper 1998, Shane et al. 2009, Knight & Fayek 2000). The literature review included exploration of research reports and publications, government reports, news articles, and other published sources. From the study some factors

were identified which were external and internal to organization and question was asked from experts that in their opinion which is the most critical factors effecting price escalation.

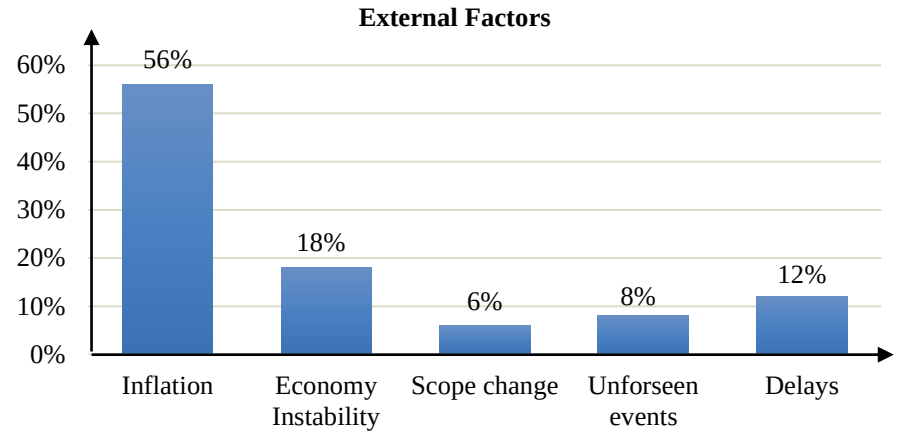


Figure 6 External Factors for Price Escalation

The result is presented in Figure 6 which reflects that under external factors Inflation is the major factor for the price escalation in construction projects in Pakistan and Economic instability is the second largest reason for the contract price escalations. And Figure 7 is showing that poor estimation is one of the major factors under internal factors.

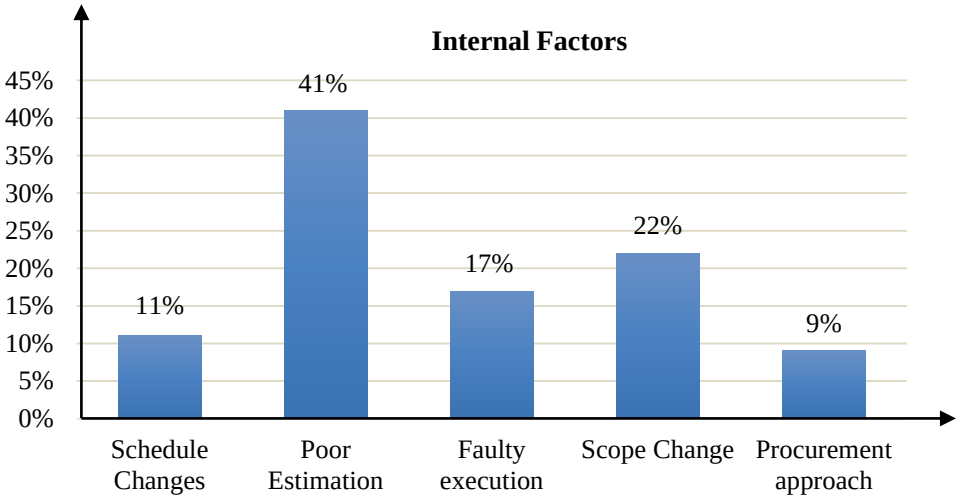


Figure 7 Internal Factors for Price Escalation

3.4.3 Price Escalation Impact

To see the impact of fluctuation in prices on a construction project, a list was given to professionals to choose most critical impacts. Figure 8 shows majority of the professionals feels that the price escalation can cause the problems of price overburden is most of the

construction projects especially in highways, which will directly affect cash flows of construction project besides causing the loss in profit, delays and poor quality.

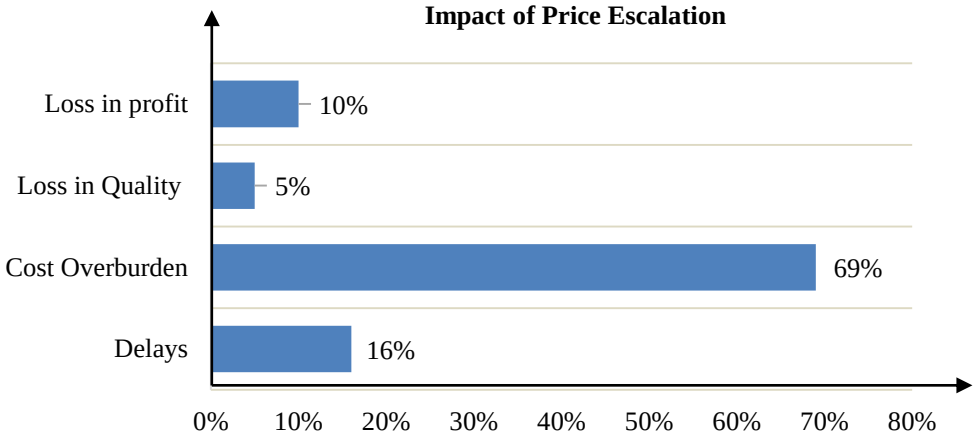


Figure 8 Impact of Price Escalation

3.4.4 Susceptible Material to Price Escalation

There are several materials which are considered critical to price escalation and usually price escalation is admissible on them in construction contracts in Pakistan (PEC, 2009). Professionals were asked to judge which material is more susceptible to price fluctuation. The results are shown in Figure 9 in Pakistan fuel prices are the most sensitive to the price fluctuation and hence can have their impact on the construction project.

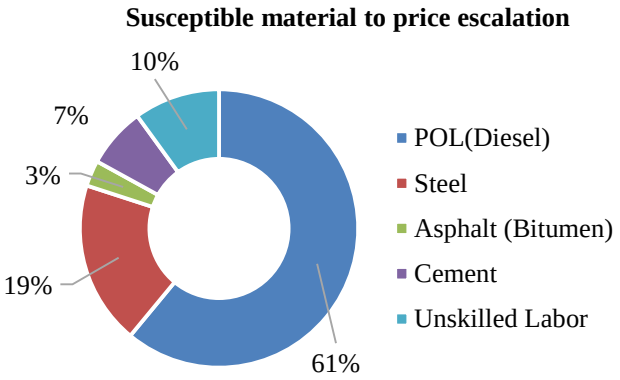


Figure 9 Susceptible material to price escalation

3.4.5 Types of Escalation Methods

There are several methods used for price adjustment. Some of them were used in past and many of the construction professional have no idea about them. Majority of the contracts in CI of Pakistan have provision of PEC price adjustment formula.

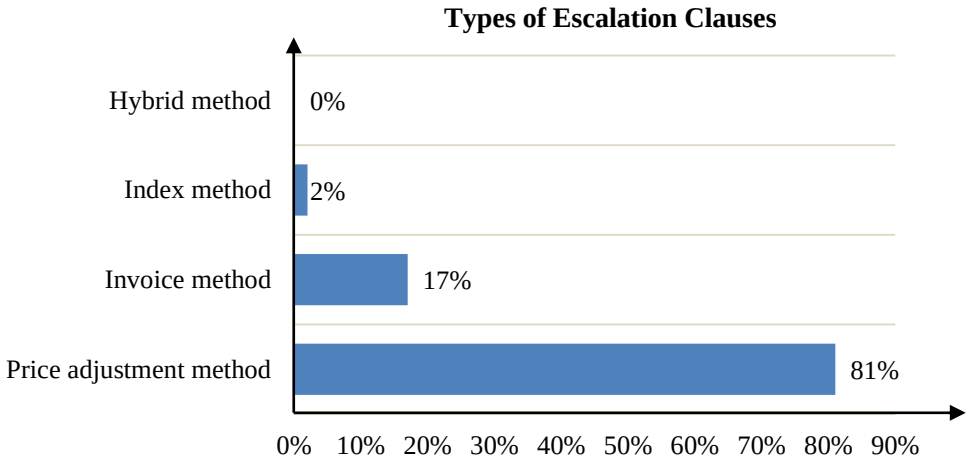


Figure 10 Types of Escalation Clauses

3.5 Knowledge Elicitation Procedure

In this part of study, group discussion and interviewing session was done on construction contracts and price adjustment guidelines provided by PEC. The point was to derive the arrangements that empower us to plan an objective way to deal with the acceleration framework in development projects. In addition, this managed development work where value acceleration variables were considered in the value estimation stage; where heightening procurements were reflected in the contracting stage. Amid this stride a few meetings were led to offer shape to the contending focuses. The consequences of the meetings were ordered into contentions and resolutions. In light of these outcomes from a few meetings supposition of members had a tendency to be strikingly thought.

3.6 Arguing Points In Relation to the Present Price Adjustment System

There are lots of arguing points. For example, applicability of price adjustment formula, sources of material prices, weightages of the items, fixed and adjustable portions of formula, type of contract and determination of C factor.

In this study, 8 items were drawn out by extensive discussion and interviews with the experts.

1. Price change period for escalation application? At the time of design completion, bidding and signing the contract.
2. When adjusting the contract amount according to price changes project duration should be considered as bar, not the budget of the said project.

3. When adjusting contract sum minimum percentage for item weightages to be included for price adjustment should not be limited.
4. When the contract amount is adjusted, the items not used in particular billing month should be considered as unity for both current and base price indices.
5. When calculating price adjustment for particular project every type of labor is merged under unskilled labor, which should be critically examined, as rates for skilled and unskilled labor have a lot of variation.
6. Percentage of fixed (Profits, overheads, advance payments) and adjustable portions of price adjustment formula should not be fixed.
7. When adjusting the contract amount total project sum is inclusive of the profits, over heads and provisional sums, is it necessary to adjust the overhead and profit in every IPC?
8. Sources for material prices mentioned in guidelines Federal Bureau of Statistics (FBS), which has some deficiency regarding prices of particular item, is it desirable to follow the only source?

3.7 Results and Discussion

3.7.1 Initial Date in Reckoning the Price Fluctuation

All in all, while ascertaining the change rate, it is important to contrast the base date and the present date. At that point, there were a few contentions with respect to the base date (or beginning date). From the examination, the accompanying three choices were recommended as based date: 1) plan fruition, 2) offering and 3) marking the agreement.

Be that as it may, actually, the value change can happen after the time when the development cost was ascertained. When all is said in done, around 2~3 months is required from the offering date to the agreement date. Hence, some demand that the offering date is alluring as a starting date of value change, instead of the agreement marking date. In the meantime, there is a conclusion that development contracts have attributes of casual and consensual contracts that can be accepted just by consenting between the two gatherings concerned (Cha, 2004). Subsequently, the agreement might get to be legitimate from the minute when a fruitful bidder is settled on at offering stage and the agreement is honored.

In this way, an agreement marking date is not viewed as proper to use as the beginning date of the heightening, yet an offering date was more fitting when alluding to discourse results with experts.

3.7.2 Limitations of Price Adjustment Formula

The value alteration might be pertinent just at the agreements having contract cost surpassing money related point of confinement of PEC temporary worker's class C-5 and contracts having esteem equivalent to or not as much as this utmost will be considered as settled cost.

While considering the authoritative methodology for heightening or the solidness of an agreement, it is important to endorse a base passed period that empowers one to ask for the acceleration from the starting date or from the balanced date (which means the date on which the reason for change have happened).

A few specialists contend that the base slipped by period for acceleration ought to be a year after the beginning date (for instance, an offering date), considering the bookkeeping and planning frameworks of people in general project proprietors. Likewise, albeit some material costs go up quickly, there is a conclusion communicated in the board that the heightening ought to be led after the costs of the materials turn out to be significantly balanced out.

If there should be an occurrence of the FIDIC conditions, the base passed period to change the agreement sum is recommended as a month unless generally expressed in the Appendix to Tender. Moreover, the base passed period is managed at 90 days in Korea, 6 months in the Philippines, and 1 year in Japan. In any case, in Japan, an incomplete acceleration is conceivable against a sudden ascent in the cost of indicated materials inside of the year (Chio, et.al, 2006).

Taking everything into account, by and large six months is required to change the agreement sum, because of managerial systems. Subsequently, unless the uncommon procurement is acquainted with mirror the value change of particular materials, the 180 days regulation as a base slipped by period may be an important confinement.

3.7.3 Minimum Percentage for Item Weightages

As mentioned in PEC, 2009 guidelines each of the price elements having price impact of 5% or higher can be nominated for adjustment.

In field of highway construction projects weightages of some materials like steel, cement and bitumen have sometimes impact of less than 5%. To avoid abnormal high bidding it should be of the view that such materials must be included in the list of specified materials regardless for their percentages.

Furthermore, it was discussed that in many cases price adjustment limit cannot truly represent the price fluctuation for the project because sometimes factors less than 5% which are omitted in price fluctuation may cause major price impact due to high fluctuation in the market for that specific item. Therefore price adjustment factor should not be limited to 5% price impact factors only and may be relaxed up to 2% for consideration of price adjustment factors for a project.

3.7.4 Provision for Items Exclusive of Billing Period

As said in PEC guidelines, if any item not used in billing period the base and current price indices should be considered as one.

The approach is generally used for the contracts where the escalation is to be paid as per actual. If price adjustment is to be made as per formula mentioned in the PEC standard bidding document, then utilization of material is irrelevant during the billing period.

Materials like bitumen is used in the later stage of highway construction projects, while executing the activities like prime coat, tack coat, asphalt base course and asphalt wearing course. Consideration of 'current price' of the said materials equal to 'base price' is not logical. Provision of such guide line, especially for long term contracts, is against the objective of said document.

The consideration of not including the items, it is contended that formula should be applied with adjustable current rate and base rate up to the actual completion period of project, irrespective of the usage of any particular item in any particular billing period because price adjustment formula is the index of price adjustment over the project measured in the form of specified item irrespective of their usage in any period over the project. As well as the base price and current price ratio should not be considered as unity while that particular item is not used in the billing period, otherwise it will jeopardize the basic essence of the formula mentioned in clause 70 of standard condition of contracts.

It can also be seen from table in which existing project is taken as reference that if ratio of current and base prices considered as unity in case of particular billing month the contractor will be in severe loss.

Table 3 Calculation of price adjustment formula

Calculation of Amount against Price Adjustment					
S.No	IPC No.	Billing Month	Value of Work for the Billing Month (Rs.)	Price Adjustment Amount (Rs.)	
				Old Formula*	New Formula**
1	**IPC No. 02**	Oct-10	72,136,898	983,503	1,241,963
2	**IPC No. 03**	Nov-10	42,404,402	1,033,354	860,359
3	**IPC No. 03 Rev.**	Dec-10	7,094,111	254,732	225,790
4	**IPC No. 03 Rev.A**	Jan-11	165,119,793	6,817,902	5,733,510
5	**IPC No. 04**	Feb-11	49,229,759	1,890,184	1,566,877
6	**IPC No. 04 Rev.**	Mar-11	76,172,061	4,532,127	2,827,101
7	**IPC No. 05**	Apr-11	67,919,007	5,426,572	2,835,445
8	**IPC No. 05 Rev**	May-11	132,863,354	12,060,851	5,946,799
9	**IPC No. 06**	Jun-11	89,093,969	8,004,756	3,793,499
10	**IPC No. 06 A**	Jul-11	29,328,684	3,002,519	1,547,020
11	**IPC No. 06 B**	Aug-11	18,245,468	1,783,616	962,406
12	**IPC No. 06 C**	Sep-11	47,689,910	4,702,746	2,533,078
13	**IPC No. 06 D**	Oct-11	61,531,385	6,309,771	3,331,576
14	**IPC No. 07**	Nov-11	30,004,597	3,133,065	1,624,579
15	**IPC No. 07 Rev.A**	Dec-11	39,252,225	4,249,534	2,250,172
16	**IPC No. 07 Rev.B**	Jan-12	94,506,782	10,349,649	8,042,882
17	**IPC No. 08**	Feb-12	122,506,282	13,803,203	11,961,507
18	**IPC No. 09**	Mar-12	112,804,187	13,243,531	10,652,159
19	**IPC No.10**	Apr-12	77,561,850	9,985,733	8,078,872
20	**IPC No.10 Rev. A**	May-12	223,876,826	29,060,774	23,556,752
Total Amount Against Price Adjustment			**1,559,341,550**	**140,628,121**	**99,572,348**
Price Adjustment Percentage of Workdone				**9.02%**	**6.39%**

Reference Project: New Islamabad International Airport (Package-8A)

*Any material which is not used in the current IPC, the basic and current price indices are used

**Any material which is not used in the current IPC, the basic and current indices have to be taken as same (1)

3.7.5 Provision for Items Exclusive of Billing Period

As mentioned in PEC guidelines that the unskilled labor is representative of price elements of all types of labors, which should not be done, as there is a lot of difference between their rates.

The experts were of the view that although the document does not restrict to merge all type of labor, however, to avoid misinterpretation, it will be appropriate to mention that 'skilled labor' and 'unskilled labor' can be mentioned in the list of specified materials separately in Appendix C to bid. Rate of 'Mason' can be taken as reference or price adjustment against 'Skilled labor'.

3.7.6 Weightage of Fixed and Adjustable Portion of Formula

As mentioned in guidelines for nonadjustable portion shall never be less than 35% and the non-fixed portion shall never be > than 65%.

Keeping in view the market prices of construction items, the accumulative weightage of HSD, labor, steel, bitumen and cement is calculated based on estimated price. Experts are of the view that in order to receive more competitive offers from reputable parties, the weightages should be determined as per guidelines without the restriction of any ceiling in order to meet the total variation in price as close as possible to actual one.

3.7.7 Provision Regarding Temporary Works, Provisional Sums and Other Overheads

PEC document has no provision regarding the determination of weightages by taking into account the temporary works, provisional sums and engineer/employers facilities.

As the common practice is that weightages are calculated by dividing the price of the specified material by the total project estimate (Engineer's Estimate). It is suggested that a clarification note be provided as follows.

1. Amount of such items which are not part of permanent works, however, included in the BOQ (e.g. Engineer/Employer facilities, maintenance of vehicle/offices, laboratory equipment, rent of office etc) be excluded from the total amount of project while determining the weightages of specified items. As well as price adjustment is not applicable on the items which are valued at market price or provisional sum items.
2. Pn is a price adjustment factor to be applied to the amount for the payment of work carried out in the subject month, excluding provisional sums and the amount of the items mentioned in PEC guide line.

3.7.8 Sources of Material Prices

Sources for material prices mentioned in guidelines Federal Bureau of Statistics (FBS), which has some deficiency regarding prices of particular item.

Sources of materials is mentioned as Federal Bureau of Statics (FBS) which are not regularly published and cause a delay for price adjustment bills. Moreover some item rates are not available on FBS price list like bitumen and therefore FBS source may be replaced with PICC source rates for specified materials.

3.13 Chapter Summary

Detailed analysis of the collected data and results obtained, have been discussed in this chapter. Prevalent practice of price adjustment formula have been discussed in detail through a case study example. PEC price adjustment formula is discussed in detail with several arguing and discussion points.

CHAPTER 4. PRICE ESCALATION MODEL

4.1 Introduction and Background

This chapter discusses the case study approach to investigate perceptions concerning and operations in the construction industry of Pakistan regarding price adjustment mechanism and implications of the said formula.

The data collection procedure is described, followed by data analysis and the limitations of the research thesis. Finally, the framework for this research is introduced. This will help finding out probabilistic project price along with escalation factors, including the effects of price risk factors and future price variation factors over time.

A more sensible approach to survey value heightening is to consider the vulnerability in the estimation of acceleration component. This instability is a noteworthy supporter to the general value vulnerability and can be displayed utilizing fitting probabilistic models.

4.1.1 Research Methodology

Research strategy shows how the researchers are going to carry out their study to achieve the research objectives (Saunders et al., 2007).

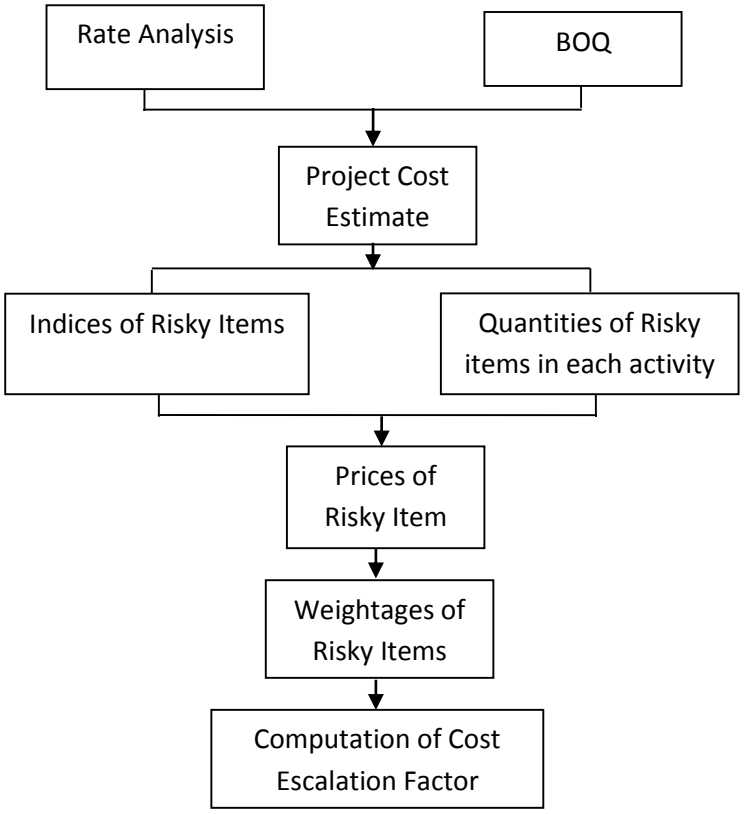


Figure 11 Demonstration of Model

This research is conducted as an exploratory and comparative study of the International Federation of Consulting Engineers (FIDIC) price adjustment formula and its implications in construction contracts and suggested measures to improve the formula. Graphical layout of the research methodology used in this research is given in Figure 4.1.

4.2 Procedure for Application of Price Adjustment Formula

As per guidelines of FIDIC and PEC, the procedure for the price adjustment using the FIDIC price adjustment formula can be divided into following steps:

1. The Engineer's Estimate will be prepared for the complete project, and the prices of the basic elements, on which price adjustment is to be admissible, are calculated from the engineer's estimate. Each price element determined above is then divided by the total amount of the engineer's estimate to get the co-efficient of the weight-ages.
2. Weight-age of the fixed portion (A) which is also called the non-adjustable portion of the estimated price of the contract, will be determined as following:
    a. First the weight-ages of all the elements are added (elements having values of 5% or more are considered, except POL and Labour which are taken into consideration irrespective of their percentage weight-age) to see whether the added total is 65% or less. If the total weight-age of the price elements including POL and Labour exceeds 65%, then the elements having lower percentages other then POL and Labour will be excluded to keep the total percentage equal to or less than 65%.
    b. Fixed or non-adjustable portion should never be less than 35% and accordingly the adjustable portion should not exceed 65%. A rate breakup is normally price of material and services etc plus 25 % for profit overhead. The 25 % part, therefore, needs no escalation consideration plus 10% for smaller or less price items other than specified items.
    c. When the weight-ages a,b,c,d …….. and so on, and fixed portion "A" are added, the result should always be "1".
3. The contractor will submit his bill for each month (if the billing period is more than one month, then the billed amount will be segregated for the work done in each month separately).
4. The Base Dates and Effective Dates shall be calculated from the source of price as per procedure explained in Table 2.1.

5. The price adjustment factor "Pn" is then calculated for the billing amount submitted by the contractor for the month under consideration, by the application of the formula. This factor is multiplied by the amount of the bill to get the adjusted price for that particular IPC.

4.3 Case Study

The prices escalation clause of a project is presented here for having a better idea of price escalation system in CI of Pakistan. The working for price escalation clause of National Highway Authority for a project of 4-Lane Underpass at Wah Gate-1 Taxila (N-5).

Following is the example of calculation of price adjustment using the price adjustment formula for a project. The project is named as "4-Lane Underpass at Wah Gate No.1 Taxila (N-5)". Table shows the details of the price adjustment formula for the subject contract. The fixed and adjustable portion detail is given in table-5.

Table 4 Details of the price adjustment formula

Sr. #	Description	Basic Price		Value of "C" Factor
		1		2
1	b-**Cement**	**Co**	4,930.00	0.06
2	c-**Steel Billet**	**So**	62,100.00	0.18
3	d-**Bitumen**	**Bo**	50,197.00	0.07
4	**Labour**			
	e –**Skilled**	**Lo**	550.00	0.08
	f -**Un-Skilled**	**Uo**	300.00	0.05
5	g -**High Speed Diesel**	**Do**	50.13	0.12
H	**Total Adjustable factors** (b (Cn/Co) + c (Sn/So) + d (Ln/Lo)+……			**0.56**
I	**Non Adjustable factor** (**A** +…….)			**0.44**

Table-7 presents the calculation for an IPC and EPC for particular period of time. Table-6 presents the complete sheet for the calculation of adjusted price through price adjustment formula for the subject project. Price adjustment factor (Pn) is calculated for work-done for each month by putting the relative data in the formula and that factor is multiplied with the value of work-done (VOW) for each month, thus obtaining the adjusted price payable to the contractor.

Table 5 Price Adjustment under Clause 70.1 (b)

NATIONAL HIGHWAY AUTHORITY

4-LANE UNDERPASS AT WAH GATE NO.01 TAXILA (N-5)
PRICE ADJUSTMENT UNDER CLAUSE 70.1 (b)
5-FOR MAY-2009

Tender Date (14-07-2008)

Commencement Date (20-12-2008)

Completion Date (31-10-2011)

28 Days Prior 03 May, 2009

Price Adjustment # 05 (IPC # 01 to 17 & Final)

Sr. #	Description	Value of "C" Factor		Basic Price		Curent Price Indices	Current Factor	Remarks
		1		2		3	4 = 3/2 x 1	
1	b-**Cement**	0.06	**Co**	4,930.00	**Cn**	6,590.00	0.08	**Annexure # 08 & 01**
2	c-**Steel Billet**	0.18	**So**	62,100.00	**Sn**	41,180.00	0.12	**Annexure # 08 & 01**
3	d-**Bitumen**	0.07	**Bo**	50,197.00	**Bn**	40,597.00	0.06	**Annexure # 08 & 01**
4	**Labour**							
	e -**Skilled**	0.08	**Lo**	550.00	**Ln**	600.00	0.09	**Annexure # 08 & 01**
	f -**Un-Skilled**	0.05	**Uo**	300.00	**Un**	300.00	0.05	**Annexure # 08 & 01**
5	g -**High Speed Diesel**	0.12	**Do**	50.13	**Dn**	57.14	0.14	**Annexure # 08 & 01**
h	**Total Adjuctable factors** (b (Cn/Co) + c (Sn/So) + d (Ln/Lo)+……						**0.54**	
i	**Non Adjustable factor** (**A** +…….)						**0.44**	Fix as per Clause 70.1 (b)
j	**Total Price Adjustment Factor (Pn = A + b (Cn/Co) + c (Sn/So) +….**						0.98	
k	Pn should be (as per Clause 70.1 b)						1.00	
m	**FINAL ADJUSTMENT FACTOR THIS MONTH EPC**						**-0.02**	m = j-k
n	Value of Work Done for This Month (subject to Escalation)						65,982,619	See Attached VOW Sheet
o	**Total Price Adjustment For This Month**						**(1,319,652)**	o = m x n

Table 6 Summary of Price Adjustment

4-LANE UNDERPASS AT WAH GATE NO.01 TAXILA (N-5)
PRICE ADJUSTMENT UNDER CLAUSE 70.1 (b)
Summary of Price Adjustment No. 05 (Final)
(From IPC 01 To IPC 17 Final)

Tender Date (14-07-2008)

Commencement Date (20-12-2008)

Completion Date (31-10-2011)

IPC #	Month	Value of work done (Rs)	Price Adjustment Factor		Final Adjustment Factor	Adjustment Value of work done (Rs)	Escalation Amount (Rs)
	1	2	3			4 = (2 x 3)	5 = (4 - 2)
1	Dec-08	**Mobilization**					
1	Jan-09	2,223,482.00	Pn=	0.98	-0.02	2,179,012.00	-44,470.00
1	Feb-09	20,592,462.00	Pn=	0.97	-0.03	19,974,688.00	-617,774.00
1&2	Mar-09	42,053,121.00	Pn=	0.98	-0.02	41,212,059.00	-841,062.00
2	Apr-09	37,985,074.00	Pn=	0.98	-0.02	37,225,373.00	-759,701.00
3	May-09	65,982,619.00	Pn=	0.98	-0.02	64,662,967.00	-1,319,652.00
4	Jun-09	31,509,840.00	Pn=	0.97	-0.03	30,564,545.00	-945,295.00
4 & 5	Jul-09	38,885,624.00	Pn=	0.98	-0.02	38,107,912.00	-777,712.00
5	Aug-09	8,043,761.00	Pn=	0.98	0	7,882,886.00	-160,875.00
5 & 6	Sep-09	48,726,348.00	Pn=	1.01	-0.01	49,213,611.00	487,263.00
6 & 7	Oct-09	48,874,609.00	Pn=	1	0	48,874,609.00	-
7 & 8	Nov-09	33,584,865.00	Pn=	1.01	0.01	33,920,714.00	335,849.00
8	Dec-09	19,113,001.00	Pn=	1.02	0.02	19,495,261.00	382,260.00
8	Jan-10	18,043,127.00	Pn=	1.01	0.01	18,223,558.00	180,431.00
9	Feb-10	11,878,318.00	Pn=	1.02	0.02	12,115,884.00	237,566.00
9	Mar-10	13,150,995.00	Pn=	1.03	0.03	13,545,525.00	394,530.00
9	Apr-10	12,726,770.00	Pn=	1.07	0.07	13,617,644.00	890,874.00
9 & 10	May-10	25,024,983.00	Pn=	1.08	0.08	27,026,982.00	2,001,999.00
10 & 11	Jun-10	37,864,961.00	Pn=	1.09	0.09	41,272,807.00	3,407,846.00
11	Jul-10	15,400,912.00	Pn=	1.1	0.1	16,941,003.00	1,540,091.00
11 & 12	Aug-10	15,812,071.00	Pn=	1.09	0.09	17,235,157.00	1,423,086.00
12	Sep-10	8,036,853.00	Pn=	1.11	0.11	8,920,907.00	884,054.00
12 & 13	Oct-10	8,096,614.00	Pn=	1.11	0.11	8,987,242.00	890,628.00
13	Nov-10	5,996,720.00	Pn=	1.12	0.12	6,716,326.00	719,606.00
Sub Total to-date Price Adjustment upto EPC # 05 (A)							**8,309,542.00**

4.4 Selection of Project for Cost Escalation Model

Another objective for this research was to design a framework for project price escalation factor. For this purpose highway project was selected with following details.

Two lane Road of 10km length with 7.3 m width and 2.5 m shoulder width was considered. Main reason for considering ‘10 km of Road’ as highway project for modelling because of their wide applicability, as these are commonly executed in Pakistan. A typical cross-section of road for highway model is shown in Figure 11.

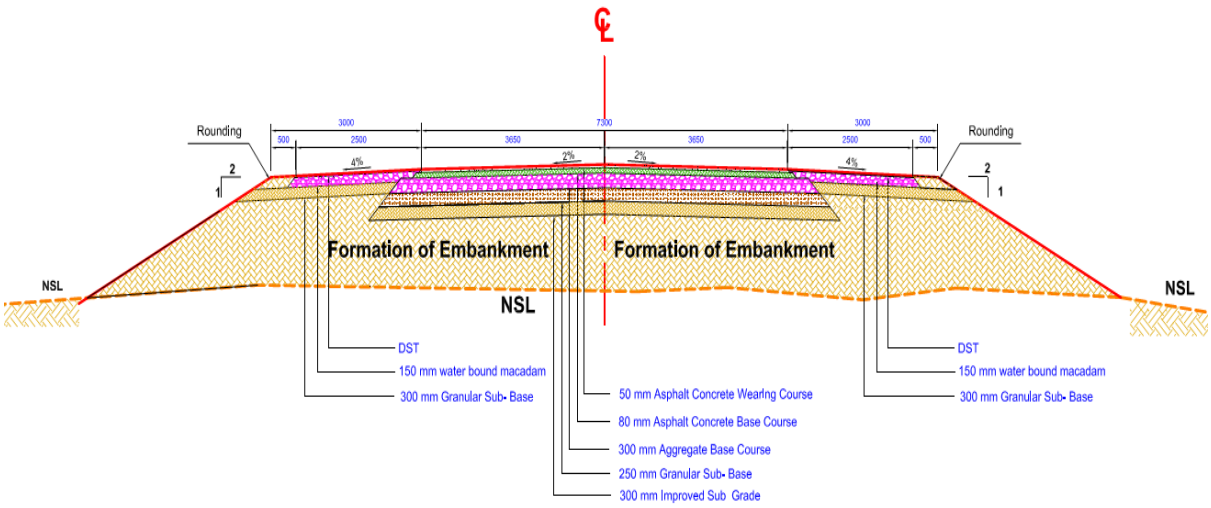


Figure 12 Typical Road X-Section for Highway Project

4.5 Identification of Project Price Risks

After development of project price estimation models, risky items (uncertainties) were identified which may cause project price overrun those are materials, manpower and machinery rate/ price indices. With the help of thorough literature review and expert opinion risky items were identified. As PEC has already defined list of certain materials which are susceptible to price fluctuation, which are;

- POL (HSD)
- Labour Unskilled
- Cement
- Bitumen
- Other major elements depending upon the nature of the project.

The focus of this model will be mainly on these items.

4.6 Framework for Project Price Estimation Model

Price estimates were to be developed for a typical highway construction project, with the help of design specifications collected. Model was developed on Microsoft Excel. The model was typical and simple form of project price estimates, which is commonly prepared by estimators. Firstly quantity sheets were prepared followed by rate analysis sheets and then all excel sheets (quantity sheet, rate analysis sheets for project activities and BOQs) were interlinked to produce project price estimation model.

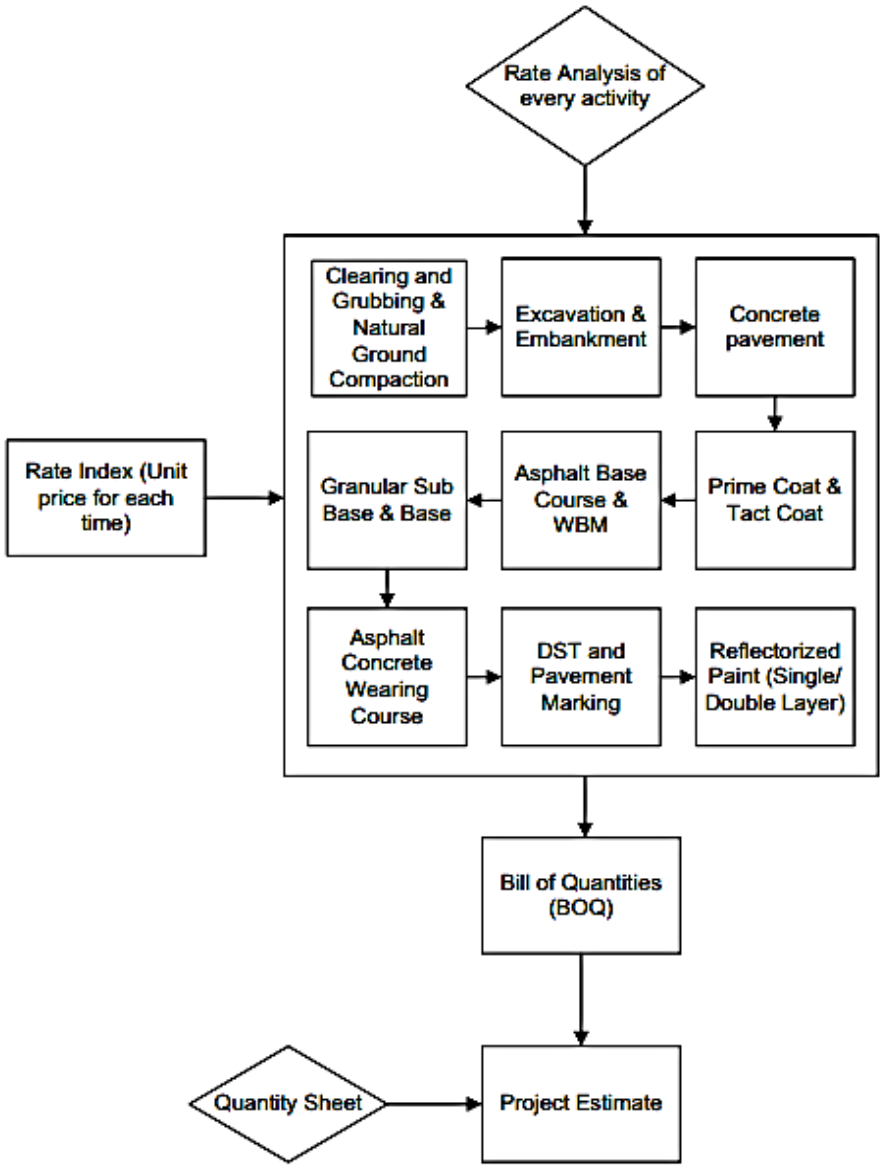


Figure 13 Project Price Estimation Model

4.7 Development of Price Escalation Model (PEM)

Basic Project price estimation model was developed for highway project. After project price risks were identified and detailed data was gathered against each identified price risk. Next step was development of PEM in which all the identified price risks could be adjusted and realistic project price escalation factor could be predicted for future scenarios as well as at realistic bids should be prepared. PEM was developed after following three phases; (1) development of probabilistic project price model, and (2) forecasted indices for each vulnerable item (3) combined theses indices to forecast escalation factor for each risky item.

After preparing probabilistic project price model an index will be developed for every item, through percentage of that item to total price of project. And those percentages are combined accordingly to get 'C factor'. Keeping in mind the end goal to show the instability in the estimation of the file, we propose to utilize a rundown of conveyance to speak to the heightening element. Demonstrating the acceleration element as an arbitrary variable will permit the acknowledgment of the scope of heightening costs that can influence the project. This PC model mulls over the instability and variability of heightening component in a coordinated probabilistic methodology. The considering so as to demonstrate of value acceleration element is finished its variability and its connection with ensuing periods.

4.8 Results and Discussion

Construction price indices have been used to measure the price trends in the construction industry (Wilmot and Cheng 2003). Current model will closely examine the subsequent increase in the price indices of materials. By which we can plot combined cumulative function of the indices.

As extracted from model figure 14 shows that there is constant increase in the construction price of 10 km road. It means inflation is affecting project items every year, so need of hour is modelling price escalation factor.

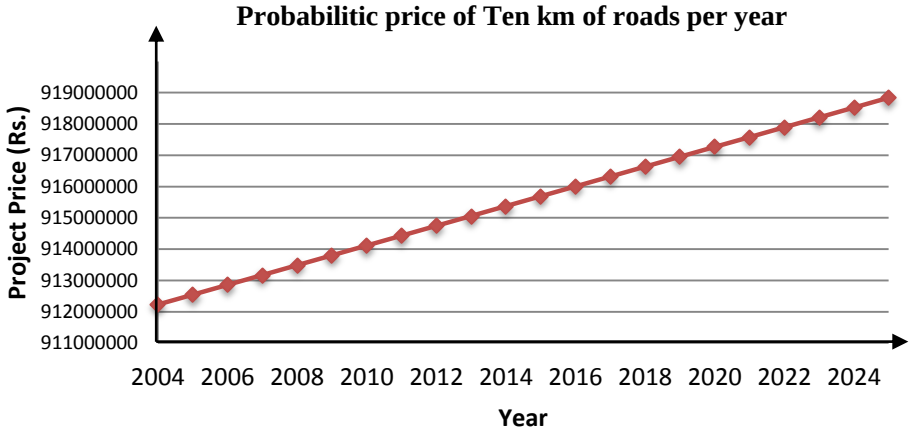


Figure 14 Probabilistic price of 10 Km road per year

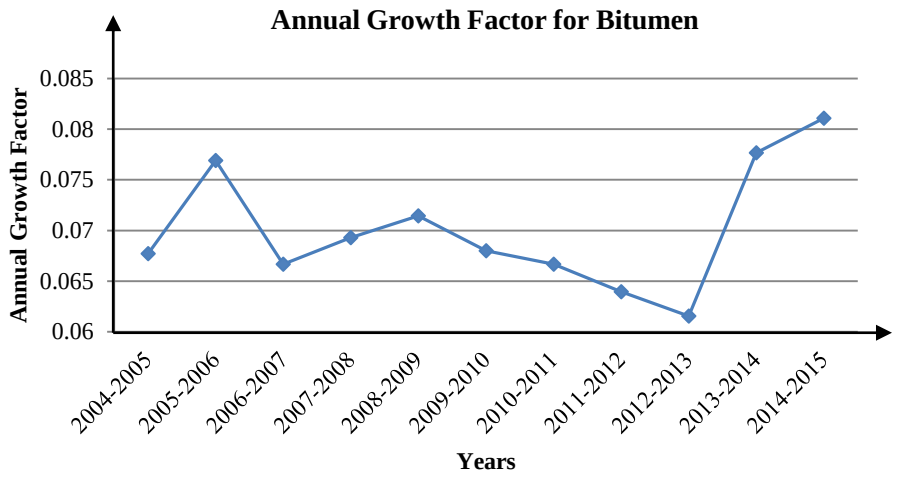


Figure 15 Annual Growth Factor for Bitumen

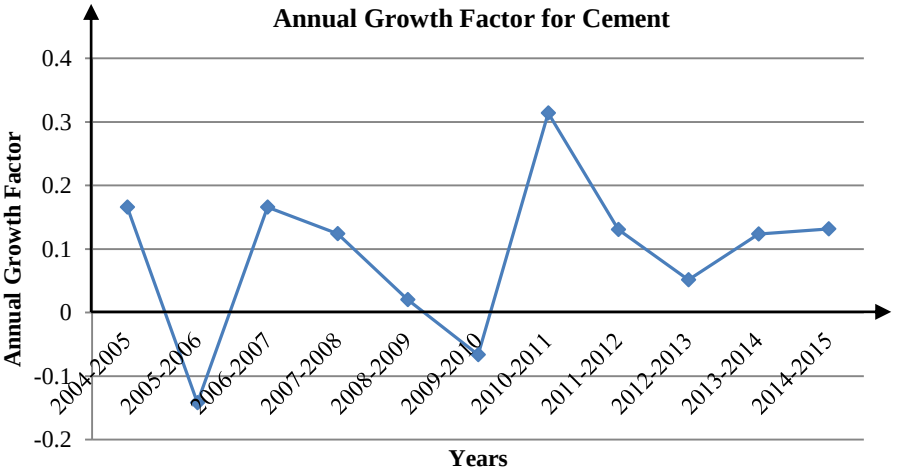


Figure 16 Annual Growth Factor for Cement

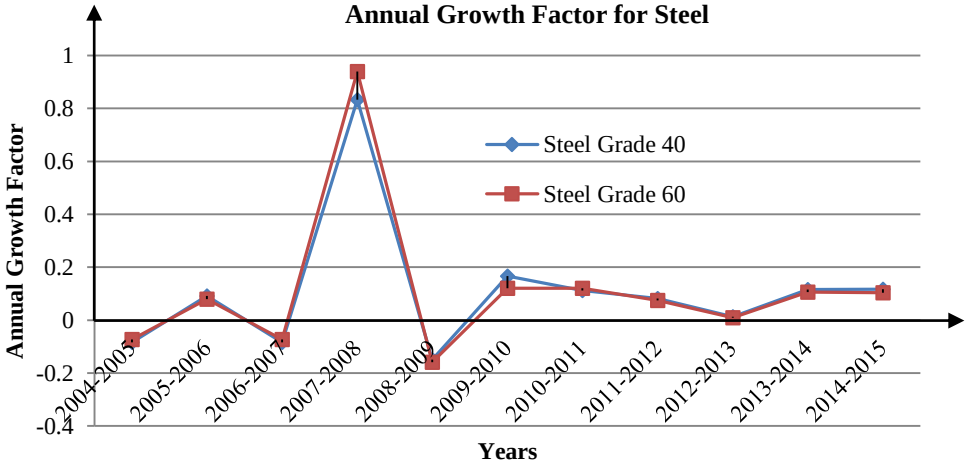


Figure 17 Annual Growth Factor for Steel Grade 40/60

Analyzing price changes of each item separately. Escalation is driven by economic trends. The primary econometric measures of price change overtime (i.e., escalation) used by economists are price indices. The index is usually expressed as a relative factor with a value of 1.00 representing the price at a given base time. Following Figures 15,16,17,18 and 19 shows the annual growth of bitumen, cement, steel, HSD (Oil) and unskilled labor respectively.

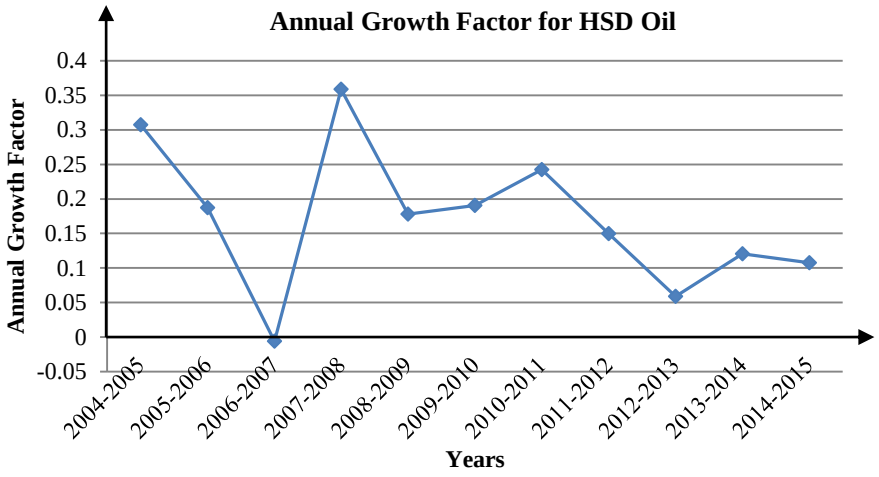


Figure 18 Annual Growth Factor for HSD Oil

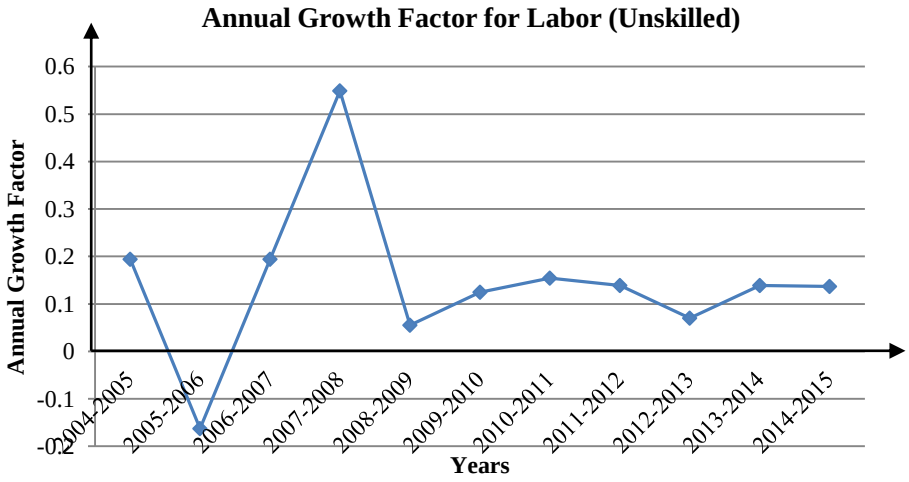
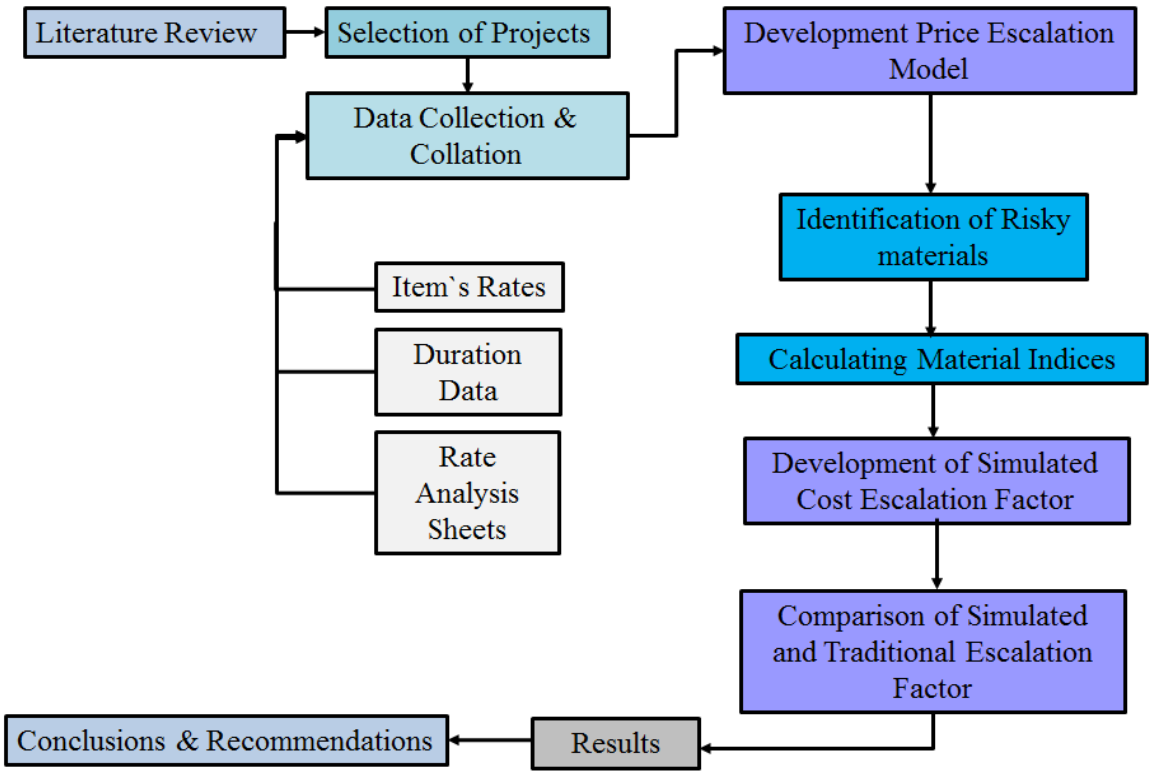


Figure 19 Annual Growth Factor for Labor (Unskilled)

It can be seen from the annual growth factor of each item is continually facing escalation and de-escalation. These factors were incorporated into the simulation model and escalation factor was devised for particular project. This simulation model takes into consideration the uncertainty and variability of escalation factor in an integrated probabilistic approach. The modelling of price escalation factor is done by considering its variability and its correlation

with subsequent periods. The proposed model provides a powerful tool to assess the impact of this factor.

4.9 Framework Application:

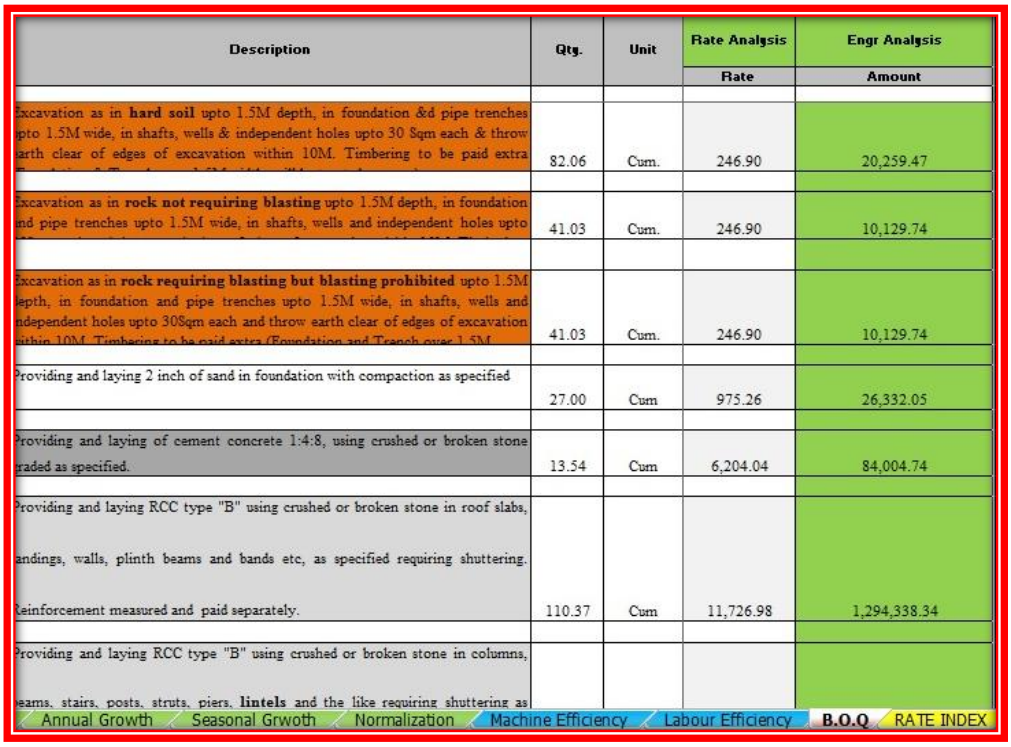


EXCAVATION				
UNITS	Cft			
DESCRIPTION	Excavation for foundation trenches and drains in all kind of soil (except gravelly and murum soil) and backfilling the excavated material in foundation, plinth or under floor including			
	1000	Cft		
DETAILS	UNITS	QUANTITY	January	
			rate	AMOUNT
Labor				
Beldaar	No.	8.5	475.0	4317.8
Coolie	No.	5	475.0	3038.7
Bhishti	No.	0.16	380.0	65.0
Sundries	LS	30.0	1.0	30.6
		Total		7452.1
		Add 1.5% Water charges		112
		10 % contractor profit		745
		Total		8309.1
		Rate per cft	Rs.	8
EXCAVATION				
8.30907	8.39248	8.41311	8.45438	8.47502
Rate per cft				

Figure 20 Rate Analysis Sheet

Sr.No			Description	Total Quantity	Unit
1			Preparation of site / Site Clearing	1125	Sft
2			Excavation	755.8258	Cft
3			Concrete in Foundation (P.C.C 1:4:8)	195.8125	Cft
4			Brickwork		
	a.		Brickwork in Foundation	410.4478	Cft
	b.		Brickwork in Ground Floor		
		i.	Providing and laying first class solid burnt brick masonry set in cement mortar 1:6 in straight or curved walls 9" to 13-1/2" thick including scaffolding, raking out joints and curing etc. complete in superstructure.	1491	Cft
		ii.	Providing and laying first class solid burnt brick masonry set in cement mortar 1:6 in straight or curved walls 4-1/2" and less in thickness including scaffolding, raking out joints and curing etc. complete in superstructure.	0	Cft
	c.		Brickwork in First Floor		
		i.	Providing and laying first class solid burnt brick masonry set in cement mortar 1:6 in straight or curved walls 9" to 13-1/2" thick including scaffolding, raking out joints and curing etc. complete in superstructure.	1491	Cft
		ii.	Providing and laying first class solid burnt brick masonry set in cement mortar 1:6 in straight or curved walls 4-1/2" and less in thickness including scaffolding, raking out joints and curing etc. complete in superstructure.	0	Cft
	d.		Brickwork in Mumty		
			Providing and laying first class solid burnt brick masonry set in cement mortar 1:6 in straight or curved walls 9" to 13-1/2" thick including scaffolding, raking out joints and curing etc. complete in	0	Cft

Figure 21 Quantity Takeoff Sheet



Description	Qty.	Unit	Rate Analysis	Engr Analysis
			Rate	Amount
Excavation as in **hard soil** upto 1.5M depth, in foundation &d pipe trenches upto 1.5M wide, in shafts, wells & independent holes upto 30 Sqm each & throw earth clear of edges of excavation within 10M. Timbering to be paid extra	82.06	Cum.	246.90	20,259.47
Excavation as in **rock not requiring blasting** upto 1.5M depth, in foundation and pipe trenches upto 1.5M wide, in shafts, wells and independent holes upto	41.03	Cum.	246.90	10,129.74
Excavation as in **rock requiring blasting but blasting prohibited** upto 1.5M depth, in foundation and pipe trenches upto 1.5M wide, in shafts, wells and independent holes upto 30Sqm each and throw earth clear of edges of excavation within 10M. Timbering to be paid extra (Foundation and Trench over 1.5M	41.03	Cum.	246.90	10,129.74
Providing and laying 2 inch of sand in foundation with compaction as specified	27.00	Cum	975.26	26,332.05
Providing and laying of cement concrete 1:4:8, using crushed or broken stone graded as specified.	13.54	Cum	6,204.04	84,004.74
Providing and laying RCC type "B" using crushed or broken stone in roof slabs, landings, walls, plinth beams and bands etc, as specified requiring shuttering. Reinforcement measured and paid separately.	110.37	Cum	11,726.98	1,294,338.34
Providing and laying RCC type "B" using crushed or broken stone in columns, beams, stairs, posts, struts, piers, **lintels** and the like requiring shuttering as				

Annual Growth | Seasonal Grwoth | Normalization | Machine Efficiency | Labour Efficiency | B.O.Q | RATE INDEX

Figure 22 Cost Estimate

Items	Unit	Quantity	Rate (Base)	Base Price	Wightage
Aggregate / Stone Crushed 3/8" to 1" (Graded) (at site)	100 Cft	0	1776.74	0	0.00%
Aggregate 1.1/2"-3/4"	100 Cft	3937.37404	1776.74	6995689.953	4.34%
Aggregate 3/4"-3/8"	100 Cft	3062.929804	1776.74	5442029.901	3.38%
Aggregate 3/4"-3/8"	100 Cft	2562.219203	1776.74	4552397.346	2.82%
Aggregate NO. 3/8'-NO 4	100 Cft	0	1776.74	0	0.00%
Aggregate NO. 4 -NO.200	100 Cft	4267.182577	1776.74	7581673.972	4.70%
Hand Broken stone 2. 1/2"-1/2"	100 Cft	3227.100267	1776.74	5733718.129	3.56%
Aggregate	Cu ft	0	5	0	0.00%
Aggregate (3/4")	100 Cft	0	1776.74	0	0.00%
Aggregate (1/2")	100 Cft	0	1776.74	0	0.00%
Aggregate (1/4"-3/16")	100 Cft	0	1776.74	0	0.00%
Aggregate (1/2"-3/16")	100 Cft	0	1776.74	0	0.00%
Aggregate (1"-3/16")	100 Cft	0	1776.74	0	0.00%
Aggregate (1-1/2"-3/16")	100 Cft	0	1776.74	0	0.00%
Aggregate (3/4"-3/16")	100 Cft	0	1776.74	0	0.00%
Bitumen 60/70 & 80/100 (packed)	P.Kg	0	20.61979	0	0.00%
Maxphalt / Bitumen 60/70 & 80/100 (packed)	Ton	1332.58923	20619.79	27477707.42	17.04%
Asphalt Liquid	P.Kg	0	20	0	0.00%
Granular Sub Base	100 cu ft	10046.84391	489.5402	4918333.783	3.05%
Graded Stone for Base course	100 cu ft	10817.04619	1278.13	13825591.38	8.58%
Binding wire	Kg	0	45	0	0.00%
Brick	No	0	2.8	0	0.00%
Bitumen (maxphalt)	Ton	0	65	0	0.00%
Cement	Bags	7978.666667	230	1835093.333	1.14%

Figure 23 Calculation of Risky Item Indices

NATIONAL HIGHWAY AUTHORITY

4-LANE UNDERPASS AT WAH GATE NO.01 TAXILA (N-5)

PRICE ADJUSTMENT UNDER CLAUSE 70.1 (b)

FOR JANUARY-2009

Tender Date (14-07-2008)
Commencement Date (20-12-2008)
Completion Date (31-10-2011)

28 Days Prior 03 Jan, 2009

Price Adjustment # 05 (IPC # 01 to 17 & Final)

Sr. #	Description	Value of "C" Factor	Basic Price		Current Cost Indices		Current Factor	Remarks
		1	2		3		4 = 3/2 x 1	
1	b-Cement	0.06	Co	4,930.00	Cn	6,745.00	0.08	Annexure # 08 & 01
2	c-Steel Billet	0.18	So	62,100.00	Sn	40,020.00	0.12	Annexure # 08 & 01
3	d-Bitumen	0.07	Bo	50,197.00	Bn	41,385.00	0.06	Annexure # 08 & 01
4	Labour							
	e -Skilled	0.08	Lo	550.00	Ln	600.00	0.09	Annexure # 08 & 01
	f -Un-Skilled	0.05	Uo	300.00	Un	300.00	0.05	Annexure # 08 & 01
5	g -High Speed Diesel	0.12	Do	50.13	Dn	57.14	0.14	Annexure # 08 & 01

Figure 24 Calculation of Detailed IPC

Table 7 Construction Price Escalation Model for forecasting Escalation Factor

Base Price Indices	Cement	Steel	Labor(Unskilled)	Bitumen	HSD Oil	**Project Start Date**											01/01/2015
	270	64000	325	59428	73.39	**Project End Date**											23/07/2015
Sr No	**Projects**	**Start Date**	**End Date**	**Total Budget**	**Escalated Amount**	**Escalation Factors**											
						1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Project 1	01/01/2015	23/07/2015	797,297,416	50,492,860.09	1.01	1.02	1.04	1.04	1.04	1.06	1.08	1.09	1.09	1.10	1.10	1.10
2	Project 2	01/04/2012	01/04/2013	773,378,493.52	48,978,074.29	0.98	0.99	1.01	1.01	1.01	1.03	1.05	1.06	1.06	1.07	1.07	1.07
3	Project 3	03/02/2013	03/02/2014	781,351,467.68	49,483,002.89	0.99	1.00	1.02	1.02	1.02	1.04	1.06	1.07	1.07	1.08	1.08	1.08
4	Project 4																
5	Project 5																
6	Project 6																
7	Project 7																

4.10 Chapter Summary:

This chapter discussed about the simulation PEM model has been designed to incorporate the effect of price escalation on highway construction projects. This model takes into consideration the uncertainty and variability of escalation factor in an integrated probabilistic approach. The modelling of price escalation factor is done by considering its variability and its correlation with subsequent periods. The proposed model provides a powerful tool to assess the impact of this factor. Further this model can be used to see the variability in price escalation factor over the years on particular project and future can be forecasted.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Synopsis of the Research

This research study focuses on the prevalent price adjustment practices in construction industry of Pakistan. For this purpose the Federation Internationale des Ingenieurs Conseils (FIDIC) price adjustment formula has been studied in comparison to the previous method of calculation for price adjustments concluded from the price fluctuations in the market. Also this research is conducted as an exploratory and comparative study of the FIDIC price adjustment formula and its implications in construction contracts and suggested measures to improve the formula. The interviews with professionals provided result that there is considerable differences between escalation systems provided by PEC in form of guidelines and actual practices in CI of Pakistan. The substantial amount of contractual detail have provided indicates some of the original solutions parties have devised for resolving some apparently inflexible problems of price adjustment practices in CI of Pakistan. Factors that cause price escalation were identified through comprehensive literature review and were validated through knowledge elicitation technique. The study established that project delay, poor quality and price overruns were the effects of price escalation. The framework for this research is then introduced. Which helped finding out probabilistic project price as well as indices of particular items like cement, steel, POL, unskilled labor and bitumen. Model is designed in such a way that it will predict the project price along with escalation factors, including the effects of price risk factors and future price variation factors over time.

5.2 Findings and Recommendations

The major findings from this research are as follows;

The research have revealed that the stakeholders of CI do not have the detailed and frequent exposure towards the price adjustment process. Only 41% of the professionals confirmed that they have the exposure to this process.

Result revealed that under external factors Inflation is the major factor for the price escalation in construction projects in Pakistan and Economic instability is the second largest reason for the contract price escalations. And under the head of internal factors poor estimation is one of the major factors of price escalation. Also the results from figure 10 shows that one of the major problem faced by the stakeholders due to the price escalation is the problem of price overburden, which creates hindrance towards the successful completion of the projects. Schedule delays come second on list.

As per opinion of the Construction Industry professionals, the most susceptible material with respect to the price fluctuation is the POL prices, whereas the steel prices come second in this list. The research has revealed that the price of materials used to exhibit a very high increase (by more than 34%) and that of skilled labor exhibited very high increase (by 30-50%) over the past few years. Out of several methods of price escalation adjustment majority of the contracts in Construction Industry of Pakistan have provision of PEC price adjustment formula.

In conclusion expert's meetings noticed that there are significant contrasts between acceleration frameworks and rules gave by PEC. These things, and additionally basic contentions and there compressed results are as under;

Price fluctuation may cause major price impact due to volatile nature of the market. Therefore price adjustment factor should not be limited to 5% price impact factors only and may be relaxed up to 2% for consideration of price adjustment factors for a project. Further provision be made to merge the weightages of minor elements in the weightages of specified materials. This will reduce risk of bidders and definitely result in realistic bid.

Accordingly, the current and base price indices should not considered as unity in case of particular billing month otherwise the contractor will be in severe loss. In order to receive more competitive offers from reputable parties, the weightages should be determined as per guidelines without the restriction of any ceiling of fixed and adjustable portions in order to meet the net variation in price as may actually occur. Adjustment factor should be applied to the amount for the payment of work carried out in the subject month,

excluding provisional sums and the amount of the items mentioned in PEC guide line. Source of material prices i.e. FBS should be replaced with PICC source rates for specified materials like bitumen.

The research has shown that price fluctuation occurs any time; but the magnitude and occurrence time of price fluctuation, whether increase or decrease in price, is the most difficult to predict. It is difficult to predict accurately and determine how the price of materials would increase or decrease. The price escalation model will predict probabilistic factors for escalation of certain materials.

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