QUANTIFICATION OF ACCELERATION CLAIMS: A SIMPLIFIED APPROACH

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ALİ ÖZGE ILGAR

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Prof. Dr. Canan ÖZGEN
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Prof. Dr. Erdal ÇOKÇA
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Assoc. Prof. Dr. İrem DİKMEN TOKER
Co-Supervisor

Prof.Dr. Talat BİRGÖNÜL
Supervisor

Examining Committee Members

Asst. Prof. Dr. Metin ARIKAN	(METU, CE)	
Prof. Dr. Talat BİRGÖNÜL	(METU, CE)	
Assoc. Prof. Dr. İrem DİKMEN TOKER	(METU, CE)	
Inst. Dr. Engin ERANT	(METU, CE)	
M. Firat AYGEN	(Günsayıl İnş.)	

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Name, Last name: Ali Özge ILGAR

Signature:

ABSTRACT

QUANTIFICATION OF ACCELERATION CLAIMS: A SIMPLIFIED APPROACH

ILGAR, Ali Özge

M.S. Department of Civil Engineering

Supervisor: Prof. Dr. Talat Birgönül

Co-Supervisor: Asst. Prof. Dr. İrem Dikmen Toker

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Operating a successful business within the construction industry has become more difficult for companies as the profitability margins decreased considerably compared to previous years. Even, global economy has created an environment in which construction firms are enforced to bid projects at or below lowest profit levels. At the same time, owners are demanding more difficult projects without increasing the quality of contract documents. This has placed an added burden on the individual contractor to construct sophisticated projects. Under these circumstances, it is not surprising that the number of disputes within the construction industry continues to increase. Thus, contractors requested additional payments from the owners and the concept of claim and claim management developed. However, implementation of a well developed claim management process is crucial as the consequences and reimbursement depends on this process.

The objective of this study is to discuss potential sources of disputes and types of claims in the construction industry by focusing on acceleration claims. Quantification methods for owner directed acceleration are discussed as well as required documentation and claim management strategies for preparation of acceleration claims. Two different methods, namely theoretical approach and simplified approach, are presented here and examined in detail mentioning their advantages and shortcomings. These methods are applied to two different real cases, one in Turkey and the other one is abroad in order to have a better understanding of these approaches. Furthermore, a computer program is developed to carry out the calculations that constitute the necessary steps of simplified quantification method.

This study can be considered as a complete guide for young civil engineers about quantification and management of acceleration claims.

Key Words: Claim and Claim Management, Quantification of Acceleration Claims, Construction Delays, Disputes.

ÖZ

HIZLANDIRMA TALEPLERİNİN HESAPLANMASINA YÖNELİK KESTİRME BİR YAKLAŞIM

ILGAR, Ali Özge

Yüksek Lisans, İnşaat Mühendisliği Bölümü
Tez Yöneticisi: Prof.Dr. Talat Birgönül
Yardımcı Tez Yöneticisi:Doç. Dr. İrem Dikmen Toker
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Kar paylarının geçmiş yıllara göre dikkat çekici ölçüde düşmesinden ötürü, şirketlerin inşaat sektöründe işlerini başarıyla yürütmeleri oldukça zorlaşmıştır. Hatta küresel ekonomi öyle bir ortam yaratmıştır ki, şirketler artık projelere verdikleri tekliflerde en düşük kar payının bile altına inmek zorunda kalmışlardır. Aynı zamanda sözleşme dokümanlarının kalitesi artmamasına rağmen, müteahhit firmalar müşterilerden gelen daha zor ve kapsamlı proje talepleriyle karşı karşıya kalmışlardır. Bu durum çok yönlü ve karmaşık projelerin müteahhitlerine fazladan birim yük getirmektedir. Bu şartlar altında, inşaat sektöründeki müşterilerin ve müteahhitlerin arasındaki ihtilafların sayısının artıyor olması şaşırtıcı değildir. Sonuçta, müteahhit firmalar müşterilerinden ilave karşılıklar talep etmeye başlamışlardır ki, bu da talep ve talep yönetimi kavramlarının ortaya çıkmasına sebep olmuştur. Ancak iyi

geliştirilmiş bir talep yönetimi metodunun uygulaması çok önemlidir çünkü tüm sonuçlar ve geri ödemeler bu metodun uygulanmasına bağlıdır.

Bu çalışmanın amacı, hızlandırma taleplerini detaylı bir şekilde ele alarak tarafları anlaşmazlıklara iten potansiyel faktorleri ve inşaat sektöründeki talep çeşitlerini incelemektir. Ayrıca bu çalışmada, hızlandırma taleplerinin hazırlık aşamasında uygulanan talep yönetim stratejileri ve gerekli dokümantasyon ile birlikte işveren kaynaklı hızlandırma taleplerinin hesaplama yöntemleri anlatılmıştır. Bu noktada, teorik yaklaşım ve kestirme yaklaşım adı altında iki farklı yöntem ortaya konmuş, avantajları ve eksiklikleriyle detaylı olarak anlatılmıştır. Bu iki metod, yaklaşımlarının daha iyi anlaşılabilmesi amacıyla biri Türkiye'de diğeri yurtdışında olmak üzere iki gerçek örnek üzerinde uygulanmıştır. Ayrıca hesaplamaların yapılması için kestirme hesaplama yaklaşımının gerekli adımlarını içeren bir bilgisayar programı geliştirlmiştir.

Bu çalışma, hızlandırma talepleri ve bu taleplerin sayısal hesaplamalarıyla ilgilenen genç inşaat mühendisleri için kapsamlı bir yol gösterici olarak düşünülebilir.

Anahtar Kelimeler: Talep ve Talep Yönetimi, Hızlandırma Taleplerinin Hesaplanması, Süre Aşımları, İhtilaflar.

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To

My Family

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LIST OF ABBREVIATIONS

AAA	American Arbitration Association
BOT	Build-Operate-Transfer
CII	Construction Industry Institute
CPM	Critical Path Method
DAAC	Delayed, Accelerated, Added And Cancelled
EBD	Escrow Bid Document
IFC	Issued for Construction
ITP	Inspection Test Plan
LD	Liquidated Damages
MICS	Management Information Control System
PMT	Project Management Team
QA/QC	Quality Assurance / Quality Control
PERT	Program-Evaluation-Review Technique
ASCE	American Society of Civil Engineering

CHAPTER 1

INTRODUCTION

Day by day, it is getting tougher for firms, especially for construction companies, to be differentiated and distinguished among many others serving in the construction market. The rules are being standardized; the methodologies that lead to success are being restricted by the clients. Accordingly, companies are seeking new opportunities, new ways to strengthen their existence in the market, increase their success, reputation and profitability in order to lead the ones behind. Therefore, the companies are on the lookout for new projects to get involved to increase their turnover. However, the selection of company - which fulfills the requirements of the client like administrative and financial status, past experience (completion of similar projects in last five to ten years), some certificates etc. - for awarding the projects is determined mostly according to the lowest cost criteria. Therefore the efforts are concentrated on decreasing the cost as expected. The companies deployed various strategies to enhance their productivity and decrease the costs. Some of them are diversified (backward and forward), some established long lasting relationship with suppliers and/or clients etc. At this point, in construction market, the idea of claim management started to be pronounced frequently nowadays. In this chapter, some headings about claim management in this sector will be reviewed through literature survey.

As indicated by Kangari (1995), “the construction industry is increasingly burdened with disputes. Today, construction projects are the subject of more disputes than in any other time in history although the construction business environment has moved toward partnering arrangements. The sluggish global economy has created an environment in which construction firms are forced to bid projects at or below minimum profit levels. At the same time, owners are demanding more complex projects without increasing the quality of contract documents. This has placed an added burden on the individual contractor to construct increasingly sophisticated projects with fewer capital resources and lower-quality documents. Under these circumstances, it is not surprising that the number of disputes within the construction industry continues to increase."

Meanwhile, an advanced application of claim management comes to help at this stage in order to defend the rights of contractors against clients with documentation and math through which they can avoid further losses and gain additional profits. However, many of the problems in claim management involve quantification of concepts that are not easily measured, even conceptualized.

The claims of the contractor may sometimes be accepted by the client and through an agreement between parties containing information about offering additional time and payment conditions to contractor is settled so that the problem is resolved. However in most cases the disputes are carried to the courts. Therefore, it is very essential to pay attention to have solid evidences and proofs instead of void aspersions, to be able to defend the claims while dealing with laws.

Claims can be classified differently since they may ask for additional time or additional money depending on the situation. Nevertheless, it is important to illustrate some situations that contractor may go for claims:
Variations from the previous requirements of the contract like;

- Quality
- Quantity
- Shift of milestone dates

- Shift of project completion dates
- Force majeures
- Design changes
- Clerical but vital errors on IFC (issued for construction) drawings
- Change of working hours
- Change in ITPs (inspection test plans)
- Demand for Additional services

Extent of claims changes with respect to the project, role of parties etc. In general it is easier for a contractor to ask for compensation and/or time extension if he is only responsible for the construction part of the work, that is to say, he is not an EPC (Engineering Procurement and Construction) company. The organizational scheme of the project could be;

Client (the employer)
Main contractor (design and occasionally procurement)
Contractor (execution of the work)

This kind of an organizational structure may be an advantage for the contractor since the claims regarding the late delivery of materials, equipments and design mistakes could be raised against the main contractor since they will shift the subsequent activities and result with delay if no precaution is considered. On the other hand, for an EPC company the reasons that constitute the basis of claim are more limited.

Acceleration claims are in the picture where it is not possible to bear delay in projects. During this type of claim, the calculations mostly depend on the productivity in addition to rates of direct costs and indirect costs which include the wages of the labors (foreman and downward) and machinery/equipment involved in execution of the project. Nevertheless, the productivity rates will differ according to the location, type and working conditions of the project. The details of the concept are explained deeply in chapter two.

This study aims to develop a framework for construction companies to be used as guidance for managing acceleration claims and a computer program to determine the necessary steps to quantify both tangible and intangible concepts, so that the user will be able to calculate the incurred cost which was not seen during the bidding stage.

Next chapter constitutes the theoretical background and general view of acceleration claims. Definitions, reasons leading to acceleration, construction disputes, documentation, construction delays, productivity concept and the proposed methodologies for quantification of acceleration claims in literature are also be discussed in this chapter.

In the third chapter, the details of theoretical approach for quantification of acceleration claims are explained. The developed framework and its steps like sources/type of data to be utilized, mechanisms are explained deeply. Also in this chapter, a real project data is used to demonstrate the implementation of this method.

In fourth chapter, the second methodology, named as simplified approach, is discussed. The framework, necessary steps and fundamental assumptions of this quantification method is explained. Further, the shortcomings and advantages of the proposed methodology are listed in order to inform the user about the shortcomings of the approach.

CHAPTER 2

THEORETICAL BACKGROUND

Operating a successful business in the construction industry means conquering today's challenging conditions, rising costs, high competition, changing laws/regulations and more. The company managers and owners continuously seek new methodologies, innovations to overcome these hindrances so as to meet their goals and budgets.

Most construction projects both in Turkey and abroad involves a contract for design of the project followed by a separate contract for construction. Even if the client agrees on a "turnkey" contract with company, again different subcontractors are preferred by the main contractor for the execution of the project. At this stage considering the relation between main contractor and subcontractor, it is not so surprising to mention that their position is similar to the one between client and main contractor. Scott and Harris (2004) explained the purpose of contracts by stating that; the contracts for construction are governed by contract conditions that had developed over time and aimed to share the construction risks in a fair manner. Each party to the contract is also aware of their rights and responsibilities where the contractor is also aware of the opportunities to claim additional time or cost in particular to prescribed conditions.

Since 90's, the concept of claim management has spread widely among many companies in construction sector as it works well against the clients by providing additional profits to contractors. On the other hand, client's understandable dissatisfaction at being enforced to release large additional payments beyond the sums initially budgeted and assumed to be sufficient, damages the relation with the contractor. A survey study by Semple at al. (1994) concludes that the most common causes are increases in scopes, weather conditions, restricted access, and acceleration, in addition to the above causes Adrian (1993) indicated relatively low profitability of the construction industry and changing of product delivery, finally, Jergeas and Hartman (1994) made their contribution by adding other factors like; inadequate bid information, faulty or late owner-supplied equipment or material, inferior quality of drawings or specifications, and stop-and-go operations. Kumaraswamy and Yogeswaran (1998) based on 91 projects, concluded that the most crucial sources of claims are unclear or inadequate documentation, late instructions, variations initiated by the employer/engineer, measurement related issues, inclement weather, and time extension assessment.

The difference between how firms manage these claims, however, can impact their profitability both in the short term and the long term. Consequently, a good background with efficient knowledge is essential during both interpretation and application of Claim methodology in order to reach satisfying results, that is, knowledge is defined as one of the key elements through which an organization can reach to success. As indicated by Preskill and Torres (1999); increased globalization, changing workforce patterns and technology has led the transition to the knowledge era in which knowledge, not physical labor, remittances and assets, has become the most critical resource of and organization and the fountain of organizational and personal power. In addition to above statement, it is also crucial to be able to utilize the gathered information and knowledge in an efficient way so that an effective claim management strategy is determined and the claimant can take advantage of it.

2.1 CONSTRUCTION DISPUTES

Construction engineering and management involve concepts like project scope definition, management capability, project complexity and past contractor performance which are considered critical to construction success but difficult to quantify. AbouRizk and Dozzi (1992) cited;

> Complex projects often lead the contractors to underestimate jobs, designers to make mistakes and contractors are faced with tight budgets especially after committing to a competitive low-bid lump sum contractual arrangement. This frequently leads to disputes generally ending with expensive mediation, arbitration, or litigation.

Typically a dispute can be over an amount or entitlement (allocation of responsibility). Depending on parties' attitude and subject under discussion the disputes could require concentration on subjects described below;

Table 2. 1 1 Issue of Dispute by Mitropoulos and Howell (2001)

Position on Responsibility	Effect on Project: Small	Effect on Project: Large
Disagree	*Entitlement 2*	*Entitlement and Amount 4*
Agree	*Measurement of Solution Costs 1*	*Measurement of Solution and Disruption costs 3*

Disputes in category 1 require measurement; category 2 requires allocation of responsibility, whereas dispute in category 3 require a detailed analysis and quantification and finally category 4 requires liability assessment, calculation of disruption and solution cost. Most of the time, solution cost is calculated easily, on the contrary, quantification of disruption cost may be extremely difficult as this task may involve some allocation of responsibility.

Furthermore, the causes of construction disputes stem from multiple factors which are not directly measurable. Riad et al. (1994) listed unusual characteristics of construction disputes through which they are differentiated from other types of disputes. These are;

1. Construction disputes usually involve more parties and more contracts than just the general contractor, the owner and the agreement between the two
2. The issues commonly raised are diverse, numerous, complex and interwoven
3. The events leading up to the dispute may take place over months, or even years
4. The dispute often arises during, not after, construction thereby requiring immediate decisions and actions during the heat of battle rather than affording the parties a reasonable period for reflection, study, review and consideration.

The reasons of construction disputes may be classified according to the contractual language and its judicial interpretation, the technical causes of claims (Semple et al. 1994), the importance of front end planning (Vlatas, 1986, Halligan et al. 1987), contractual equity (Ashley et al. 1989) and parties' relationships (Kashiwagi et al. 1988). However, the concept cited by Mitropoulos and Howell (2001) "…consideration of individual factors and identifying how the interaction of technical, contractual and behavioral factors affects the dispute development process" is the key element in understanding construction disputes. Although it is difficult to quantify intangible variants of construction dispute elements, there has been a trend toward the use of multivariate regression techniques to measure these concepts as indicated by Russell and Jaselkis (1992); Sanders and Thomas (1993); Diekmann and

Girard (1995); and Molenaar and Songer (1998). There have been some proposed methodologies to be applied before execution of a project in order to be able to understand the susceptibility of that project to contract disputes. Through use of these methodologies, parties can have an early knowledge of the characteristics that correlates to disputes. Moreover, as cited by Molenaar et al. (2000), this knowledge "…allows owners and contractors to mitigate or avoid potentially costly and time consuming contract disagreements". Molenaar et al. (2000), classified characteristics that influence disputes into 3 main categories and described what these issues involve as following:

1. People issues
2. Process issues, and
3. Project issues

People issues involve organizations, relationships, roles, responsibilities, and expectations that affect these people. On the other hand, process issues involve the manner in which the contract and project are carried out. Finally, project issues include those characteristics that define the technical nature of the work. As per their study they concluded that; people do not cause disputes directly, but people do affect dispute performance more than any other variable. Even, large complex project or contracts with improper risk allocation are naturally tougher; the people have the greatest affect on the performance. The impact of the process issues falls somewhere between the impact of project and impact of people.

2.1.1 Driving Factors of Construction Disputes

According to Mitropoulos and Howell (2001) the basic factors that drive the development of disputes are (1) project uncertainty; (2) contractual problems; and (3) opportunistic behavior

2.1.1.1 Uncertainty

Uncertainty can be defined as the difference between the amount of information required to do the task and the amount of information already processed by the organization (Galbraith, 1973). Uncertainties are common to any task since every detail of a project can not be planned before work begins (Laufer, 1991). The amount of information required depends on task complexity, that is, the number of different factors that have to be coordinated, performance requirements like budget and time constraints. When uncertainty is high, initial drawings and specifications may change and project members are enforced to solve problems during construction.

Uncertainty remains unrecognized until the start of construction. The degree of uncertainty determines the number of problems. *The problem* is considered as an obstacle that causes a decrease in performance with respect to safety, cost, timeliness, quality or other project aspects that are to be achieved. The problems that initiate the dispute may be classified in to three parts as suggested by Mitropoulos and Howell (2001);

- *Work directives* like clarification of work requirements, omissions in scope of work, designs, plans and specifications.

- *Changed Conditions* such as lack of information during the planning stage, different site conditions, adverse weather, materials availability etc.

- *Contractors' Performance* may cause problems due to the difference between the actual performances of planning, production, support system and the anticipated performance of contractor.

If these problems can not be managed before they grow in to larger issues, the resolution of raised disputes is detriment to both parties as determination of the recovery costs and actions get more complicated.

2.1.1.2 Contractual Problems

Although there are many definition for contracts in the literature, the below two designations will provide a better understanding of the subject;

The participation of different parties in a project is governed by a contract, which defines the exchange of construction materials and services for money (Mitropoulos and Howell, 2001). In other words, a contract is a promise or the set of promises for the breach of which the law gives a remedy, or the performance of which the law in some way recognizes as a duty (MacNeil, p.693).

Classical Contracting attempts to regulate the exchange through contingency clauses and suitable for short term transactions. Contingent claims attempt to anticipate and resolve all possible contingencies at the out set. This contracting corresponds to ideal market transaction where the nature of agreement is carefully defined and limited; remedies are prescribed for a party's failure to perform as promised. A contract for procurement of a car could be considered as an example to this situation since the responsibilities are well defined and there is an agreement that the seller has to make the repairs after delivery on certain conditions. However classical contracting is not appropriate for long-term transactions executed under conditions of uncertainty such as construction projects. First, it is not possible to anticipate all potential contingencies. Second, the proper adaptations for many contingencies and their costs are not clear until the situation occurs. Finally, classical contracting gives rise to arguments over the truth, if changes are unclear (Williamson, 1979).

Mitropoulos and Howell (2001) listed the reasons of contractual problems as following;

1. The contract cannot predict all possible problem situations.
2. The parties may have a different perception of the facts of the situation
3. Differences may exist in the parties' perception of risk allocation. A study of contract clauses found that there are significant disparities among owners and contractors with respect to the perception of risk allocation of contract clauses (Ibbs and Ashley, 1987)
4. The integrity of contractual terms may be questionable. Such terms include clauses which are unfair at the beginning, or, because of later formal or informal agreement, some of the contractual terms may be invalidated. A study of differing site conditions claims revealed (Halligan et al. 1987) that the hard contracting approach (where the owner attempts to clearly shift all risks to the contractor) does not prevent claims, despite the clear allocation of risks. No matter what contractual clauses are used, the contractors do not accept the responsibility for a differing site condition, and find a path to be compensated.
5. Both parties may have failed to perform some contractual duty, making cause and effect analysis difficult.

2.1.1.3 Opportunistic Behavior

Since gaps in contracts are unavoidable, a mechanism is needed to govern contractual adaptations to the evolving circumstances. In the absence of opportunism, the gaps could be filled as they arose. Either contracting party has power to bargain whenever a proposal to adapt the contract is made. (Williamson, 1979). On the other hand, although both parties have long term interest in profit maximizing kind jointly, each also has an interest in gaining as much as they can on each occasion. An excessively opportunist party can take advantage of the other in order to maximize its own gains. At this stage the relationship of the parties become more important as they affect their ability to achieve agreement.

The three factors (uncertainty, contractual problems and opportunistic behavior) are similar to the three causes of disputes identified by the Dispute Prevention and Resolution Task Force of the Construction Industry Institute (CII) (Vorster, 1993);

1. Project uncertainty, which causes change beyond the expectations of the parties
2. Process problems, including imperfect contracts, and unrealistic performance expectations
3. People issues, problems due to poor communication, poor interpersonal skills and opportunistic behavior.

An opportunistic party may simply reject responsibility to avoid losses, or, claim that a problem existed in an effort to take advantage of the other party. However, (Mitropoulos and Howell, 2001) stated that, it is often hard to tell if a party acts opportunistically, or if there is an honest disagreement about the responsibility allocation. Misattributing the cause of the behavior by either party makes settlement difficult.

2.1.2 Model of Dispute Development and Resolution

Figure 2.1 showing dispute development and resolution process is introduced by Mitropoulos and Howell (2001) and presents the model of disputes, and the factors affecting the process.

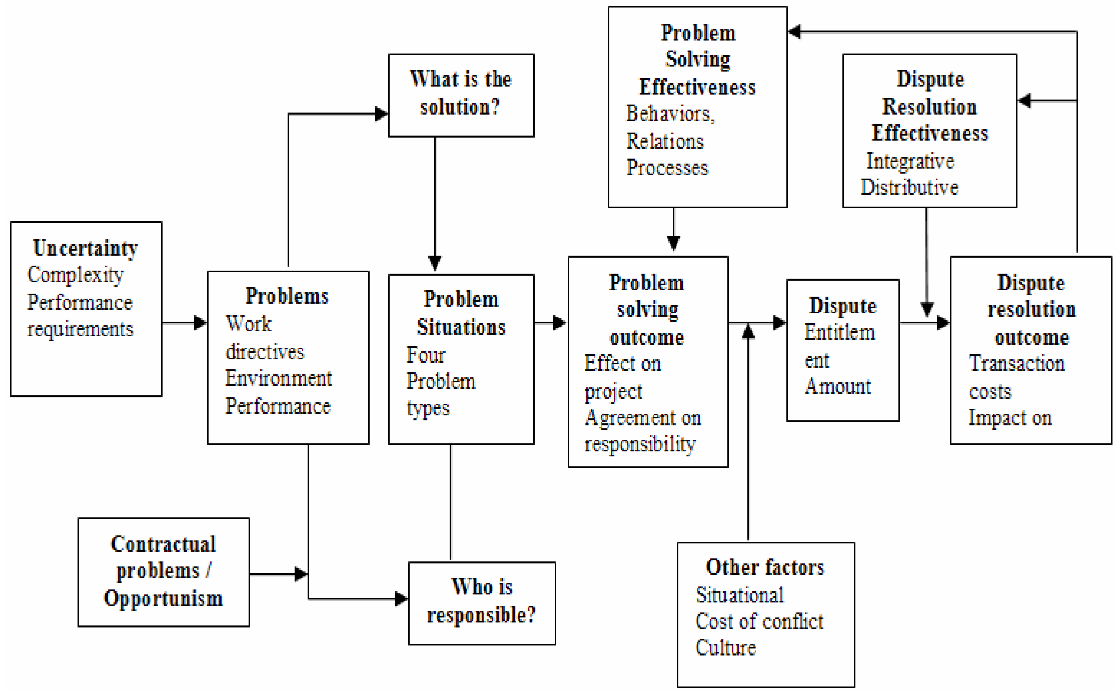


Figure 2.1 Model of dispute development and resolution by Mitropoulos and Howell 2001)

The arrows between factors illustrate that one factor causes another. An arrow pointing another arrow means that the factor influences the relationship between the two other factors. Mitropoulos and Howell (2001) cited that;

> "…in the problem development phase, uncertainty results in problems. The model shows that the problem complexity and the parties' positions on responsibility produce different problem situations. During the problem-solving phase, a solution must be found and responsibility must be established for any additional costs. The effectiveness of problem solving is influenced by the parties' behaviors, relationships and problem solving processes. The actual effect of the problem and the parties' positions on responsibility, determine the potential for dispute, which along with other factors, determines if a dispute will actually develop. If a dispute develops, a resolution process follows. The effectiveness of

> dispute resolution determines the cost of resolution and the organization’s ability to solve future problems.”

In order to have a better understanding of the proposed model, below headlines should also be clarified in addition to previously discussed subjects (uncertainty, contractual problems, opportunism, disputes)

2.1.2.1 What is the Solution?

Depending on the complexity and scope of the problem, solution uncertainty is determined, that is, a simple problem affects only few activities while having an obvious solution without any necessity of designer or other specialist. Whereas a relatively complex problem affects several activities and a thoroughly analysis is required, one of the several alternatives is to be decided by the involvement of project participants and/or specialists.

2.1.2.2 Who is Responsible?

Although contract is the departure point for each party’s position as it allocates the risks and responsibilities for potential contingencies, most of the time due to interpretation and complicated application of contract, it is not easy to evaluate responsibilities.

2.1.2.3 Problem Situations

All of the analysis indicate that problems are different with respect to the uncertainty of solution and the parties’ position on responsibility, either they agree or disagree on their responsibilities. According to the uncertainty and parties’ position on responsibility, problem situations are classified into four different groups as Mitropoulos and Howell (2001) stated;

A. The solution is simple/known and the parties agree on the responsibility.
B. The solution is simple/known, but the parties disagree on the responsibility
C. The parties agree over the responsibility, but the problem is complex and the solution uncertain
D. The problem is complex (and the solution is unknown) and the parties disagree over the responsibility.

Table 2. 2 Problem Situation Matrix by Mitropoulos and Howell (2001)

Agree on Responsibility	What is the Solution	
	Known	Unknown
Disagree	B	D
Agree	A	C

Actually, there is not a common rule that all problems result in claim, that is, many of them may be solved at the project level without becoming disputes. Effectiveness of problem solving plays an important role in outcome of a problem, resulting different potential costs. As cited by Mitropoulos and Howell (2001), the resolution of a problem requires finding a solution, and agreeing on responsibility. The resolution of problem leads to three types of cost; solution costs, disruption costs and resolution costs. Solution costs are the costs of the action to be taken to correct unsatisfactory actions like extra-work, overtime, extra-time and delays. Whereas, disruption costs are the expenses to be spent for finding a solution. Finally resolution costs are classified as expenditures of resolving the issue of responsibility. Resolution and disruption costs depend on the duration to determine and implement the solution. If quick responses to problems are given and urgent actions are taken, disruption and solution costs can be minimized.

2.1.2.4 Problem-Solving Effectiveness

Organizations' ability and approach to solve the problems and agree on their responsibility depends on parties' behaviors (compete or cooperate), relationships (previous experience with same party, perceived fairness of contractual risk allocation, previous dispute resolution process, events and behaviors during the project) and processes (project organization requires agreement on project goals, effective decision-making processes, problem solving and negotiation skills), explicitly, an effective project team can minimize the effect of large complex problems, while an ineffective one may exaggerate small problems and allow them to grow into larger issues.

2.1.2.5 Problem-Solving Outcome and Potential for Dispute

The effectiveness of problem solving process determines the problem's effect on the project (small–large) and the parties' position on responsibility (agree-disagree). Mitropoulos and Howell (2001) classified outcome of problem-solving into four categories as below;

Table 2. 3 Claims Matrix by Mitropoulos and Howell (2001)

		Effect on Project	
		Small	**Large**
Position on Responsibility	**Disagree**	*Small*	*Large*
	Agree	*Very Small*	*Small* *Medium*

The potential for dispute is defined as the difference between the owner's and the contractor's evaluations concerning the allocation of additional costs

2.1.2.6 Dispute Resolution Effectiveness

In the literature there are two main approaches to dispute resolution: (1) the adjudicatory approach and (2) the collaborative approach (Keating and Shaw, 1990). Both approaches are based on different assumptions and have different implications for dispute resolution.

2.1.2.6.1 Adjudicatory Approach

The assumption of this approach is "disputes arise when interpretations of people differ over the meaning and application of standards". Under this circumstance, conflict resolution requires a third party to evaluate the facts of the situation, allocate liability correctly to the parties, and finally to select and apply the appropriate standards. After completing the liability assessing phase, the determination of appropriate remedies takes place. However, again this is a difficult task since the faced problems may be very complex. Moreover, the high cost of litigation drove companies to select less formal (faster and less expensive) adjudicatory processes such as binding and advisory arbitration. In addition, as cited by Brett et al. (1990) adjudicatory processes typically require high cost procedures and the outcome drives parties to have more adversarial relationships. Also due to nature of resolution process, there exists high recurrence of disputes if parties are not satisfied with the outcome.

2.1.2.6.2 Collaborative Approach

This approach is based on the assumption that dispute arise when the behavior adopted by one party to fulfill interests, meet needs, or protect values which impacts adversely on the interests, needs, or values of the other party as cited by Keating and Shaw (1990). The main purpose of this approach is to maximize joint benefits and typically accomplished through meditation. The mediator tries to find mutually acceptable solutions by facilitating the parties' understanding of each other's objective. Reconciling interests has lower costs and tends to produce higher satisfaction with outcomes, better relations, and less recurrence of conflicts (Brett et al., 1990)

2.1.2.7 Other Factors

Other factors contain three subgroups which are; situational factors, cost of conflict and culture.

Situational Factors: The contractor's financial position may affect the development of disputes. For example, if the contractor is experiencing losses and cash flow problems (due to errors in the bid) even small issues may result in disputes, as the contractor tries to recover losses through increased claim activity (Diekmann and Nelson, 1985)

Cost of Conflict: The cost of conflict may prevent a party from pursuing claims for small amounts (Zander, 1982).

Culture: Certain cultures admire display of anger or stubbornness, while others consider avoidance of conflict which is extremely important in resolution of conflicts (Zander, 1982).

2.1.2.8 Dispute Resolution Outcome

Dispute Resolution Costs have four components (Brett et al., 1990); (1) transaction costs include the time, money, and emotional energy expended in disputing, and increase with the time it takes to reach a resolution (Halligan et al., 1987); (2) satisfaction with process and outcome depends primarily on whether the outcome meets the parties' interests and secondarily on whether the parties' believe the process was fair; (3) effect on the relation means both the outcome and the procedures affects' the parties ability to resolve future disputes and their ability to work together day-to-day; and (4) recurrence of disputes, that is, whether disputes stay resolved or recur.

2.1.3 Factors Affecting the Disputes and Resolution Process

Two main factors determine the parties' ability to resolve the dispute through negotiations; the potential impact on the parties' interest and parties' relationship. According to the contractors and the department's managers, the most important factor that prevented the resolution of claims, was strained relations between the contractors and the department (Mitropoulos and Howell, 2001). To illustrate, previous research on differing site condition claims has revealed that "contractors tend to appeal adverse decisions until they reach a level of dispute resolution where their interests are taken into consideration and the contract is interpreted loosely for the sake of fairness (Halligan et al., 1987).

2.2 CLAIM and CLAIM MANAGEMENT

The construction process became increasingly a dispute prone activity Riad et al. (1994) cited and added; the distribution of risks between the owner and contractor is tilting in favor of the owner, leaving the contractor with enormous risks, including inflation, strikes, labor problems, adverse weather, accidents, shortages of materials and skilled labor and unforeseen conditions at the construction site. Furthermore, the contract between owner and contractor is getting more complex day by day. The number of disputes increased significantly with the increasing complexity and magnitude of projects. The disputes should be resolved immediately, better if it is resolved within parties but not in courts, in order not to hamper progress, achieve project objectives and go out of planned budget. However, if one of the parties is not satisfied with the resolution, the concept claim and claim management come into picture. While there is no unique definition of the subject in the literature, a claim can be defined as "*right* given to the party who deserves a request for compensation for damages incurred by the other party" (Simon, 1979) whereas a construction claim can be named as "request by a construction contractor for compensation over and above the agreed-upon contract amount for additional work or damages supposedly resulting from that were not included in the initial contract" (Adrian 1993)

Approach of KMB Keller+Partners Company (www.kmb-kessler.de) authorities could also be accepted as a reference. They state;

> "Due to the special qualities of project business (e.g. long-term situations, complexities, variability in size of the delivery), not all events that take place during the course of project can be completely written down in advance or at the time the contract is being drawn up. Furthermore, disputes can occur that hinder the agreed progress of a project. Since changes or disputes in a project often lead to increased costs and delays, financial or scheduling demands (claims) may result in which one contract partner can make a claim against a third party

outside the limitations of the original contract. A claim is therefore a demand on contract partner for work that must be done in addition to the scope of the contract and was caused by the client or for expenses emerging from a subcontractor's or supplier's non-fulfillment of contract, either in quality or quantity".

Consequently, claims within a project or an order can be directed toward the top (against client), from the side (against a consortium partner) and/or toward the bottom (against the supplier) as illustrated in Figure 2.2 explicitly;

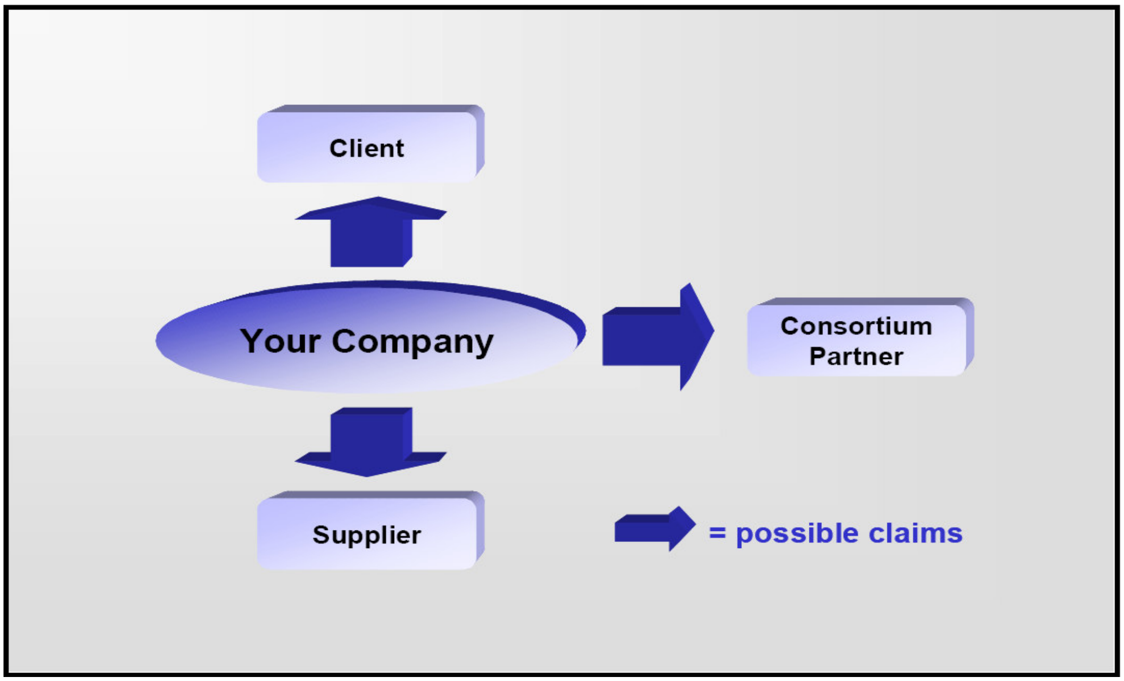


Figure 2.2 Possible external interfaces of a company that are in the focus of every Claim-Management (www.kmb-kessler.de)

Moreover, the concept of claim management is designated by KMB as an instrument to deal with and manage disputes during the course of a project, meanwhile, its primary task is identified as the early recognition and active management of potential and real changes that take place while contractual responsibilities are being fulfilled in order to forecast and quantify the effects of changes with a view of improving the project result. Briefly, claim management is a process that starts with the agreement of a project and gets completed with the finalization of the same.

Furthermore, according to Proclaim Management Solutions Company (www.proclaim.com.au);

> "Claim management is the application of the right resources to manage a portfolio of losses arising from anticipated company activities. It involves combining the right levels and amounts of internal technical expertise with systems and external partners to minimize a company's exposure to a series of anticipated (and sometimes unanticipated) exposures. When done correctly it should also produce risk management reports, which can identify corporate exposures and form the basis of an effective risk management strategy."

Zack (1993) classified claim types as below;

1. Loss of productivity claims
2. Cardinal changes; (US concept) a change to public contract which substantially changes the nature of the agreement and should have a separate procurement activity
3. Project float claims; include the principle that float belongs to the contractor – so a claim for a compensable delay even when the project is not delayed is noticed.
4. Acceleration claims

Although the claim types are different, the framework for claim process is applicable to all. The difference of pre-defined types is the reasoning and evaluation processes of these claims.

2.2.1 Claim Process Framework

The basis for any contractual claim must be founded in a clause of contract, but although identifying the circumstances where claim may be made, such clauses are often not exhaustive about how claim should be made. This often leaves much to the judgment of the parties concerned and therefore much on which to disagree (Scott and Harris, 2004). On the other hand, a well established and developed claim management methodology surely helps construction managers to assess the level of effectiveness for their construction claim and audit their organizations' construction claim process capabilities. As indicated by Kululanga et al (2001) the need for such a structured instrument for auditing construction contractor's claim process can not be overemphasized for the purpose of reducing time and cost increases. In order to be able to set up such a methodology, the variables should be determined carefully. The researchers were concerned with construction claim process and focused on variables that form it. Based on literature review, the researchers modeled and developed the construction claim process based on following variables. (Easton 1989; European 1996; Kartam 1999);

- Claim documentation
- Claim Identification
- Claim Notification
- Claim examination
- Claim presentation
- Claim negotiation

2.2.1.1 Construction Claim Documentation

Construction claim documentation constitutes a very important phase of claim management and thus explained in detail in the following section.

2.2.1.2 Construction Claim Identification

Construction Claim identification involves timely and accurate detection of a construction claim. This is the first and critically important ingredient of the claim process. For example, some construction claims of excellent merit are lost solely due to failure of identifying them (Easton, 1989). Hence, an awareness of job factors, which give rise to construction claims, is a skill that generally has to be specially acquired. Such knowledge not only make construction managers sensitive to possible construction claims but also exposes company-wide problems to management.

2.2.1.3 Construction Claim Notification

Construction claim notification includes alerting other party about a potential problem in a manner that is not unpleasant as time limit requirements are very crucial and critical. For example, a typical contract provision such as “shall be confirmed in writing as soon as practible and no later than twenty days” means exactly that (Sawyer and Gillot, 1990). An initial letter of claim notice to the other party should be short, clear, simple, conciliatory, and cooperative, that is to say, it should not contain any hostile information and approach to the subject in order not to create tension between parties at this early stage. The letter should point out the problem and alert to the other party of the potential increase in time or cost.

2.2.1.4 Construction Claim Examination

This step involves establishing the legal and factual grounds on which the claim is going to be based on. This should also involve the estimate of the possible recovery. Such issues may have to be investigated carefully and in detail by interviewing staff who worked on the project. The primary sources for claim examination could deal with project files, video recording if possible, memos etc. that must be used to prove the time and cost elements of the claim. Moreover analysis of the existing data via available programs like Primavera, Ms Project and office tools can come to help at this stage to forecast roughly the route of the project.

2.2.1.5 Construction Claim Presentation

A claim presentation should be logically built up, well organized and exactly convincing. Therefore, claim should be written in a format that emphasizes the fact that contract requirement was breached. A contractor must then demonstrate the resulting harm was caused by the owner's acts. Atkinson (1985) has appropriately said that presentation is best separated into two the entitlement and the quantum. The former section should have the legal and factual basis while the latter should provide the estimated recovery of the claim.

2.2.1.6 Construction Claim Negotiation

According to Easton (1989) an organized and proper negotiation preparation includes (1) ascertaining that all information is current and complete; (2) minimizing the scope of negotiation beforehand so that insignificant points should not precipitate a violent argument and disrupt progress; (3) knowing one's weakness and trying to utilize weak points by conceding them in return from the other party (4) foreseeing problems; and (5) anticipating the opposition's next move. To benefit from this stage, a contractor needs experts that have skills for negotiation. It is more important to be prepared than it is to be right. Therefore getting help from experts or consultants may be advantageous if the project team dealing with the claim is insufficient. Moreover, in construction disputes, it is often difficult to determine the “right” whereas it is the preparation for negotiation that really counts.

2.2.2 Claim Management as a Strategy

In view of the fact that, through a successfully implemented claim management, additionally generated income (up to %25 depending on the size of project) is realized by the company, can it be used as a strategy?

Nowadays due to challenging situation, companies accept orders under conditions which are not reasonable and even not achievable. Even though profit margins are relatively low they still are barely acceptable by the clients. Most of the time, contractors disregard safety and risk premiums in order not to jeopardize the chance of receiving the project. Especially in a competitive bidding system and public funded projects, it is not unusual for contractors to bid low on a project and hope to recover the loss through negotiations and claims. This approach is named by Zack (1993) as “bid your claims” meanwhile the same approach is called as “opportunistic bidding” by S.Ping Ho and Liang Y. Liu (2004). However, considering the shortcomings of this approach this option is mostly neglected by contractors. Opportunistic bidding may lead to unanticipated results like damaging the relationship with the client therefore loosing the possibility of getting new jobs from them. Moreover claim negotiations could end up unexpectedly so that the case could be directed to courts. At this stage, risk of loosing the lawsuit should be considered thoroughly since the court will cost extra amount to the contractor.

2.3 DOCUMENTATION DURING CONSTRUCTION

Claim documentation is collection of hard facts that give the actual history of a construction claim and plays an important role in the claim process since it stands as an aid for contractors to justify their claims. A well prepared defendant quickly demolishes evidence and claim costs that are not supported by accurate reports. In deed, having signed documents by the client is very important to beneficiary since the objections to these documents will be nothing but void. According to Kululanga et al. (2001);

> "Minute inaccuracies can be seized upon to cast doubt on the entire claim. The documented facts are the glue that holds legal framework together. If these are inadequate the claim will not stick."

Arbitrators give advice to construction professionals to properly record project information before a dispute arises. According to them, the party keeping the most comprehensive and detailed records will have advantage in any dispute-resolution proceeding. Arbitration remains the preferred alternative method to litigation for resolving disputes within the construction industry; however, other dispute-resolution methods such as mediation, dispute resolution boards and minitrials are gaining popularity although majority of construction disputes are resolved through mediation. During these procedures the evidence presented is primarily document based. According to these document based information, arbitrators reconstruct the circumstances/story under which the dispute occurred. As cited by Kangari (1995), this enables the arbitrator to evaluate the merits of each case presented and to determine which party, if any, deserves an award. Thus, without adequate documentation, a claimant or respondent will have a difficult time proving the standing of his or her case to a panel of arbitrators. He also mentioned that, when a dispute arises during the project, it is far more likely to be settled in an expedient manner if proper management of document based information has been maintained.

Kangari (1995) evaluated the subject under 4 groups as below;

Document-Based and Document-Supported Evidence

- Construction Schedule
- Video and Photographs

Effectiveness of Testimony in Support of Document-Based Evidence

- Firsthand Witness versus Written, Dated Documentation
- Expert Testimony in Support of Document-Based Evidence

Project Documentation and Daily Information Management

- Recommendations for Project-Management Information-Control System
- Differences in Documentation for Potential Disputes

Document-Based Information and Inadequate Documentation

- Presenting Documentary Evidence
- Effect of Poor Documentation on Case Outcomes
- Problematic Document-Related Issues

2.3.1 Document-Based and Document-Supported Evidence

2.3.1.1 Construction Schedule

The construction schedule determines the approach of contractor to project in means of timing, sequence and coordination of the construction process. The nature of claim determines the role and the importance of the schedule in arbitration process. In cases dealing with delays, acceleration or other time-sensitive issues the construction schedule is the critical piece of evidence examined by the arbitrators (Kangari, 1995). If the claim depends on schedule related items generally the parties present four separate schedules.

1. As-planned or original schedule
2. As-built schedule

3. Modified as-built schedule, reflecting all delays – owner, contractor and excusable
4. Adjusted schedule, to establish completion of the project absent of owner delays

According to the survey investigated by Kangari (1995) the arbitrators were divided almost evenly (47% vs. 53%) over the issue of critical-path-method (CPM) schedule versus the simpler bar chart presentation, more specifically, arbitrators with legal background were likely to favor the simple bar chart presentation supplemented with credible, expert testimony, whereas arbitrators with construction backgrounds favored the more complex CPM or program-evaluation-review technique (PERT) charts. However, the best method is preparing both versions if it is considered by contractor that the schedule is to be a material part of the claim.

2.3.1.2 Video and Photographs

Video and photographic evidences show the actual job progress and status of a project at a specific point in time. They also play an important role in case-specific issues like lack of compliance to standards, poor workmanship, and damage claims. There is a common thought among arbitrators like “a picture is worth a thousand words” which highlights the vitality of this type evidence. Although they both present visual evidences, videos are considered more boring since it takes more time and they are rambling when compared to photos. Whether videos or photographs are used, the usefulness of these evidences is highly dependent on how well they are taken during the project. Kangari (1995) cited that, the arbitrators make the following suggestions for use of such visual evidences:

- **Timing**: the photos and/or videos should be obtained before construction starts, and they should be taken periodically in synchronization with progress payments and of course if a significant incident occurs in any time during the project life.

- **Control**: each photo should be signed and dated mentioning also the location.
- **Scope**: Specific items should be recorded and full job views should be taken.

These evidences should be organized and presented chronologically to show a logical sequence of the evident. Further, the submitted photos/videos should also include notes and captions to explain their relevance to the subject. It is also better that they are explained by project personnel during arbitration.

2.3.2 Effectiveness of Testimony in Support of Document-Based Evidence

2.3.2.1 Firsthand Witness vs. Written, Dated Documentation

Testifying firsthand witnesses supported by credible, dated documents are beneficial for arbitrators under ideal circumstances. However due to nature of construction projects it is not always possible to have all the evidences which are consistent at the same time. As Kangari (1995) mentioned arbitrators have 3 distinct views about the subject like; 35% of 54 arbitrators surveyed indicated that if all other conditions considered equal, document-based evidences are advantageous over testimony, whereas 39% favored the testimony of a firsthand witness over a dated document. And the remaining 26% maintained that it depends on the situation. In details the surveyed arbitrators defended their standings on valid foundations. Arbitrators who supported witness testimony over document based evidence considered that it is more crucial to have the luxury of cross-examining the witnesses. Documents are inadequate as they could not be cross-examined. On the other hand, arbitrators who favored written contemporaneous documents believed that witnesses may change their positions to meet their counsel’s expectations however; document-based evidence better reflects the parties’ true intentions at the time.

2.3.2.2 Expert Testimony in support of Document-Based Evidence

A realistic expert witness is an extremely valuable asset to the arbitrator, that is, a qualified expert can analyze large volumes of documents and present summarized results and/or can explain complex or unusual topics in areas beyond the arbitrator technical experience. Therefore, an arbitrator does not waste his time on irrelevant issues rather concentrates on most significant subjects. Furthermore, an expert witness gives the arbitrator an opportunity to ask questions about anything if a clarification of this particular issue is required.

Kangari (1996) indicated that the arbitrators surveyed designated that the credibility and objectivity are the most important characteristics of a “good” expert witness as his testimony can add strong support to document-based evidence. Beyond the advantages of expert testimony, there are some drawbacks such as the occurrence of conflicting testimonies of rival experts. Moreover the expert witness may be less knowledgeable about a particular subject than the panel arbitrators.

2.3.3 Project Documentation and Daily Information Management

2.3.3.1 Recommendations for Project-Management Information-Control System

The most common and complained problem in construction companies is the poor record keeping as most managers believe that their primary job is to construct the project not to build monument of documentation. However, a good information-control system should be set up at the very beginning of the project as project information begins in the day the decision is made to bid on the contract and continues until final acceptance is received from the client. As Kangari (1995) cited, a management information-control system (MICS) from a construction manager's perspective can be defined as a process of documenting transactions (project activity), communicating, and maintaining information by a consistent and ordered method. He also listed the types of data controlled by a typical MICS as;

1. Raw data: basic information that furnishes factual support for technical information like building codes, test data, and topographical surveys.
2. Fundamental documents: written material establishing essential criteria for the project like contract documents and agreements, project manual, and master schedule.
3. Transaction documents: documents that have as their fundamental purpose the documentation of a specific project activity such as; request for proposal, request for information, change orders, field reports, and meeting minutes.
4. Transaction files: the method by which transactions are recorded through their progression with the project; for example, RFI log, shop-drawing/submittal log, and bid tabulation forms.
5. Technical products: documented results of a technical or analytical effort on the project; like, estimates, cost records, quantity take offs, as-built schedules, and value engineering studies.

Since the documentation plays an important role in several areas, an organized and functioning documentation procedure should carefully be implemented during the project. More specifically;

- Daily reports about progress, spent man-hours, inspections, weather, unusual conditions should be prepared by site supervisors. Although site supervisors do not like paperwork this is one of the most important phases of documentation.

Therefore, the use of small tape recorder may be practical without any loss of effectiveness. Thereafter these tapes could be sent to technical/head office to be written down by the secretary.

- The reports gathered at site should be directed to both technical office and head office to be filed and utilized as database.
- If allowed, photos should be taken within predetermined intervals (weekly) and on special occasions.
- Written letters should be issued to confirm immediately verbal agreements and prevent any abuses
- All received documents/files should be date-stamped, even time should be indicated.
- All correspondences should be answered promptly to expedite the resolution of faced problems.
- Duplicates of all files should be stored in case any original gets lost.

Nowadays, the storage of documents in computer databases is trendy among comparatively larger contractors easing the procedure. Kangari (1995) highlighted the main problem in this area as “The main drawback is not the sophistication of the technology but the ignorance of users”

2.3.3.2 Differences in Documentation for Potential Disputes

Contractors/owners intend to record, organize or store project documents differently if they feel that a particular issue is open to any discussion and dispute. They would like to record extra information and keep additional files like supplementary photos, notices of potential claims, RFIs, change notices and change orders. However, if each job is organized and based on a comprehensive filing system, no additional documentation will be necessary. In addition, it is believed by arbitrators that, “if there is a need to give added emphasis to particular claim then the filing system in use is inadequate and should be improved”. Briefly, the projects should be conducted as if they were headed for litigation and the authorities should act accordingly in order to have a complete documentation.

2.3.4 Document-Based Information and Inadequate Documentation

2.3.4.1 Presenting Documentary Evidence

Presenting the evidence is as important as having well organized documentation. Therefore the authorities highlight some points to be paid attention.

- Arbitrator's viewpoint should be clearly identified and the organization of presentation should be accomplished in a way that he will like
- Chronological order should be followed in order not to cause any confusion
- The evidences should be shown to all arbitrators and the documentary evidences should be summarized whenever and wherever possible
- The tendency to over document should be avoided not to overwhelm the arbitrators.

2.3.4.2 Effect of Poor Documentation on Case Outcomes

Poor documentation is a serious problem since it may alter the outcome of the case and claimant may loose the case although he deserves compensation. To illustrate, due to missing material delivery receipts the contractor may not prove the default of client who is responsible of shipments or missing weather reports may play a crucial role if the location of site is not close to any residential area.
Two different approaches may lead to poor documentation; mistake/oversight and deliberate omission. Basically, claimants' intention is to present documents which support his case which is considered a conscious omission. In this case, the arbitrator's situation is rather difficult since he has to go beyond the claim

and analyze what has happened to reveal the evident. On the other hand although oversight also complicates the situation, it is easier to deal with this kind of problem since the claimant does not wish to hide the facts of the situation.

2.3.4.3 Problematic Document-Related Issues

Joseph Kangari (1995) listed five major problems which are encountered by the 52 arbitrators (members of American Arbitration Association (AAA)) participated in his survey.

- Too voluminous, irrelevant or redundant (50%)
- Not summarized (35%)
- Disorganized/poorly indexed (20%)
- Inferior presentation (13%)
- Inadequate/incomplete (13%)

In point of fact, forming a group involving competent legal counsel for collection of document-based information is the best way to have proper well organized information about the project. Although it has an initial cost, it pays back almost all projects.

2.3.5 Escrow Bid Documents

Many methods of dispute avoidance and alternative dispute resolution are being used to evade increasing problems and costs associated with construction claims such as partnering, design/build construction methods. However, according to Schroedel (1997) the use of escrow bid documents (EBDs) is forgotten which could be utilized for many types of construction. Parenthetically, the word “Escrow” is defined as an amount of money or property granted to somebody but held by a third party and only released after a condition has been met (Microsoft® Encarta® Reference Library 2003). Purpose of EBDs is to preserve the bid documents of the successful bidder for use by parties in any claims or litigation between the Department and Contractor. EBD consists of all writings, working papers, computer print outs, charts, quantity take offs, calculations, quotes, consultant's reports, notes and other information which is believed to be essential to be used by a bidding contractor to calculate bid price. It also includes contractor equipment rates, overhead rates, labor rates, efficiency or productivity factors, and quotations from subcontractors/material suppliers. All of this information, upon being escrowed for protection constitutes the files of EBD which will be the basement of claim if any deviations are observed other then the available information during the bidding phase, that is, if a dispute arises; these documents will prove how the project was bid. As Schroedel mentioned, based on experience and work of the American Society of Civil Engineering (ASCE) Technical committee, EBD documents should include;

- Scope. Who provides what material.
- Ownership. The EBD remains the property of the contractor.
- Purpose. Only for resolution of disputes
- Format and contents. What must be provided, noting no specific format is required.
- Submittal. Description of submittal requirements
- Storage. In mutually agreed upon location, paid for by the owner
- Examination. Procedures and requirements prior to escrowing
- Final Disposal. Returned to the contractor upon project completion.

2.3.5.1 Typical Procedure for EBDs

Firstly a predefined format is prepared and the formed booklet is set up. This is a signed, sworn statement by the bidding contractor that the documents consist of all of the information used during bid stage. This booklet is sent to two three lowest bidders to submit their EBDs in case the apparent low bidder is unable to execute the contract. According to these documents, the second lowest responsive/responsible bidder is selected by the owner and the EBDs are placed in a sealed container. Thereafter, the EBDs are jointly examined by the owner and contractor to ensure completeness, legibility and organization of the information. If there exists any deficiency, the parties agree on what additional information is required. Upon completing the inspection of EBDs, these documents are stored at a mutually agreed location like banks or escrow services. Finally the contract is awarded and EBDs of other bidders are returned.

2.3.5.2 Typical Concerns

The bidding contractors have many concerns with providing copies of their bid documentation, which may contain innovative construction procedures and proprietary know how information. Therefore, there is a serious concern about the protection of EBDs. It should be clearly understood that the EBDs remain the property of the contractor, that is, without the approval of contractor they should not be subjected to disclosure in response to bid protests, public open document etc. Furthermore, it must also be clear that the EBDs should not be considered as the attachments of contract as they do not modify any of the contract documents. They should be regarded only as references when a specific dispute arises after the award of contract. Briefly, EBDs are under the property of the contractor although the cost of escrow is borne by the client. The client has no right to the bid documentation other than to verify the contents and legibility of the bid documentation unless a claim is received or litigation ensues between the contractor and client.

2.4 ACCELERATION

Schedule acceleration as described by Thomas (2000) is having more work to perform in the same period of time or having a shorter period of time to perform the same amount of work. Acceleration of the work is noticed when the contractor tries to speed the progress up through additional workforce, extra equipment, overtime work, night operations or any other means that increase the pace. However, if acceleration is attempted by taking one more personnel, than the effect is less than expected, or it may have consequences that are costly – to illustrate, after having hired an extra labor, it is not easy to fire him at will so mostly management might need to keep the workers idle, or work on tasks in a non-optimal sequence to keep the workforce occupied, or even work on tasks before being given client approval. Actually, such an action might even be counter productive. On a normal project, the amount of work available to be performed, or work flow, follows a predictable pattern. The amount of work available, increases at a steady pace during the bulk installation period. At some point in time between the milestones of 50 and 85% of elapsed time, a peak is reached, followed by steadily declining work available as the building systems are completed. When work is made available in an inconsistent way, labor inefficiencies occur. This condition is true whether too much or too little work is made available.

For the responsibility allocation different scenarios may be faced. If the owner desires to have the work completed before it is supposed to be, he is entitled to order the contractor to accelerate the pace of the project. Definitely, in this situation the owner issues a written request and signs a formal change order demanding the acceleration. Accordingly, the contractor receives additional compensation. However, when the contractor falls behind the pre-determined and agreed schedule and the reasons are not excusable, surely he is the responsible party to take necessary actions in order not to suffer from liquidated damages. In this case the expense incurred is solely belongs to the contractor.

Reid et al. (1994) explained the condition that leads to dispute as following;

> "Disputes arise, however, when the owner refuses a request for a time extension, or the owner implies in his communications with the contractor that the contractor must accelerate the pace of construction to avoid imposition of actual or liquidated damages. The contractor, rather than relying on his entitlement to a time extension and subsequently seeking to obtain funds withheld by the owner for the ensuing delay, may interpret the owner's action as requiring acceleration in order to complete the work according to the original schedule. In this event, he may assert a claim for "constructive acceleration" against the owner, seeking to recover all costs both direct and indirect."

Issues (1988) listed necessary elements to be present in order for the contractor to recover his costs from the owner.

- There must be a period of excusable delay
- The owner must be given notice of delay, unless the pertinent information is already known to owner
- The contractor must submit a timely report for a time extension, in compliance with the contract requirements
- The contractor must give the owner a reasonable opportunity to grant or deny the request
- The owner must indicate that he will insist on completion by the originally scheduled completion date
- The contractor must actually accelerate the activities in the remaining portion of the project in an effort to meet the un-extended date, which results in additional costs

Again, in acceleration claims, Critical Path Method (CPM) is utilized to determine the cumulative effect of delays on project duration and to evaluate the effect of owner-directed acceleration. Thus, if acceleration is ordered for only one specific activity, then its effect on total project duration and the extra cost involved can be calculated easily. Nevertheless, if acceleration is requested for many activities in a project due to reason that the project was delayed by owner and/or contractor-caused events, the allocation of extra acceleration cost between parties is not that much simple. In order to resolve this problem and reach a fair and reasonable solution, Arditi and Patel (1989) proposed a procedure which includes a mechanism called “time impact analysis”. Time impact analysis is a procedure that involves the use of network-based scheduling tools to identify, quantify and explain the cause of schedule variance (Lee, 1983). So as to implement time impact analysis proposed, it needs five types of network schedules which are similar to the ones explained in construction delays section besides having small differences.

1. The as-planned schedule: This is the original work schedule prepared by the contractor at the inception of the work.
2. The As-built schedule: It presents the actual sequence of events which occurred during the life of a project up to a given point of time. It contains all delayed, accelerated, added and cancelled (DAAC) activities that took place in the completed part of the project.
3. The adjusted schedule: A series of adjusted schedules are prepared to explain the sequence of events which transform the as-planned schedule into the as-built schedule
4. The as-projected schedule: Once all the work changes and delays are considered and as-built schedule is generated for a given point in time, the expected project completion date has to be calculated. If the project is complete, definitely the project completion date is the one shown on the as-built schedule. If the project, however, is not complete, remaining activities in as-planned schedule should be added to the as-built schedule to reach an as-projected schedule showing the expected project completion date

5. The contractor/owner-accountable schedules: The responsibility for each DAAC events that occurred in the accomplished portion of the project is assigned by using the contract documents, the chronological delay information collected during the project. With that respect, the contractor-accountable schedule contains all DAAC activities that were caused by the contractor. On the contrary owner-accountable schedule contains all DAAC activities that were caused by the owner.

Obviously, for time impact analysis (for CPM analysis) activity durations and logical relationships between activities are required. At this point any project management package such as primavera or MS Project would be sufficient. In order to carry out a time impact analysis one should start with comparing planned dates and actual dates of the activities (early start, late start etc) so as to determine the delayed, accelerated, added and cancelled (DAAC) activities. Using planned and actual dates of activities, it is possible to generate a projected schedule. At a specific point, the actual dates of the activities that are completed up to that date are taken (as-built schedule), for the activities that are not started or still in progress planned durations (as-planned schedule) are added to sequence and accordingly through CPM analysis, with a small assumption (on going activities have no delay at that specific time) the completion date of the project is forecasted (as-projected schedule) by observing the combined effect of all DAAC activities. However, in order to evaluate all DAAC effects separately, these activities should be inserted to as-planned schedule one by one and the result (as-projected schedule) should be monitored. Since there are some floats for activities that are not in critical path all DAAC activities will not shift the project completion date.

When all DAACs are determined, the next step is allocation of responsibilities. The person from project management team should be questioned to identify the default party for every single DAAC activity whether this one is cancelled, added or there is a specific agreement for it between parties.

Two main concepts constitute the basis of acceleration claims. The first one is the construction delays and their allocation on parties and the latter is the productivity concept. Since this thesis is focused on accounting of acceleration claims, general views of mentioned subjects are given and not discussed in detail in following sections.

2.4.1 Construction Delays

Completion of project within the prescribed time scale, budget and with appropriate technical performance/quality is an important measure of a successful management of construction project. As indicated by Williams (2001); projects have tended to become more time constrained, and the ability to deliver the project quickly became an increasingly important element in winning a bid in recent decades, further, there is an increasing emphasis on tight contracts, using prime contractor ship to pass time-risk on to the contractor, frequently with heavy liquidated damages (LDs) for lateness. Unlike the budget problems, to determine and calculate the direct effects of delay is more problematical and intricate since it does not have straight monetary terms. If any delay occurs on completion date; it will cause financial penalties, loss of reputation, loss of profits that would have accrued through use of project (like in BOT projects). Delays should be investigated thoroughly and carefully as the results may vary widely. Some may not affect the whole project, that is, their impact is solely the cost of resources working at a reduced efficiency. These activities are considered to have float time within the programme, and their influence on the project is limited. Whereas, some delays do impact the project completion and accordingly their financial implications are much greater. It is crucial to be able to prove that a delay affects the overall project completion date if any considerable reimbursement is to be requested for recovering the delays.

If there are limited number of delays or disruptive events (and, if change orders are an issue, the number of change orders is not sufficient to constitute a “cardinal change”), then simple network based methods can be used. Otherwise, if there are many events affecting the project, or the project was so complex that the out-turn can not be intuitively expected from the effects known to have a triggered behavior, it is necessary to understand why the out-turn occurred and to trace the casualty from triggering effects. Critical path method (CPM) is applied to solve such problems. CPM networks can give the answer “what would have happened...” (had this effects not compounded together, had there not been systemicity within these effects; in particular, had management not acted in response to the triggering events and for example accelerated the project). Below listed some reasons that cause delays:

Table 2. 4 Reasons of Delays (proposed by Yates 1993)

Engineering	Inaccurate drawings Incomplete drawings Late engineering
Equipment	Equipment breakdowns Equipment delivery Improper equipment Shortage of equipment
External delays	Environmental issues Later than planned start Regulatory changes Permit approval
Labor	Craft shortages Labor productivity Labor Strike Rework
Management	Construction methods More work than planned Quality assurance/quality control Schedule too optimistic Not working on critical tasks
Materials	Damaged goods Improper tools Material delivery
Owner	Change orders Design modifications Inaccurate estimates Owner interference
Subcontractor	Bankruptcy Subcontractor delay Subcontractor interference
Weather	Freezing Heat and humidity Rain Snow

Furthermore, if a delay occurs, the determination of the responsible party will be the most important issue since consequences may range from an agreed extension to the project time with payment of the Contractor's overhead cost to the deduction of liquidation damages from the contractor. Because of the many sources and causes of construction delays, it is often difficult to analyze the ultimate liability in delay claims (Kraiem and Diekmann, 1987). After settling on the responsible party, the application of the remedy is straight forward.

Although the contract between the parties determines the remedy, the common resolution may be as shown in table 2.5;

Table 2. 5 Possible remedy as per the responsible party (Yates 1993)

Responsible Party	**Remedy**
Employer	Extension of time with recovery of overhead costs or directed acceleration with additional cost (agreed btw. parties)
Contractor	No compensation in either time or cost
Neither party	Depends on contract but commonly, extension of time without any additional cost

Meanwhile, the similar approach named differently by Williams (2001) and he classified the situation in to three groups as given in table 2.6;

Table 2. 6 Classification of parties' defaults and possible remedies by Williams (2001)

excusable / compensable	The client's fault, so the contractor gets extension of time and delay damages
excusable / noncompensable	Not the client's or contractor's fault, so the contractor gets an extension of time but no delay damages
non-excusable / noncompensable	The contractor's fault, so no extension of time, and indeed the client can claim damages

Inadequate supervision and technical support, late agreements with subcontractors/suppliers, insufficient workforce, rework, delay in producing as-built drawings are the major examples to contractor-responsible delays. Whereas changes to contract documents, request of suspension, additional works to be carried out at a particular stage, failure to provide land and/or information within a predetermined duration, failure to approve or at least comment on Contractor's method of working expeditiously could be listed for employer-responsible delays. Finally, delays due to neither party may be listed as; adverse weather conditions, strikes and force majeures (events completely unpredictable).

An analysis using CPM should be carried out to demonstrate the consequences of the delay. To implement this methodology Scott (1993) indicated in his article that four CPM diagrams should be prepared. These are:

- As-planned CPM
- As-built CPM
- As-built CPM with all delays
- Adjusted CPM

2.4.1.1 As-planned CPM

A reasonable 'as-planned' CPM is constructed to determine the schedule and the sequence of construction that is planned by contractor. It measures the contractors planned performance and time allocations to the activities. However as cited by Bramble and Callahan (1992); it does not measure the effect on the actual performance which will be considered as a bottleneck for the methodology. Furthermore, in order to perform a complete analysis, all the requests of clients should be awaited thereafter the schedule should be recalculated.

An as-planned schedule should maintain the followings in order to be useful.

As-planned schedule is the basis of the contractors bid, that is to say, prepared before the execution phase. Accordingly getting signature from an authorized representative of the client on these documents is crucial so that they can be used for delay analysis.

The logic, work sequence of the schedule should be correct and applicable.

The durations assigned for activities should be correct. Specifically, the set-out durations "tie" to the estimate and can be derived by a calculation that recognizes the quantity of work to be performed, a reasonable estimate of productivity, and an assignment of crew size (the size that was actually used) (Adrian, 1988)

2.4.1.2 As-built CPM

An as-built CPM presents the actual starts ad ends of all activities. Through this, the actual critical path may be identified. This procedure, sometimes referred to as the "Traditional Method", is the most frequently used and easily recognized, but the most misunderstood and misused Delay Analysis Method (Bramble and Callahan, 1992). After getting approval for the as-planned schedule, the detailed as-built schedule is developed as per the project records noting that as-built schedule should correspond to the activities included in as-planned schedule. The comparison of as-built and as-planned schedules reveals the delay under consideration. Thereafter, the next step comes into picture which is the allocation of responsibilities for the delays incurred.

2.4.1.3 As-built CPM with all Delays

An as-built CPM reflecting all delays shows the delays for which the employer, the contractor and neither party are responsible. As-built CPM with all Delays diagram may be considered as an overlay on previous as-built CPM that serves to segregate the delays and any knock-on effects encountered into those for which the employer, the contractor or neither party were responsible (Scott, 1993)

2.4.1.4 Adjusted CPM

An adjusted CPM is used to establish the time for completion of the project in the absence of *employer delays*. This presents the delays that are attributable to contractor and neither party delay. The project completion date is calculated. The completion date difference between two CPMs presenting all delays and delays caused other than employer gives the amount of delay for which the employer is liable in terms of both cost time. The work in the field does not often match the theoretical activity breakdowns of a planned network schedule (Harris, 1978; Brample et al., 1990; Callahan et al., 1992). Due to this reason, it was reported that as-built method is an unreliable procedure to accurately measure the impact of a project delay on affected activities.

Although use of CPM method stands as an aid, it has its own bottlenecks due to which interpreter should pay enormous attention before reaching any conclusion. Hohns (1981) cited that as-planned CPM does not reflect the sequence of work as actually intended and performed. It is more like a guess of what should have happened throughout the project life. He also adds that the schedule may be changed before the delay (due to any reason), so it is not correct as it stands but must be modified leading to change of critical events and finally critical paths. Cushman et al. (1996) indicated that, there are many possible critical path schedules for any particular project depending on variables such as projected or actual material, labor and equipment resources, and depending on the sequence preferred by the superintendent in charge. In addition, as-planned schedule almost always differ from the as-built schedule, because as the project moves forward, contingencies arise, that delay some activities and accelerate others so that the critical path changes.

2.4.1.5 Concurrent Delays

These types of delays are described by Rubin et al. (1983) as two or more delays that occur at the same time, either of which, had it occurred alone, would have affected the ultimate completion date. However in concurrent delays both parties allege that the other party should be kept responsible, claiming that even if they were not in default the project's completion date would have been postponed. Hughes (1983) explained the philosophy behind this procedure as; once the job is stopped by one cause of delay, it cannot be any more stopped by another delay, unless and until the second delay continues after the first delay has ceased. Briefly, he mentions that liability must rest with the party responsible for the first delay encountered for the duration of this delay (first cause defines liability) and subsequent delays that occur during the period of the first delay should not affect liability. Hughes (1983) proposed a table showing the liabilities and the remedies as below;

Table 2. 7 First cause defines liability by Hughes (1983)

------C----- ----E---- ---N---	Initial delay, C, continues beyond the end of both delays of type E and N therefore no claim could be justified
-----C----- ---E---- N----==	Delay of type N continues beyond the end of the initial delay, C, causing possible extensions of time
-----C----- --E-------≈≈ N----------==	2^{nd} delay E continues beyond the 1^{st} delay causing a possible extension of time with cost; delay of type N continues beyond the end of 2^{nd} delay causing possible extension of time
-----C----- E-----------≈≈ --N------===	2^{nd} delay, N, continues beyond the end of the initial delay, C, causing a possible extension of time; delay of type E continues beyond the end of second delay causing a possible extension of time with costs.

C: contractor, E: employer, N: neither party.
Extension of time: =, Extension of time with cost: ≈

Nevertheless, the justice of this way of doing things must surely be questioned, when apparently one cause of delay began a couple of hours before another cause of delay.

Definitely, extension of time considerations could only be applied for delays on critical path or path became critical as a result of delays. Moreover, this methodology has one serious bottleneck since it does not offer any solution if it happens that causes of delay start at the same time (mostly experienced at beginning of contracts). Yogeswaran et al. (1998) looks at claims for extension of time under excusable delays by analyzing 67 civil engineering projects in Hong Kong; looking at non critical activities they indicated; an excusable delay to non-critical activity does not give rise to an extension of time to the date for completion unless the delayed period exceeds the float available to the non critical activity.

Different than Hughes's approach and similar to the one King and Brooks (1996) cited, (when each party has contributed to delay each party then bears its own costs of the delay), Kraiem and Diekmann, (1987) highlighted the problem and its solution in a distinct way for date assessment of concurrence. Their approach relies on legal interpretations of the remedy for the compound and complicated effect of any combination of delays due to different causes as shown below;

Table 2. 8 Remedy for Concurrent delays by Kraiem and Diekmann (1987)

Concurrent delay types		**Remedy**	**Name**
1	Any delay concurrent with a type N delay	Extension of time only	EASY RULE
2	Concurrent delays type E and C	Extension of time OR Apportionment of liability	FAIR RULE

In order to implement this method, one should asses for each day of the project if more than one delay has occurred on parallel critical paths through CPM method in order to determine the combined effect for all such delays in line with the remedies discussed above.

There are different approaches to the problems offered by different authors. To manage claims sensibly, the procedures adopted must be capable of dealing with the complexity of the network situation and also with any problems that arise concerning concurrent delays, further, they must also recognize the nature of delays and be able to deal with real-life events in a way that does not defy common sense (Scott 1993).

2.4.2 Labor Productivity

Over many years, many attempts have been made to establish a mathematical models reflecting the relationship between the construction environment and labor productivity in order to forecast the change in productivity due to change in this environment since the productivity is considered one of the key variables in claim analysis.

"Productivity" is the work hours during a specified time frame divided by the quantities installed during the same time frame (Thomas and Napolitan, 1995), whereas Klanac and Nelson (2004) defined the "Productivity" as the quantity of work produced or work output per unit input or effort while productivity measurement is expressed as a ratio or factor, percentage or as a production rate.

Any impediments to progress lead to a reduction in efficiency, consequently to a reduction in output relative to input and hence an increase in cost per unit of work produced (Jergeas and Revay, 1992). There are several factors that influence project performance which caused the variances in construction productivity like changes in anticipated means (methods, techniques, scheduling, work sequence etc.), project characteristics, site conditions, project execution, weather effects, supervision effects, management of time, local labor market conditions, scheduled overtime, availability of tools and construction equipment. Project characteristics include the size, complexity, schedule, extent of revamp, construction contract, availability of labor, and the location. Site conditions which are considered as another influence on labor productivity contain elements like access to site, its distance from local manpower suppliers, congestion in areas, intensity of labors in a particular area, type of work (hazardous procedures/materials), requirement of different clothing, use of site work permit, strictness of safety requirements. Amount and timing of project changes, the quality of delivered material, engineering, and review time for approval of drawings could be classified as project execution based obstacles that effect productivity

Weather conditions are directly related with the labor productivity. Extremely hot, extremely cold, inclement (rain, wind, snow, ice) weather or availability of weather protection are typical illustrations to this category. Depending on the contract terms and the circumstances, unusual weather may be a force majeure that justifies an increase to the contract time but rarely an increase in the contract price (Klanac and Nelson, 2004). Since it is well known that, certain climatic conditions have a negative effect on labor productivity, a systematic analysis (mostly regression) should be carried out on climatic conditions in order to forecast its effects with acceptable precision. Mohamed and Srinavin (2005) stated that productivity gets reduced due to the discomfort associated with noticeable thermal environment variations, for example, strong radiation from the sun causes workers to feel exhausted and seek more rest under shelter. Even more, working in hot weather also has physiological and psychological effects on workers; it reduces their productivity, and increases their irritability and loss of their enthusiasm for their work (Hancher and Abd-Elkhalek, 1998). Recent studies of thermal environment suggest that a combination of four main variables (air temperature, mean radiant temperature, relative humidity and wind velocity); and two additional variables (clothing ensemble on workers, and effort to perform the task expressed as metabolic rate) have an influence on thermal comfort and hence affect productivity (Parsons, 1999). There are previously proposed methodologies not considering all these factors together till 2002 when Srinavin (2002) established predicted mean method (PMV)-productivity model.

Overtime is an indirect factor that causes disruptions in the work environment and may cause to ripple effects as a scheduled overtime situation causes other variables to be activated. When going from a regular schedule without any disruption to an overtime schedule most of the time there would be a decline in performance, that is, performance factor would decrease. For example, increasing working hours from 40h/week to 60 hr/week increases the labor component by 50% however, does the work finish 50% earlier? Certainly, this can not be expected because the entire system must respond to the increase in work hours if decrease in working efficiency of labors due to fatigue is neglected. The capacity of other components like material delivery, equipment use, supervision etc should also be increased by 50%. BRT (Business Roundtable), 1980 published its first overtime table in the early 1970s and revised it several times. Through these tables they have assisted the calculations for cumulative efficiency values.

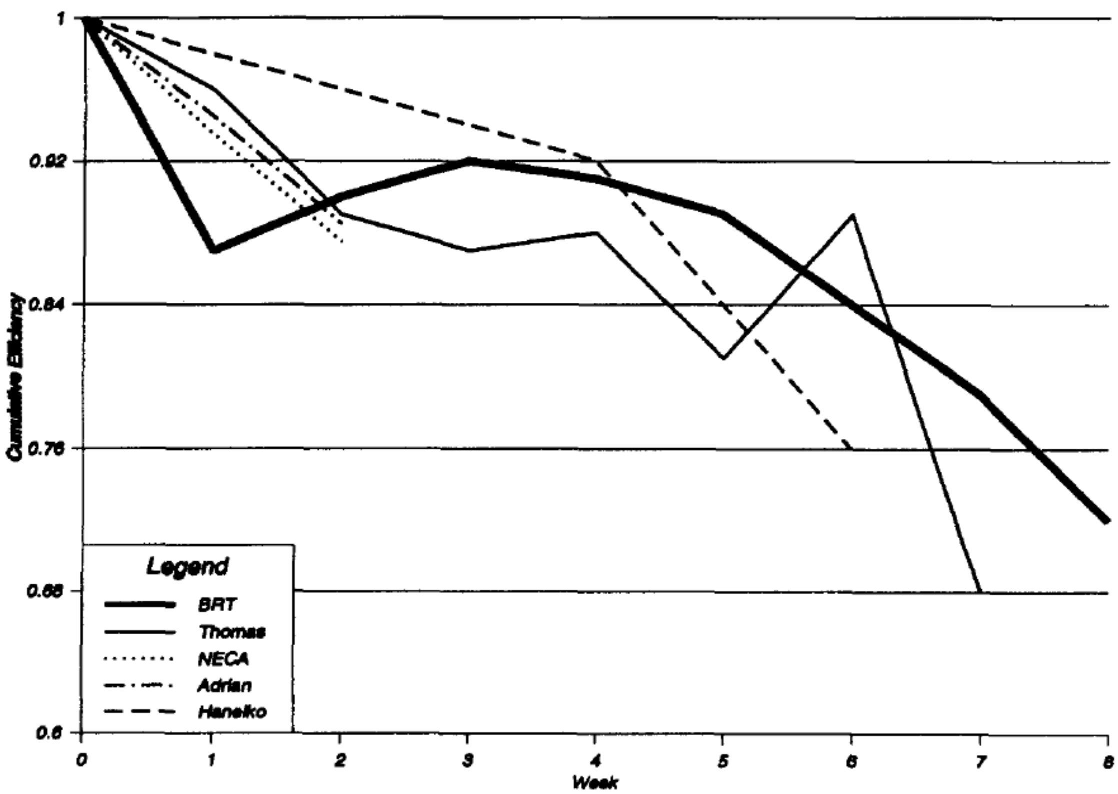


Figure 2.3 Average Overtime Efficiency for 50-h per Week Schedule by BRT (1980)

Effects of construction changes on productivity also needs further attention since it may influence more than one factor (it has indirect effects) resulting with an enormous productivity rate variation. Any disruption to task in the sequence will surely impact the following (remaining) tasks even if the change order itself does not involve these tasks (known as ripple effect).

Construction changes, some of which are necessary and inevitable are particularly irritating and costly problem and sometimes may alter the schedule and cost of the project dramatically when compared to original scope of work. In order to have better understanding of concept Factor Model is proposed by Thomas and Sakarcan in 1993 as shown in Figure 2.4;

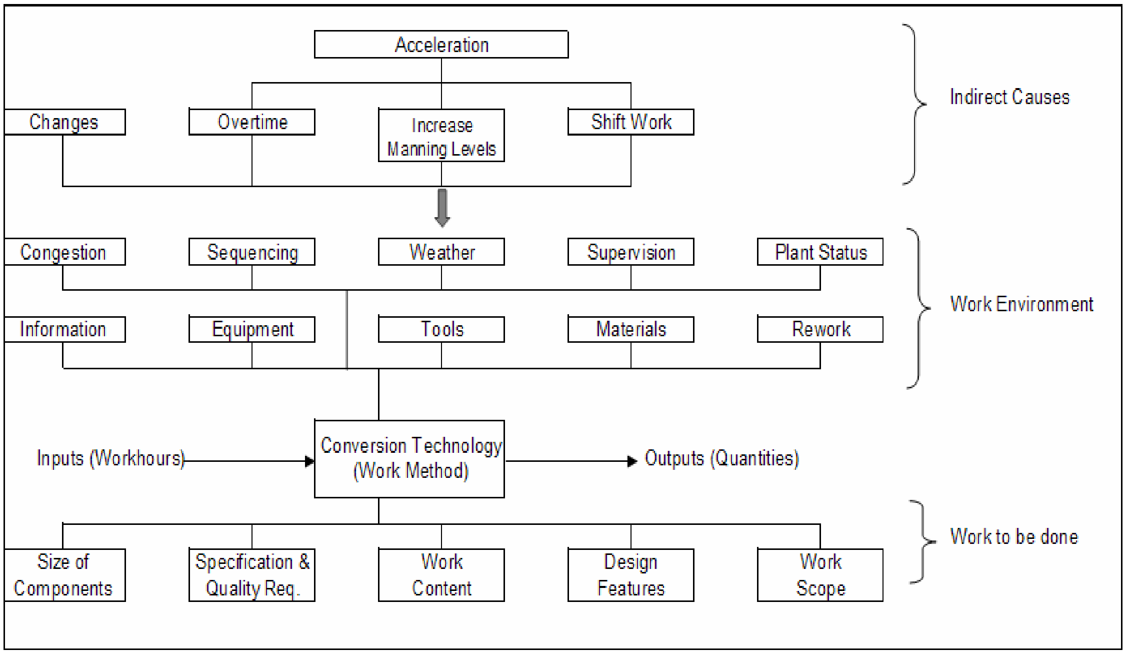


Figure 2.4 Factor Model by Thomas and Sakarcan (1993)

As indicated in the table, changes, overtime and etc. are indirect factors since they do not lead to productivity or efficiency losses; instead, they cause other disruptive influences to be activated. A change in the scope may cause the site to get congested and/or alter the work sequence, that is, the crew doing the work needs to stop their present assignment and plan and reorganize for the new work. This phenomenon is called as *the loss of momentum or loss of rhythm* since new arrangements, coordination with other crews and depending on the type of change, planning many other elements of the work in a level of detail would be necessary (Thomas and Napolitan, 1995). Furthermore, the change may require different rapidity due to (for example) the reason that the extended initial planning and setup period is disturbed over a much smaller scope of the work. Briefly, changes in the scope and complexity of the work as well as the environment in which the work is done lead to loss of productivity since the number of work hours required is very sensitive to changes in work environment.

Labor productivity also depends on supervision. Explicitly, the quality and experience of supervision is an important criteria. Number of supervisors (the ratio of them to the foremen and to workers (known as dilution of supervision)), quality of supervision staff and the experience of supervisors with the labor pool are the influencing factors. Although the contractor is responsible from the supervision of works, there are cases compensable relief is warranted such as constructive acceleration where owner directions create dilution of supervision.

Amount of overtime, multiple shifts, quality of planning, CPM schedule information, and work sequence, which are the fundamentals of Time Management, influence the productivity. Increase in length of workweek, decreases the productivity due to worker fatigue. Indeed, contractor seems to be solely responsible party from Time Management issue; owner changes, acceleration whether approved directed or constructive may make the owner liable when extended overtime or changes in work sequence becomes inevitable.

Labor market conditions that may affect productivity include the volume of work in the labor market (also known as activity), size and base skills of the local labor pool, union versus non-union labor rules, local economy (wages and incentives), craft turnover and absenteeism, cultural issues (such as holidays and religious events), and abuse of drugs and alcohol (Klanac and Nelson, 2004). As labor market conditions are known at the bidding stage and usually no significant changes in local market conditions occur, contractor is kept responsible if his estimates differ from actual conditions.

Finally, the availability of construction equipment and use of appropriate tools plays an important role on productivity and normally contractor is responsible for the availability and management of tools and equipments.

Of course, productivity is inversely proportional to the man hours necessary to produce a given unit of product. Contractor bears the resulting losses if he is contractually responsible for the disruption. On the contrary, when owner/client causes a disruption (ended with productivity decrease), unfortunately the contractor is not automatically entitled to additional compensation. That is, in order to evaluate additional compensation for project inefficiencies, the contractor must prove

- Liability; through contractual clauses
- Causation; impact caused labor overruns
- Resultant cost increase; what is the compensable cost?

2.4.2.1 Productivity Measurement

Productivity is considered as a key indicator of overall project performance, therefore collecting and analyzing productivity data continuously is the best project control practice. Although the collected data is useful, the analyst should be aware of the data's transient behavior since most significant construction activities have at least three sub-phases of performance; learning (10~20%, reflects learning curve and ramp-up effects), production (10~90%, mostly the highest output) and closing (80~100%, if project is managed poorly, this phase may include excessive corrective work resulting with poor productivity and cost over runs).

Thomas and Cramer (1988) identified key information to measure the construction labor productivity, such as control accounts (classification of activities like small-bore piping versus large-bore piping), earned value analysis (assessing the progress of a control account), progress measurement system "rules of credit" (assigning partial percentage before completion of one activity like erecting steel 50%, bolt-up 25%, plumbing 15% etc), reporting of accomplished quantities and work hours (collected throughout the execution of project and reports actual quantity and work hour information for control accounts), and performance evaluation (comparison of observed values at site to the ones estimated in planning phase). Calibration curve which is developed from historical performance of similar works may be utilized for this evaluation procedure. Surely the number of data determines the correctness of estimates.

2.4.2.2 Lost Productivity Costs

After determining the liability, the contractor must prove the cost overrun is faced due to low productivity which is caused by client. At this point, other than oral testimony from project personnel and hired experts, separate records specific to that disruption like videos (showing the responsibility), financial records (for additional cost), documentation and etc. can be useful to prove costs and causation. As Klanac and Nelson (2004) cited; the contractor may need to evaluate its original estimate and supporting worksheets, daily reports showing on-site labor forces and equipment, job cost records, material quantity sheets, time logs or sheets showing labor hours expended per day and weekly progress reports etc. in order to quantify lost inefficiency costs caused by the owner. They also suggested 4 different methods for quantification.

1. Total Cost/Modified Cost Method
2. Measured Mile (or differential studies)
3. Industry Studies
4. Jury Verdict

2.4.2.2.1 Total Cost/Modified Cost Method

These methods are actually two different approaches to the subject. In total cost approach, the difference between initial estimate of contractor for the work and actual cost of the same constitutes the basis of claim. On the other hand, for modified cost method, the contractor adjusts the overrun, that is, he deducts the cost due to lost productivity for which the owner is not responsible. However it is worth mentioning that both of these methods have significant shortcomings since they may fail to reflect the lost productivity caused by the owner accurately.

2.4.2.2.2 Measured Mile (Differential Studies)

The measured mile takes a designated period on a project where a particular activity is unimpacted and compares it with the period where that activity is impacted. In order to use this method, the unimpacted period may also be taken from another project in which the activities and other relevant conditions are relatively similar. During that comparison, the work performed during an unimpacted period might not always be identical to the work performed during the disrupted period, but it is generally accepted that labor inefficiency costs are not susceptible to absolute exactness. Jergeas and Revay (1992) listed four conditions to be fulfilled by the situation so that the differential method is accepted as the best method of quantifying productivity as it takes in to consideration the contractor’s or inherent shortcomings. These qualifications to be satisfied are as following;

1. The unaffected items (having the normal productivity) are representative both in complexity and method of execution of the items which were impacted by the cause(s) under examination
2. The difference between the actual productivity (or cost) of the impacted items and the normal productivity (or cost) resulted solely from the cause(s) under examination (exclusion of any factor which may affect the productivity other than the causes under examination)
3. All items analyzed must have been impacted by the cause in question
4. The normal productivity (or cost) of the unaffected items is supportable and is valid; it allows for all applicable risks and/or inherent shortcomings of the contractor, and represents a sufficiently large

percentage of the item(s) of the work under examination to generate reasonable confidence in the comparison.

It should be noted that, the calculation is based on demonstrated ability (productivity during unimpacted phase of the project) not on the estimate. Measured Mile approach is reliable to quantify the impact of acceleration, inclement weather or changed site conditions, introduced part way into the project, which give rise to noticeable change in the conditions under which the later part of the project is being performed (Revay, 1990).

2.4.2.2.3 Industry Studies

In some cases, when other methods are not allowed, industrial reports established by associations may be referred to determine standard labor productivity rates. Klanac and Nelson (2004) cited that, in one specific claim case the subcontractor based its claim on the labor productivity rates ascertained by Mechanical Contractors Association (MCAA). MCAA manual lists several type of impacts that may occur on a project and for each impact , it assigns a percentage that represents inefficiency factor for minor, average and severe impact events such as stacking of trades (20%), concurrent operations (15%), dilution of supervision (5%), site access (5%), out of sequence work (10%). However, due to its subjectivity, and the difficulty in validating the criteria used in the guidelines this method has certain inherent problems beside its advantages. Finally, contractors should nonetheless be cautious in relying on these factors exclusively as it is always beneficial to counter check the results against other methods.

2.4.2.2.4 Jury Verdict

The jury verdict approach should not be used by contractor when making his claim since it is a tool available to the courts to utilize the evidence presented in order to award costs to the contractor when liability and causation is clear and other methods of calculating the lost productivity are not available (MCI Constructors Inc 1996).

2.5 QUANTIFICATION OF CLAIMS

To analyze and attempt to resolve claims, construction management consultants often use subjective estimation techniques, their intuition, and experience, thereby introducing new information and opinions. A mediator will use legitimate and pertinent evidence in order to satisfactorily resolve the dispute, which can be augmented by the use of available quantitative tools. As AbouRizk and Dozzi (1992) indicated, the critical path method and other network models have been successfully used in the past. Spreadsheets and spreadsheet based estimating techniques are also used. Further, time motion studies, regression methods, the method productivity delay model (Adrian and Boyer, 1976), queuing theory and mathematical modeling can be applied to measure operation’s productivity and relate it to expected (before a change) productivity. Even more during analysis stage, a system and process simulation is utilized to enhance the analysis in resolving disputes. Through this system, the effects of changed conditions are observed up to some degree. Providing many degrees of flexibility on these simulations enables the user to generate number of different scenarios so as to compare the initial situation and the latter which is the base of claim.

Entitlement and quantification are the two major obstacles to be overcome in order to reach a resolution. Although several methods are proposed up to now, the selection criteria is determined by the characteristics of the claim. Jergeas and Revay (1992) explained how to quantify claims on a case study. The labor cost per quantity is calculated under normal circumstances and for an impacted period where productivity is less. The difference between costs and the overall quantity is multiplied and this amount constitutes the basis of claim. On the other hand, Amen et al. (2003) used regression analysis for quantifying the claim. In all methods the most important part is the data collection. The claimant should plan the work carefully in advance, of course in accordance with the requirements of the contract, and should provide documentary evidence of these plans to the client and main contractor. During the execution of the work, the claimant must keep detailed records of method and performance to carry out an analysis on the work actually performed. Only after completing these preliminary steps, it will be possible to make a cost comparison of what was planned with what actually was done, which would give an estimate of comparative efficiency. Finally the efficiency ratio could be applied to the original plan and cost estimate so that the claim for additional payment could be quantified.

Definitely, in order to be able to determine the outcome of experienced disruption or change in contract conditions will have its own consequences. Accordingly, the utilization of computer programs will help to simulate the causes and effects of experienced differences. As Raid et al. (1994) suggested developing a computerized system has distinct advantages if and only if it can;

a. Perform complex schedule analysis in a speedy, accurate, reliable and economical way using a high level computer language.
b. Infer parties' contractual responsibilities/liabilities in delayed, accelerated, added and cancelled activities in the completed portion of a project, using an expert-system technology
c. Allocate owner directed acceleration costs between parties, in the remaining portion of the project, based on a procedure that uses

information acquired in items (a) and (b). Moreover that allocation should be equitable to both the owner and the contractor.

Since this thesis is concentrated on quantification of acceleration claims, in the following sections the details of these calculations and discussion of two different approaches are demonstrated.

2.5.1 Acceleration Cost

Schedule acceleration is an especially troublesome problem for construction contractors because the normal utilization of resources is greatly disrupted. Thomas (2000) cited that the economic consequences to the contractor relative to labor productivity are quite severe, with losses of labor efficiency easily within the range of 20 to 45%.

The legal requirement of determining the time and cost for which each party is involved in a claim is liable to the other party. Riad et al. (1994) cited that contrary to how delays occur, acceleration is typically well thought out by the owner before the contractor is ordered to implement it in order to achieve certain mile stones and/or project completion earlier. Which activities have to be accelerated, what is the relative cost detriment to contractor and has to be compensated are the subjects of these disputes. The cost of acceleration is generally determined by additional premium cost necessary for overtime pay plus any additional direct cost incurred by the contractor.

In the light of previous discussions, an acceleration claim should maintain following sections in order to be reasonable and defendable

- Construction disputes should be resolved and additional payment should be granted for the claimant. That is to say, the reasoning of the claim constitutes the vital part of the claim.

- A proper documentation system should be developed and all necessary data (to be used in both reasoning and quantification) should be collected on time and appropriately.
- Claim process framework should be well determined in accordance with the contract clauses.
- Delays should be attributable to the client if contractor is enforced to accelerate activities to complete the project on time. If owner requests acceleration for early completion the agreement between parties will rather be easier.
- Contractor should also be able to demonstrate the productivity loss due to acceleration. Most of the time any disruption on an activity has both direct and indirect effect on following activities (ripple effect).

Other then setting of above clauses the rest of acceleration claim is quantification. Thus, two different calculation methods are presented in the forthcoming chapters.

CHAPTER 3

QUANTIFICATION OF ACCELERATION COSTS: A THEORETICAL APPROACH

In order to obtain a more reliable and precise solution, the costs and changes in project should be determined activity by activity. Most of the time, the total cost approach may be misleading since its shows overall effects that have impact on project rather than showing cause and effect. That is, if contractor believes that the excess cost is due to client's orders and requests, **the second proposed method, simplified approach** will most likely be useful since these sorts of disruptions are considered as excusable / compensable.

In order to establish activity based analysis, appropriate data should be collected daily with good precision at site. An analysis with this data should be carried out to demonstrate the causes and to calculate the resulting effects. Clear factual evidence is therefore crucial for a successful claim. Good records help to avoid confusion and they assist in reaching agreements by defining facts, roles and responsibilities. The responsibilities should be determined for each disruption on any activity. Also a schedule impact study could be performed through computer programs which will be helpful for demonstrating the duration based effects of any obstructions. Schedule analysis is usually carried out by:

- selecting a baseline or base schedule;
- identifying the cause of delay;
- revising the duration of any affected activities in the base schedule;

- adding the duration and logical connections of any new activities;
- recalculating the overall duration; and
- comparing the completion date of the recalculated schedule with that of the baseline schedule.

Delays can also be classified as critical or non-critical (Callahan, Quackenbush and Rowings, 1992). Effects can be a delay in a critical activity (leading to a delay in project completion date), a delay in a non-critical activity (no change in total project duration but decrease in floats). Depending on the responsibility allocations (scopes), the work may be obstructed due to client based problems such as late delivery of material and/or equipment, design changes or client's failure to receive permits from government for the execution of project etc. If there is a delay that will increase the project duration (delay on critical activity), two different responses may be planned at this stage: Accelerating the delayed activity or accelerating the subsequent activities to overcome the delay. If the disrupted activity is still in progress, contractor may take action to recover the delay by accelerating the same activity by allocating additional manpower, equipment or using different work methodology. Definitely prior analysis should be carried out and client's written confirmation should be received before taking any action. If the disruption is on non-critical activity which party will carry the burden of this obstruction? In most states, floats belong to the contractor unless otherwise specified in the contract documents (Zack, 1992; 1996). Similar approaches are presented by Finke (2000), Wickwire, Hurlbut and Lerman (1974) to emphasize the ownership of floats go to contractors since the execution plan is scheduled by contractor considering the floats. Obviously, if the Contractor uses up the entire float, then clearly he must accept the consequences, but if the Customer uses up the float, it follows that the Contractor is entitled to be compensated. The argument that the float belongs to the Contractor depends upon the fact that his profit for the project is influenced by the efficiency with which his resources are applied and planned for in his tender programme. In this, the float – which is the result of resource allocation – will have influenced his costs. This means that, in theory, the Contractor has used his programme to efficiently and carefully use his resources to make the site more efficient and make the Contract more profitable. (www.rosmartin.com). Therefore, any disruption to uncritical activities requires more man-hours for them to be completed thus contractor can not shift his man power to work for other activities which increases the budget of project. This is rather more simple process since the hindrances may be resolved between parties through negotiations during execution phase.

However, sometimes due to complexity or status of the activity (activity may be completed) it is not possible to accelerate disrupted activity. Instead, contractor accelerates the subsequent activities to recover the delay previously occurred and complete the project in time. Therefore, the additional cost should again be compensated. If project is to be accelerated to recover previous delays a complete and detailed analysis should be performed for each critical activity. After settling of critical activities, they should be sorted according to their crashing costs. The activity with minimum crash cost should be compressed and its final duration should be incorporated to the project schedule to obtain a modified schedule. Also additional resource allocation or any deviation from execution plan should be listed mentioning the causes and the responsible party. Afterwards, critical path(s) should be determined again and the steps described above should be followed. Further, due to nature of construction process, both parties may be in fault having a mutual effect on project's success. At this point concurrent delays may also be encountered. However, first cause first liability rule (Hughes, 1983) could be utilized to diminish this complex problem. A similar analysis should be carried out to evaluate the consequences of delay. The very first step in this analysis is the determination of critical path. Thereafter, the contractor should show only the impacts of client based disruptions on this critical path. To recover delay caused by client, acceleration of subsequent activities and the consequences of the changes should be determined including additional resource and equipment allocations, material changes like additional formwork, scaffolding etc. and change of work execution method if required. For example, due to delays for which the client is responsible, the ready mix concrete type may be altered, i.e. additional admixtures could be necessary since the season is changed for concrete pouring activity. That is, according to execution plan, concrete pouring activity is planned to be accomplished in spring and summer seasons, however, this activity is shifted to autumn and winter just because of owner caused delays. Thus, the extra cost for admixture should be compensated by the client. Similarly, inspection test plans (ITPs) for activities may be altered by the client which leads to slower progress compared to as-planned schedule. As widely known by contractors, QA/QC process is an important part of international projects. Each activity should be inspected by QC personnel in a pre-determined duration indicated in ITPs like 12 hours or else. Without getting approval from QC personnel the activities can not be accepted as completed. If these durations are changed adversely, it means that contractor should wait more to complete the subject activity. Due to this reason additional procurement for formworks and scaffolding is inevitable which increases the initial planned cost of the project. The disruptions which are not caused by contractor may be classified in groups to manage them more easily. Following is a list of possible disruptions, not caused by the contractor.

1) Destruction or damage to completed work
2) Destruction/Damage to tools, equipment, materials
3) Defective Specifications
4) Differing Site Conditions
5) Early Completion Prevented
6) Inadequate Supervision
7) Lack of Access
8) Lack of Right of Way
9) Interference
10) Lack of Permits

11) Delayed Notice to Proceed
12) Delayed Administration of Change Orders
13) Late Drawings
14) Late or Defective Material and Equipment
15) Strikes
16) Labor Shortage
17) Superior Knowledge/Misinterpretation
18) War and Other Hostilities
19) Acts of God
20) Constructive Acceleration (Requested by client in written)
21) Adverse Weather
22) Others

Any effect noticed during construction pertinent to above groups should be recorded at the site, associated with the activity and its consequences should be calculated by project management team (PMT) and/or technical office personnel. A form as shown below may be filled by the field personnel who has encountered the problems listed above;

Date:

a. List the activities down that were exposed to this *event* and identify the project location(s) affected. (attach dwg's if possible)

b. Describe exactly what you consider *event* to be and attach any evidence (photo, invoice, signature from client's supervisors etc.) that depicts the event

c. Who or what caused this *event*?

d. When did the *event* occur (was noticed)?

   Date: Time:

e. Who observed this *event* at the project site? (if this *event* was observed by many people, list those in seniority)

   Name: Employer:

   Name: Employer:

f. Does the representative of Owner know that this *event* impacts your work? Yes / No

   If yes, identify the highest ranked individual with knowledge

   Name: Employer:

   How did this person learn this occurrence?

   When did this person learn? Date: Time:

g. Briefly describe how this *event* impacts your current work

h. Briefly describe how this *event* may impact your future work(s)

i. Did or will this *event* delay or disrupt your work force or cause work to be performed inefficiently Yes / No

j. Did or will the *event* require you to use any additional labor, material or supervisor?

k. Were any materials, equipment or tools damaged due to this *event*?

Figure 3.1 Client Notification Form

This form should be submitted to PMT / technical office for further analysis. Again a separate form as below may be filled by PMT for project records.

Date:

A. Review the form and add any supplement information with any additional facts or observations you may have

B. Determine the schedule impact of the *event.* Revise the schedule if necessary (prove that the crashing method is used correctly so that the cost is minimized)

C. Determine whether contract provides any monetary compensation, a time extension for the *event*. List the contract clauses and provisions that support the claim most directly

D. Decide whether to submit a change proposal, formal notice of a claim or both. If a claim is to be submitted, then;
Who was notified?
Who notified this person?
When was this notice given? Date: Time:
How was this notice given? Written / Verbal / Other
If written attach the document

E. Attach to this report any document that includes facts or statements concerning the *event*.

Figure 3.2 Client Notification Form with Calculations

These forms should immediately be sent to other party in order to inform them about consequences, resolve the problems and overcome the obstacles that directly affect project's success. Further, it should also be highlighted that these documents will form the evidences and facts of the project and will be referred afterwards to find out the responsible party and relevant cost impact in case litigation is unavoidable.

3.1 AN EXAMPLE

To clarify the procedure, one example is given using real data for one of the important pipeline project that is being executed in Turkey nowadays. The data of the project is as below;

Table 3. 1 Project Details

Project Start	Project Completion	Duration (days)	Budget (USD)
04/05/2005	27/01/2007	634	9,159,686

The schedule of project is prepared by MS Project and approved by the client. The schedule and critical activities are determined in MS Project as presented in Figure 3.3 and Figure 3.4, respectively;

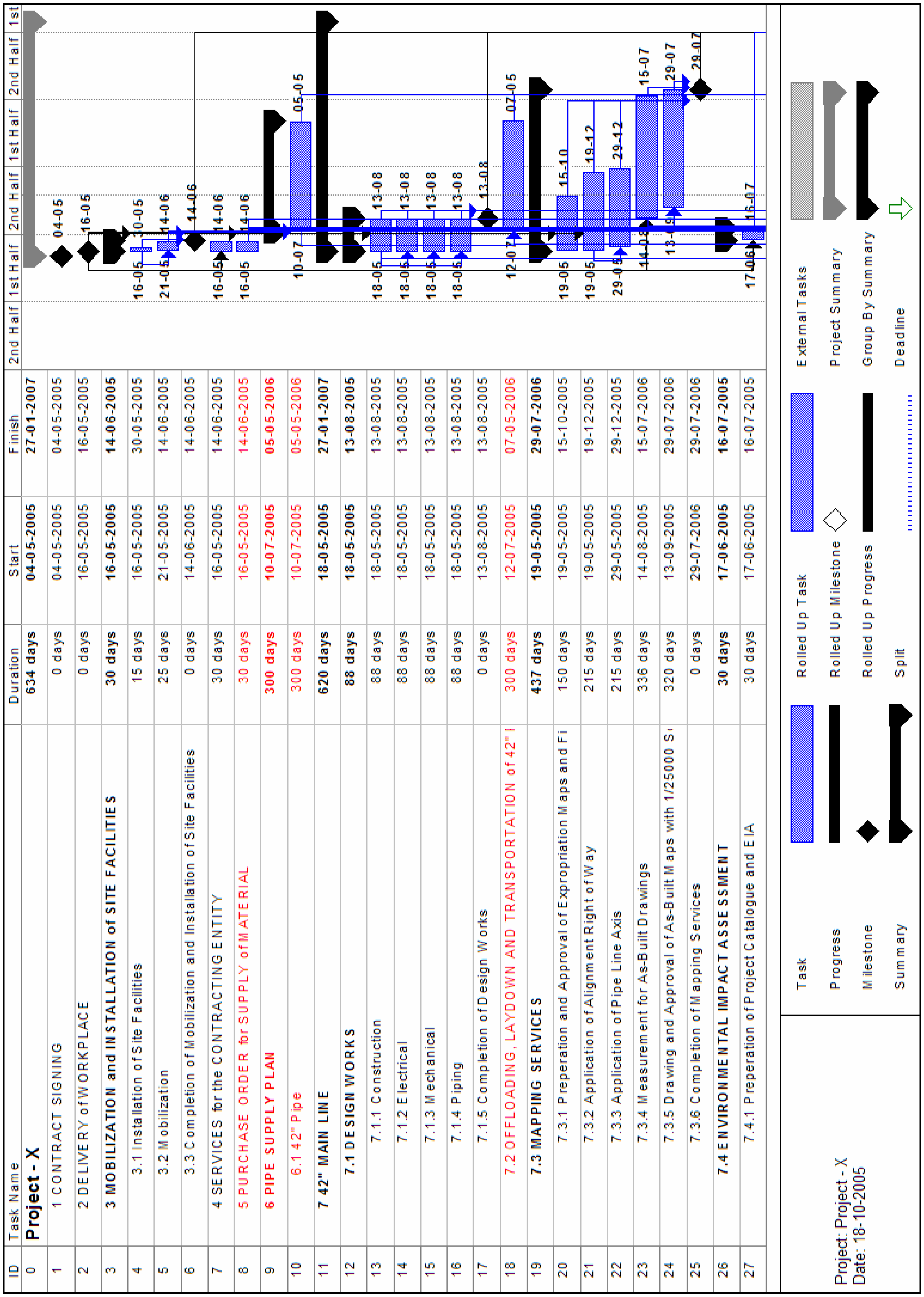
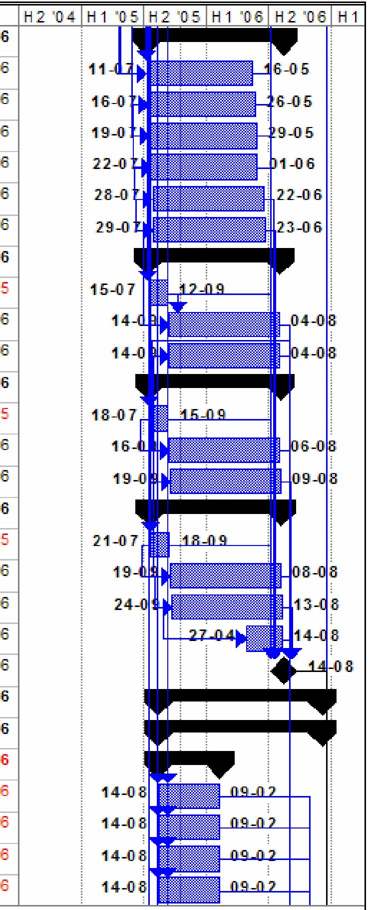


Figure 3.3 Schedule of the Project

ID	Task Name	Duration	Start	Finish
28	**7.5 CONSTRUCTION of 42" PIPE LINE**	**400 days**	**11-07-2005**	**14-08-2006**
29	7.5.1 Right of Way Clearence	310 days	11-07-2005	16-05-2006
30	7.5.2 Pipe Stringing	315 days	16-07-2005	26-05-2006
31	7.5.3 Trenching	315 days	19-07-2005	29-05-2006
32	7.5.4 Bending	315 days	22-07-2005	01-06-2006
33	7.5.5 Welding	330 days	28-07-2005	22-06-2006
34	7.5.6 Non-Destructive Test (NDT)	330 days	29-07-2005	23-06-2006
35	**7.5.7 Joint Coating for Pipes**	**386 days**	**15-07-2005**	**04-08-2006**
36	7.5.7.1 Supply of Joint Coating Materials	60 days	15-07-2005	12-09-2005
37	7.5.7.2 Joint Coating	325 days	14-09-2005	04-08-2006
38	7.5.8 Lowering	325 days	14-09-2005	04-08-2006
39	**7.5.9 CATHODIC PROTECTION**	**385 days**	**18-07-2005**	**06-08-2006**
40	7.5.9.1 Supply of Cathodic Protection Materials	60 days	18-07-2005	15-09-2005
41	7.5.9.2 Installation	325 days	16-09-2005	06-08-2006
42	7.5.10 Backfilling	325 days	19-09-2005	09-08-2006
43	**7.5.11 Supply and Installation of HDPE Pipies and Additional Manholes**	**384 days**	**21-07-2005**	**08-08-2006**
44	7.5.11.1 Supply of HDPE Pipes	60 days	21-07-2005	18-09-2005
45	7.5.11.2 Installation of HDPE Pipes and Manholes	324 days	19-09-2005	08-08-2006
46	7.5.12 Housekeeping of Workplace	324 days	24-09-2005	13-08-2006
47	7.5.13 Supply and Installation of Line Markers	110 days	27-04-2006	14-08-2006
48	7.5.14 Completion of Pipe Line Construction Works	0 days	14-08-2006	14-08-2006
49	**7.6 SUPPLY AND INSTALLATION of LINE and TAKE-OFF VALVES**	**478 days**	**14-08-2005**	**04-12-2006**
50	**7.6.1 Supply of Line Valve Materials and Installation (3 units 42")**	**478 days**	**14-08-2005**	**04-12-2006**
51	**7.6.1.1 Supply of Line Valve Materials (3 units 42")**	**180 days**	**14-08-2005**	**09-02-2006**
52	7.6.1.1.1 Valve	180 days	14-08-2005	09-02-2006
53	7.6.1.1.2 Fittings	180 days	14-08-2005	09-02-2006
54	7.6.1.1.3 Thick Wall Pipe	180 days	14-08-2005	09-02-2006
55	7.6.1.1.4 Actuator	180 days	14-08-2005	09-02-2006

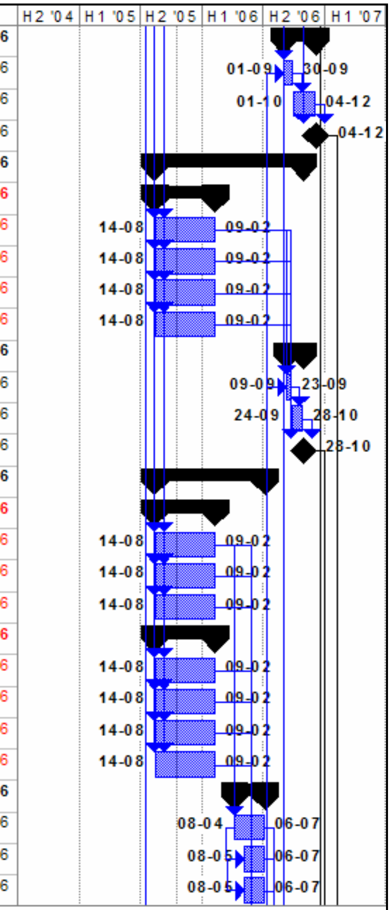


Project: Project - X
Date: 18-10-2005

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary
Deadline

Figure 3.3 (cont'd) Schedule of the Project

ID	Task Name	Duration	Start	Finish
56	**7.6.1.2 Installation of Line Valves (3 units 42)**	**95 days**	**01-09-2006**	**04-12-2006**
57	7.6.1.2.1 Installation of Line Valves (prefabrication and tests)	30 days	01-09-2006	30-09-2006
58	7.6.1.2.2 Installation of Pipe Valves	65 days	01-10-2006	04-12-2006
59	7.6.1.3 Completion of Line Valve Installation Works	0 days	04-12-2006	04-12-2006
60	**7.6.2 Supply and Installtion of Take-Off Valves (1 unit 8", 1 unit 6")**	**441 days**	**14-08-2005**	**28-10-2006**
61	**7.6.2.1 Supply of Take-Off Valve Materials (1 unit 8", 1 unit 6")**	**180 days**	**14-08-2005**	**09-02-2006**
62	7.6.2.1.1 Valves	180 days	14-08-2005	09-02-2006
63	7.6.2.1.2 Fittings	180 days	14-08-2005	09-02-2006
64	7.6.2.1.3 Thick Wall Pipe	180 days	14-08-2005	09-02-2006
65	7.6.2.1.4 Actuator	180 days	14-08-2005	09-02-2006
66	**7.6.2.2 Installation of Take-Off Valves (1 unit 8", 1 unit 6")**	**50 days**	**09-09-2006**	**28-10-2006**
67	7.6.2.2.1 Installation of Take-Off Valves (prefabrication and tests)	15 days	09-09-2006	23-09-2006
68	7.6.2.2.2 Installation of Take-Off Valve	35 days	24-09-2006	28-10-2006
69	7.6.2.3 Completion of Take-off Valve Installation Works	0 days	28-10-2006	28-10-2006
70	**7.7 PIG STATION (2 units 42" Pig Receiving and Launching)**	**327 days**	**14-08-2005**	**06-07-2006**
71	**7.7.1 EQUIPMENT SUPPLY**	**180 days**	**14-08-2005**	**09-02-2006**
72	7.7.1.1 Pig Courrier and Crane	180 days	14-08-2005	09-02-2006
73	7.7.1.2 Valves	180 days	14-08-2005	09-02-2006
74	7.7.1.3 Pig Traps	180 days	14-08-2005	09-02-2006
75	**7.7.1.4 Station Piping**	**180 days**	**14-08-2005**	**09-02-2006**
76	7.7.1.4.1 Pipies	180 days	14-08-2005	09-02-2006
77	7.7.1.4.2 Fittings	180 days	14-08-2005	09-02-2006
78	7.7.1.4.3 Insulating Joint	180 days	14-08-2005	09-02-2006
79	7.7.1.4.4 Hot Bent Pipe	180 days	14-08-2005	09-02-2006
80	**7.7.2 INSTALLATION**	**90 days**	**08-04-2006**	**06-07-2006**
81	7.7.2.1 Construction	90 days	08-04-2006	06-07-2006
82	7.7.2.2 Mechanical	60 days	08-05-2006	06-07-2006
83	7.7.2.3 Electrical	60 days	08-05-2006	06-07-2006



Project: Project - X
Date: 18-10-2005

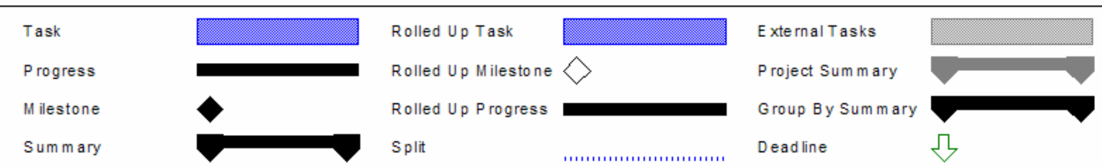
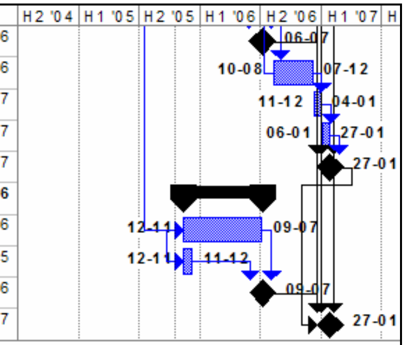


Figure 3.3 (cont'd) Schedule of the Project

ID	Task Name	Duration	Start	Finish
84	7.7.3 Completion of Pig Station Works	0 days	06-07-2006	06-07-2006
85	7.8 Hydro Testing	120 days	10-08-2006	07-12-2006
86	7.9 Caliper Pig and Drying	25 days	11-12-2006	04-01-2007
87	7.10 Commissioning	22 days	06-01-2007	27-01-2007
88	7.11 COMPLETION OF 42" MAIN PIPELINE WORKS	0 days	27-01-2007	27-01-2007
89	**8 PREPERATION of AS-BUILT DRAWINGS AND MANUELS**	**240 days**	**12-11-2005**	**09-07-2006**
90	8.1 As-Built Drawings	240 days	12-11-2005	09-07-2006
91	8.2 Manuels	30 days	12-11-2005	11-12-2005
92	8.3 Completion of Pipeline Drawings and Manuels	0 days	09-07-2006	09-07-2006
93	9 Completion of Project	0 days	27-01-2007	27-01-2007



Project: Project - X
Date: 18-10-2005

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary
Deadline

Figure 3.3 (cont'd) Schedule of the Project

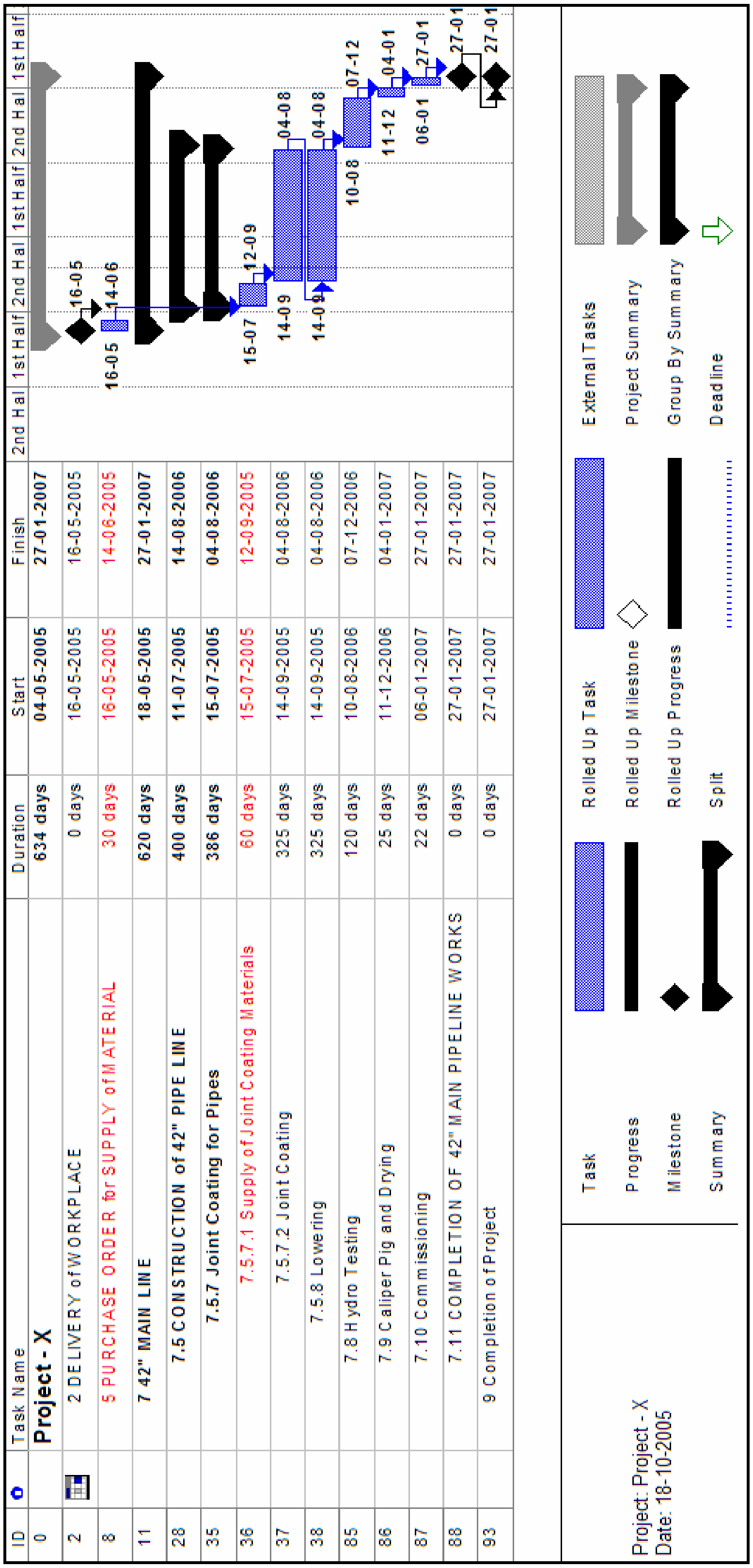


Figure 3.4 Critical Path

However, in order to visualize the critical path and manage the activities better, the activities are re-written in Table 3.2

Table 3. 2 Critical Activities

ID	Activity Description	Dur.	Start Date	Finish Date	Budget
2	DELIVERY of WORKPLACE	0 d	16/05/2005	16/05/2005	
5	PURCHASE ORDER for SUPPLY of MATERIAL	30 d	16/05/2005	14/06/2005	
7	42" MAIN LINE	620 d	18/05/2005	27/01/2007	$ 8,400,658.00
7.5	CONSTRUCTION of 42" PIPE LINE	400 d	11/07/2005	14/08/2006	$ 8,177,285.00
7.5.7	Joint Coating for Pipes	386 d	15/07/2005	04/08/2006	$ 252,650.00
7.5.7.1	Supply of Joint Coating Materials*	60 d	15/07/2005	12/09/2005	By Client
7.5.7.2	Joint Coating	325 d	14/09/2005	04/08/2006	$ 252,650.00
7.5.8	Lowering	325 d	14/09/2005	04/08/2006	$ 338,550.00
7.8	Hydro Testing	120 d	10/08/2006	07/12/2006	$ 293,410.00
7.9	Caliper Pig and Drying	25 d	11/12/2006	04/01/2007	$ 62,750.00
7.1	Commissioning	22 d	06/01/2007	27/01/2007	$ 112,850.00
7.11	COMPLETION OF 42" MAIN PIPELINE WORKS	0 d	27/01/2007	27/01/2007	
9	Completion of Project	0 d	27/01/2007	27/01/2007	$ 9,159,686.00

Activity “Supply of Joint Coating Materials” is marked with asterisk just because this item is in client’s scope. A hypothetical disruption on this activity created and delayed the completion for further 9 days. Since the disruption is caused by client, automatically the responsibility of this event belongs to client which delayed the completion of project for 9 days. However, in this case study, the completion of project in time is vital. Therefore, client requested the contractor to accelerate the project (owner directed acceleration) in order to finish the project in time and asked for the additional reimbursement. At this stage contractor should decide on activities for additional resource allocation. A detailed analysis should be carried out at this stage in order to accelerate the activities with minimum cost.

However, contractor's first step should be classification of the event and filling the forms as previously described in former chapters. This disruption is classified under item 20) Constructive Acceleration (Requested by client in written) and the forms may be filled as Figure 3.5;

Date: 18.09.2005

a. List the activities down that were exposed to this *event* and identify the project location(s) affected. (attach dwg's if possible)

Since this activity is on critical path, start and completion date of its subsequent activities are also delayed. These activities are;

Joint Coating
Lowering
Hydro Testing
Caliper Pig and Drying
Commissioning

b. Describe exactly what you consider *event* to be and attach any evidence (photo, invoice, signature from client's supervisors etc.) that depicts the event

Client's written request for acceleration is to be attached.

c. Who or what caused this *event*?

Late delivery of material (as per contract – material supply item belongs to client)

d. When did the *event* occur (was noticed)?

Date: 18.09.2005 Time: 09:30

e. Who observed this *event* at the project site? (if this *event* was observed by many people, list those in seniority)

Name: Mr. A Employer: Mr. B

Name: Employer:

f. Does the representative of Owner know that this *event* impacts your work? Yes / ~~No~~

If yes, identify the highest ranked individual with knowledge

Name: Mr. X Employer: Mr. Z

Figure 3.5 Sample Client Notification Form

How did this person learn this occurrence? Official letter is issued

When did this person learn? Date: 18.09.2005

Time: 09:30

g. Briefly describe how this *event* impacts your current work

Since this activity is on critical path completion of all succeeding activities will be delayed if no action is taken

h. Briefly describe how this *event* may impact your future work(s)

It will delay the completion of project for 9 days thus will increase overheads (indirect cost).

i. Did or will this *event* delay or disrupt your work force or cause work to be performed inefficiently Yes / ~~No~~

j. Did or will the *event* require you to use any additional labor, material or supervisor? In order to accelerate the activities, additional resource allocation is inevitable

k. Were any materials, equipment or tools damaged due to this *event*? No

Figure 3.5 (Cont'd) Sample Client Notification Form

A similar form should also be filled by technical office personnel, with proper examination of causes and their consequences

Date: 20.09.2005

A. Review the form and add any supplement information with any additional facts or observations you may have

Directed Acceleration, No further information is necessary

B. Determine the schedule impact of the *event*

The Project is delayed for "9" days

C. Determine whether contract provides any monetary compensation, a time extension for the *event*. List the contract clauses and provisions that support the claim most directly

Yes. Contract Clause (x) under "Owner Directed Acceleration" subject

D. Decide whether to submit a change proposal, formal notice of a claim or both. If a claim is to be submitted, then;

Who was notified? Employers Project Manager

Who notified this person? Technical Office Manager

When was this notice given? Date: 20.09.2005

Time: 14:00

How was this notice given? Written / ~~Verbal / Other~~

If written attach the document

E. Attach to this report any document that includes facts or statements concerning the *event*.

Detailed analysis and schedule impact is attached

Figure 3.6 Sample Client Notification Form with Calculations

It should be noted that, the additional cost can only be estimated at this stage. Actual cost will be observed when the project is completed. After the disruption, the project duration is 643 days and the relevant data is as below;

Table 3. 3 Project Schedule after disruption

ID	Activity Description	Dur.	Start Date	Finish Date
2	DELIVERY of WORKPLACE	0 d	16-05-2005	16-05-2005
5	PURCHASE ORDER for SUPPLY of MATERIAL	30 d	16-05-2005	14-06-2005
7	42" MAIN LINE	620 d	18-05-2005	27-01-2007
7.5	CONSTRUCTION of 42" PIPE LINE	400 d	11-07-2005	14-08-2006
7.5.7	Joint Coating for Pipes	386 d	15-07-2005	04-08-2006
7.5.7.1	Supply of Joint Coating Materials*	69 d	15-07-2005	21-09-2005
7.5.7.2	Joint Coating	325 d	23-09-2005	13-08-2006
7.5.8	Lowering	325 d	23-09-2005	13-08-2006
7.8	Hydro Testing	120 d	19-08-2006	16-12-2006
7.9	Caliper Pig and Drying	25 d	20-12-2006	13-01-2007
7.10	Commissioning	22 d	15-01-2007	05-01-2007
7.11	COMPLETION OF 42" MAIN PIPELINE WORKS	0 d	05-02-2007	05-01-2007
9	Completion of Project	0 d	05-02-2007	05-02-2007

The below table is obtained through discussions with the project manager to calculate the additional cost for crashing the activities

Table 3. 4 Crashing costs of critical activities

Delayed activity	Subsequent Activities on Critical Path	Dur. day	1st Crash (USD)	2nd Crash (USD)	3rd Crash (USD)	4th Crash (USD)	5th Crash (USD)
Joint Coating Supply	Joint Coating	325	1000	1350	1725	2100	2525
	Lowering of Pipes	325	1050	1400	1900	2525	3150
	Hydrotest	120	2445	3000	3650	4400	5250
	Caliper survey and Drying	25	2510	3150	3950	5100	N/A
	Commissioning	22	5130	5650	6450	N/A	N/A

To calculate the lowest cost, the activity with the lowest cost is crashed first. After crashing the activity for 1 day, critical path is controlled to see if any other activity became critical. Fortunately, in this analysis critical path remained same which made calculations rather simple. Consequently, by crashing the activities with lowest costs, the project duration is shortened 9 days.

Table 3. 5 Crashing Of Activities and Its Consequences

Crash No	Activity Name	Additional Cost	Activity Duration (day)	Project Completion Date
1	Joint Coating	$1,000.00	324	04-02-07
2	Lowering	$1,050.00	324	03-02-07
3	Joint Coating	$1,350.00	323	02-02-07
4	Lowering	$1,400.00	323	01-02-07
5	Joint Coating	$1,725.00	322	31-01-07
6	Lowering of Pipes	$1,900.00	322	30-01-07
7	Joint Coating	$2,100.00	321	29-01-07
8	Hydrotest	$2,445.00	119	28-01-07
9	Caliper survey and Drying	$2,510.00	21	27-01-07

Total cost of this acceleration is calculated as 15,480 USD. As stated previously, these calculations are based on estimations whose precision depends on the experience and talent of the project manager and the actual cost can be calculated at the end of completion of the subject activities. It should also be noted that, no indirect cost change shall be recorded at this example since the project duration remained same.

3.2 DISCUSSIONS

The theoretical approach's steps are applied in this project rather easily since the project is a comparatively simple and straight forward pipe laying project which is selected on purpose. As seen in the schedule the project is broken down to less than 100 activities making the analysis effortless. Further the disruption is also clear and its consequences may be filtered simply. However, as known by all, construction process is unique and may contain thousands of activities. This approach has its own bottlenecks like the disruptions may not be isolated simply or contractor may have concurrent disruptions or delays which result with overlapping effects. The sequences of activities may change; the site may go so congested that the productivity estimates may fell far behind the estimates. The changes may affect overall construction process and the data required for above calculations may not be collected timely which constitutes the most important part of theoretical approach. The last but not the least, client may counter claim that the contractor behaved opportunistically or due to mismanagement the actions taken are not effective, so that the presented amount as suffered is misguiding. For example in above case, the client may object the crashing costs that are estimated at the beginning of the analysis, or even worse when the acceleration completed and the actual data is gathered, the client may refuse to agree on amount what has been suffered as an actual additional cost by client. Therefore the steps explained in theoretical approach chapter may not be applicable or the amount claimed by contractor may not be compensated. Then, what is the procedure that contractor should follow? At this point, the contractor has the estimates at the tendering stage and the actual values when the project completed. The simplified approach is based on comparison of these values and extensively discussed in the next chapter.

CHAPTER 4

QUANTIFICATION OF ACCELERATION COSTS:

A SIMPLIFIED APPROACH

Acceleration occurs when the contractor is compelled by the owner to complete the project ahead of schedule. But, it comes at a price to the owner. Changes in contract time, whether delay or acceleration, increase the contractor's cost and often becomes the subject of a claim. Constructive acceleration occurs in the absence of owner directed acceleration, such as where the owner has refused a valid request for time extensions which requires the contractor to accelerate its work to avoid liquidated damages, or other losses loss. The classic case is when a request for a time extension for excusable delay is denied and the contract provides liquidated damages for late completion. The law construes this as an order by the owner to complete performance within the originally specified completion date, a shorter period at higher cost than provided for in the contract. The constructive acceleration doctrine allows recovery for the additional expenses the contractor can establish. (library.findlaw.com)

Although the methodology described in the theoretical approach section defines the necessary points to have a definite and defendable procedure for quantification of claims, it has its own drawbacks during calculations when construction process is considered. The construction process involves complex and overlapped (consequent) activities thus requires detailed analysis to have precise information about the resulting effects of any disruption. Site people are mostly concerned about whether the project is completed in time or not. The documentation is considered as a time consuming and useless excessive work by them. Further, the analysis of project data during the execution stage is most of the time limited since the primary objectives of site people and technical office staff are the works related about the execution of the work and detailed analysis requires considerable time. Besides, when a disagreement arises in any subject but mainly in monetary terms, in order to avoid further delays, client suppresses the contractor to carry on the work and leaves the cost to be agreed afterwards. However since there is no pre-agreement between the parties, most of the time contractor is unaware about what sort of data is going to be required to prove the magnitude of exact cost. Even if contractor has enough resources and data to carry out such an analysis the work breakdown structure of the activities used in project management software may obstruct the process because work programs are not always detailed as required for cause and effect analysis. Consequently, the analyst is enforced to make assumptions which are always questionable. For example if the design is not in contractor's scope, in any scheduling software, the execution of activity is connected to receipt of drawings via start to start relation with lag. In this specific case it is not mentioned which drawing will be submitted on which specific date making the cause and effect, thus calculations become difficult. In addition to above explanations, it is also worth mentioning that disruptions may have secondary, even tertiary effects. These disruptions may result in lower productivity all around the site although there is no visible connection between activities and cause and effect analysis may lead to result which underestimates contractor's losses. For example, as indicated previously, due to changes in work sequence, new arrangements, coordination with other crews and depending on the type of change, planning many other elements of the work in a level of detail would be necessary which is called loss of momentum or loss of rhythm. Or more specifically, site manager may declare additional payment or award for his employers when certain milestones are achieved on predetermined time which increases the will and the motivation of the employers. Moreover, due to client-based reasons, realization of these milestones may be postponed. Since the productivity is also influenced by psychological factors, the motivation hence the productivity of workers all around the site will be affected.

On the other hand in almost all of the projects, man-hour reports and equipment-hour reports are constantly kept on a daily basis since these data are also important for the contractor to be used in forthcoming projects. Considering the different units of measurements for construction activities like square meter, cubic meter and tons etc. the activities have nothing in common other than man-hours. Further, progress reports are prepared as per the achieved man-hours and comparing them to project total man-hours. Therefore, man-hour reports may be considered as vital elements and can easily be reached.

At the very beginning of project, man-hours are pre-allocated for construction activities (like 4 man-hour per square meter of formwork or 2 man hours for cubic meter of concrete). Any change between the estimated and actual man-hour values depends on site and project conditions assuming that initial allocations are realistic. Instead of carrying out cause and effect analysis, another simplified methodology is proposed at this section which may be called as “total acceleration cost” which entirely depends on these man-hours and equipment-hours reports.

In order to implement the proposed methodology, appropriate documentation is required. Thus, a data collection format is proposed. In most of the projects man-hour records are prepared by foremen, therefore the format of this form should be comparatively easy. Below a form is presented for keeping man-hour reports with which every contractor is quite familiar.

Title: ___________________ Date: ____________

Outline of Work:

Related Drawing:

Man-hour Spent:

No	Activity name	Crew Size	Hours Worked	∑ Man-hours
1				
2				
3				
			TOTAL	

Numbers in parenthesis indicates the overtime

No	Activity name	Equipment	Hours Worked	∑ Eqp-hours
1				
2				
3				

Numbers in parenthesis indicates the overtime

No	Activity name	Accomplished Quantity
1		
2		
3		
4		
…		

	ORIGINATOR	Client Representative
Department		
Division		
Engineer		
Signature		

Figure 4.1 Man-hour Report

The proposed method and computer program named as ‘simplified approach’ is based on man-hour data and presents the cumulative effect of disruptions throughout the life of project and guides the user to quantify the excess cost due to disruptions. Main inputs of the program are the unit cost of man-hour and equipment-hour defined by the contractor since the calculations should be based on these parameters.

It is very beneficial for contractor to be able to demonstrate the estimated man-hours and actual man-hours are quite same before any disruption is experienced. Therefore, he can defend himself more easily that his estimates reflect a realistic approach and he is well experienced about the project.

This method has some basic and fundamental assumptions about the contractor. It is assumed that the contractor;

a. is familiar and well experienced about the project, that is, he has completed similar projects (i.e. in last 15 years) thus client can not allege contractor with mismanagement. Therefore it is assumed that, all recorded costs are reasonably incurred and no costs are unnecessary, or incorrectly charged or assigned to the job
b. proposed a perfect bid
c. is not opportunistic and his purpose is just to receive reimbursement for the additional cost which is not foreseen during the tendering phase
d. keeps escrow bid documents in a safe place to demonstrate his assumptions and their validity
e. is capable of submitting the invoices and other documents that support his calculations for cost of unit man-hour
f. carefully and fully documents all delays and other factors which will aid in proving its entitlement to damages, that is he should be able to explain what has happened during the project with proper

documentation and evidence so that the client is convinced with the reasoning

g. requests a compensation which does not include the amount that the contractor is responsible, that is, the contractor was completely efficient and not responsible for any of the increased costs
h. is not subjected to any force majeure during the project
i. must give the appropriate notice of the delay and request an extension of time in order to recover any additional costs of acceleration

4.1 THE METHODOLOGY

The simplified methodology for acceleration cost is considered to serve in all projects but mainly in international projects. The methodology is described here and a computer program to guide user to quantify acceleration claim is developed. During its development stage, all variants in construction process that contribute to cost is tried to be included. The methodology is based on unit man-hour, unit equipment-month, rework and additional costs for material and new construction methods. However, due to complexity and unique process of construction work, during the utilization of computer program, some inadequacies may be experienced, i.e. additional items may be encountered and may have an affect on claim cost. To overcome these obstacles, the user may carry out his analysis and enter its consequences in Additional Material and Changes in Construction Methods section since it allows the user to enter additional cost and consumed man-hours and equipment-months directly. Definitely depending on the available data, the calculations have their own assumptions. For example, during the bidding stage although a detailed man-hour assignment is done for activities, for the equipment-hours the same procedure is ignored. Instead contractor used different approach for calculation of his bid price due to utilization of these equipments. He may use his predetermined unit price costs which are determined through his previous experiences. Therefore the comparison of actual and estimated equipment-hours, thus calculation of excess equipment-hours requires some assumptions. Briefly, although the necessary data required for this approach are clearly identified, through some assumptions, the methodology proposes reasonable solutions to data unavailability.

4.1.1 Framework for Simplified Approach

In order to quantify the consequences of experienced disruptions through out the life of a project, the framework is developed to show necessary steps of this approach as presented in Figure 4.2.

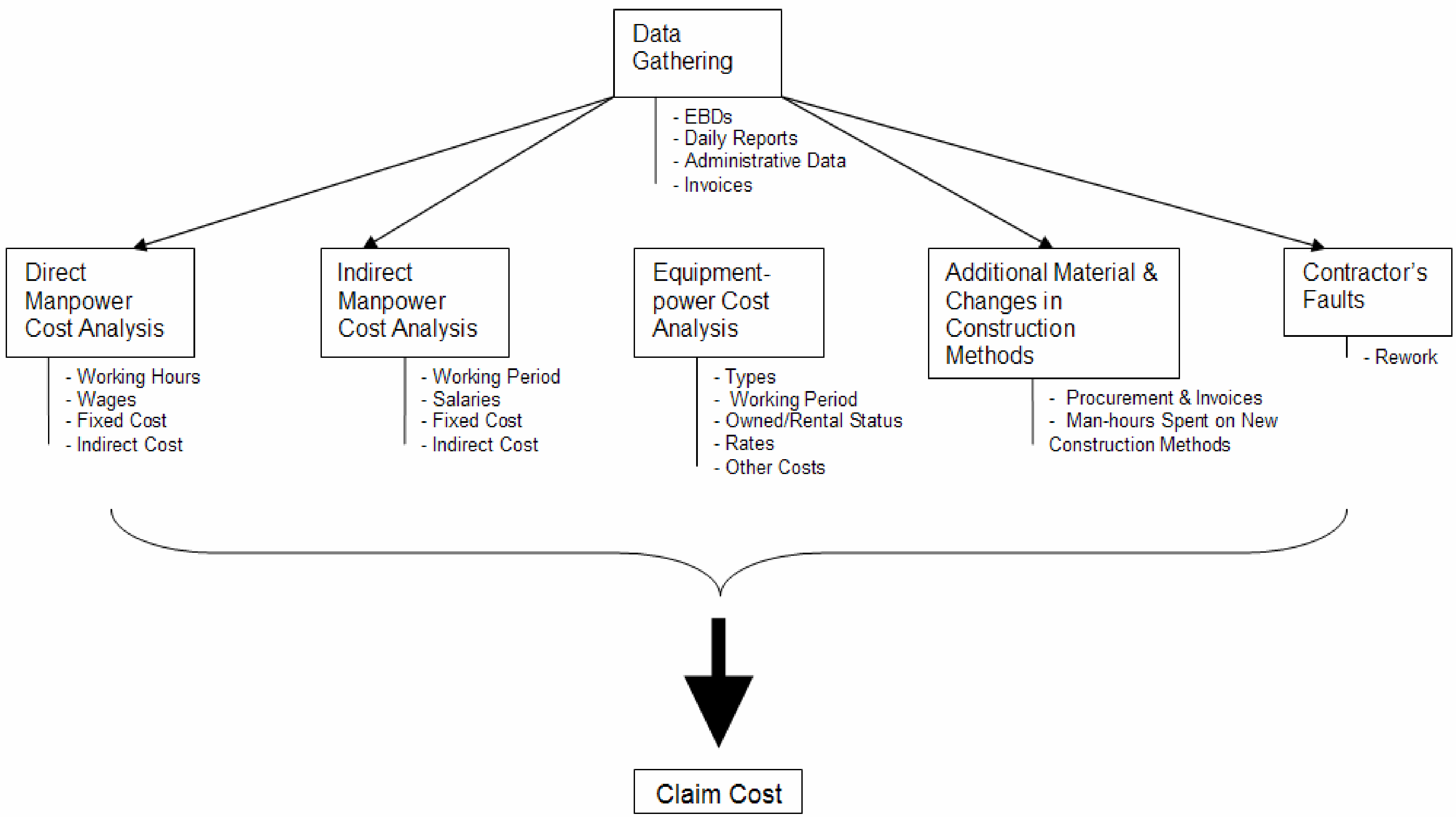


Figure 4.2 Framework for Quantification of Acceleration Claim through Simplified Approach

4.1.1.1 Data Gathering

All the data during the bidding stage constitutes the basis of the claim. The data in escrow bid documents are compared to the actual data and calculated excess cost is the subject of claim. Therefore, availability of EBDs and if possible, approval of them by client is very important to execute such an analysis. Daily man-hour and equipment-hour reports should be kept. The disruptions should also be mentioned in this form since the owner has to be notified via formal letter. If the work is for corrective action due to contractor's fault, this should also be indicated in the report (rework). Further these disruptions will constitute the reasoning part of the claims. As these reports include the accomplished quantities, it is also possible to monitor the productivity rates.

In order to use this approach, also some administrative data is required including the nationality of workers, the wages, number of work days, regional holidays, fixed and indirect cost (visa, accommodation etc.), local fuel and maintenance rates, and invoices of additionally procured materials. Most of these data is intuitively kept by project personnel as they are necessary for project records.

4.1.1.2 Direct Manpower Cost Analysis

The very first step is the determination of working hours per year per direct site personnel. In order to calculate this, below data should be known;

- Number of work days per year (non work days due to Regional holidays coinciding with work days should be deducted)
- Working hours per day
- Overtime hours per day
- Non-work days

- Regional Holidays

Through simple mathematics, yearly normal working hours and overtime hours are calculated. When yearly work hours are calculated, average salary per man-hour should be computed. The user has two options at this step:

If man-hours are known per type of worker this data, which gives more accurate results, will be used. However, due to absence of this data the user must define a team having a theoretical number of different type workers to execute the work. Below data is required for calculation of average salary per man-hour;

- Type of workers
- Number of workers
- Nationality of workers (if wages are different)
- Wage of worker per hour

Again using above data, weighted normal salary per hour is calculated for crews classified according to their nationality. Overtime cost calculation is the next step. The user should clearly define the approximate overtime hours, overtime wages (excess amount when compared to normal salary) for his personnel per working days, holidays and non-working days depending on the actual data which should be gathered from site. Most of the time overtime wages are twice as much as normal working hours. Accordingly yearly overtime cost for one worker (again classified in line with their nationalities) is determined. Dividing the calculated cost to yearly working hours gives the additional man-hour cost paid each worker as an overtime wage.
Other than salaries, contractor carries additional burden of its employees such as fixed costs and indirect costs. These costs are listed as below;

Fixed Costs

- Visa
- Translation Cost
- Mobilization-Demobilization
- Inland Transportation
- Agency Fee
- Work Permit
- Local ID
- Blood Test
- Vacation Ticket
- Safety Shoes etc
- Insurance
- Others

Indirect Costs

- Food and Accommodation
- Transportation
- Medical Care
- Other

Total amount calculated by considering above expenses for one man should be divided to yearly working hour for one worker to find out their contribution to man-hour cost.

Next, average direct man-hour cost is evaluated considering all factors mentioned above. Finally according to man-hour distribution at site the percentages of workers categorized for their nationality should be used to evaluate "weighted average direct man-hour cost". The rest is rather easy since the average cost is multiplied by man-hour difference between the planned and actual (excess man-hours) and surplus cost is computed.

4.1.1.3 Indirect Manpower Cost Analysis

Indirect personnel are considered as the site people who are not directly take place in the execution of works. Rather they supervise the workers and the construction activities. Site manager, office engineers, QA/QC engineers, draftsman, quantity surveyors, accountants, secretaries, procurement engineer and cook are examples to indirect personnel. Similar to direct manpower analysis the user should have below information to compute additional cost;

- Category of indirect personnel
- Number of indirect personnel (grouped as per their title)
- Wages
- Number of months (according to indirect manpower schedule based on the Project Execution Plan)
- Fixed cost
- Indirect Cost

In many projects, indirect personnel do not receive any additional payment for overtime work and contrary to direct manpower analysis, indirect personnel cost is calculated monthly. Monthly salaries of indirect personnel should be determined firstly. The following step is the computation of fixed cost and indirect cost of indirect personnel which is very similar to previous analysis executed for direct manpower. The expenditures are calculated yearly and monthly average additional cost is evaluated. Finally by adding up monthly average salary, fixed cost and indirect cost, average indirect man-month cost is computed. Thereafter the excess man-month is multiplied by average indirect man-month to determine excess cost.

4.1.1.4 Equipment Power Cost Analysis

This analysis is more intricate compared to previous analysis since the contractor uses both its equipments and rental ones. Definitely the cost varies from each other as owned equipment cost less. To carry out the study below data should be known by the user;

- Type of equipments
- Number of equipments
- Number of months the equipments are used
- Number of months owned equipments are used

- Number of months rental equipments are used
- Yearly depreciation percentage for owned equipments
- Purchase value of owned equipments
- Rental rates for hired equipments
- Other costs like maintenance, gasoline, oil etc.

Computations for rental equipments are executed by multiplying monthly rate and number of months for which the equipments are used. The total cost for rental equipments are evaluated by adding above values together. On the other hand, the costs of owned equipments per year are calculated by multiplying depreciation percentage and purchase value of the equipment. For monthly cost, the computed value should be divided to twelve. Like rental equipments, multiplying monthly rate and number of months for which the equipments are utilized and adding these values together gives the total cost of owned equipments used for the project. Consequently, the costs of owned and hired equipments are summed and divided to total equipment-months to find out the weighted cost per equipment. Other monthly costs including maintenance and fuel are added to pre-calculated weighted cost of equipment so that an average cost per equipment per month is determined. One can follow two different methodologies depending on the available data to calculate the excess cost. If the contractor has both equipment-month values for planned and actual resource allocation, the difference (excess) in equipment-months is multiplied by average equipment cost and excess cost is determined. However, most of the time unlike man-hours, equipment-month schedule is neglected during tendering stage. Although project records and daily reports give the actual equipment-month values, it is not possible to compare it with planned value because of its unavailability. Therefore, the contractor must have an assumption to be able to compute additional cost. It will not be unwise to assume that the ratio between actual man-hours and planned man-hours is applicable for the ratio between actual equipment-months and planned equipment-months. The contractor may use this ratio to calculate excess equipment-months. To illustrate, if the ratio between actual man-hours and planned one is 1.2 and actual consumed equipment-months is 2,400, it comes to a conclusion that planned equipment-months was 2,000 (2,400/1.2) and the excess amount is 400 equipment-months. According to this assumption, unit equipment-month is multiplied with excess equipment months and excess cost is determined.

4.1.1.5 The Cost of Additional Material and Changes in Construction Methods

Depending on the season the work is planned to be executed and information given to the contractor, the planned material and work methodologies may differ due to site and weather conditions, that is, concrete type may change due to design mistakes or admixtures may be required if the concreting works take place in winter instead of summer season. In addition to that, the excavation works may necessitate sheet piling although soil reports indicated shoring would be adequate. The burden of the additional materials and new methodologies should also be compensated if the fault does not belong to the contractor. However it should be noted that for these calculations, consumed man-hours and equipment-months should also be mentioned and deducted from previous man-hours and equipment-months in order not to claim extra costs twice.

4.1.1.6 Contractor Faults

During the project execution phase, other that client based obstructions; contractor may be in fault in specific cases which result in rework. A well known example to this type fault is the lower quality production compared to standards. Construction may also not follow the issued drawings and rework comes into the pictures. These cases must specifically be mentioned by contractor and consumed man-hours and equipment-months should be deducted from excess amounts not to claim extra costs again.

4.2 AN EXAMPLE

To clarify the procedure one example is given using real data for one of the international industrial project that was executed in between 2000 and 2003. However in order not to expose the contractor’s cost, the data manipulated and scaled. The data of the project is as below;

Table 4. 1 Project Details

Project Start	Project Completion	Duration	Budget (USD)
05/02/2000	10/06/2002	856	144,845,407.50

The schedule of project is prepared by Primavera and approved by the client. Since this methodology is not based on CPM analysis, and the number of activities entered in software is considerably high, planned schedule is not demonstrated here.

4.2.1 Reasoning

4.2.1.1 Project Details

This project under concern is an international project. The client signed a contract with single contractor (main contractor) for design-engineering, procurement and execution of project. However, the client indicated that he will have a QA/QC department to control and supervise the work and without their approval the work will not be completed. Main contractor carried out the design, procurement and supervision works and subcontracted the execution works to a single contractor (contractor). During the construction phase, contractor faced with several obstructions from which the client and main contractor is responsible such as; main contractor's delays, errors and substantial changes in engineering, lack of sufficient supervision, shortages and delays in material supply, unsequential, incomplete and/or delayed deliveries, excessive modifications and re-works, additional requirements and change in standards that were not existing at the time of contract signed. These impediments forced the contractor to increase his direct and indirect manpower, equipment power and some construction material substantially. Contractor placed extraordinary efforts in order to maintain the required completion date and commitments towards main contractor's site and senior management. The end result proved that required targets were achieved and main contractor's delays were recovered by contractor's extensive efforts. Consequently, the above summarized obstructions and subsequent measures taken thereof, resulted in extensive loss of efficiencies, and significant increase of man-hours, causing drastic and intolerable losses for contractor due to which contractor requested additional compensation (acceleration claim).

Although the causes that impeded the contractor discussed above, definitely, as discussed in construction documentation section, contractor should provide a very detailed documents to prove that these delays and excess costs are caused by main contractor such as

- Issue and reply dates of Technical Queries,
- Total man-hours spent on extra works (reduces the site efficiency),
- Frequent changes of main contractor's technical personnel,
- Delivery date of materials – improper delivery sequence,
- Site congestion,
- Delivery dates of IFC drawings,
- Design mistakes,
- Rework due to design mistakes,

- Increase in work scope,
- Incomplete delivery of construction materials (such as steel structure materials) which causes some structural elements to be left uninstalled and later on remobilization required to complete these members depending on the availability of contractors manpower and equipment power. This double handling increases the cost of works,
- Inadequacy of construction materials within country (excusable/non-compensable delay),
- Late information about material deliveries that causes contractor to hire additional equipments which remained idle most of the time,
- Location of equipment, paint and stock yards. If these locations are arranged far away from the pre-agreed positions, additional transportation costs will be faced.

4.2.2 Man-hour Reports

As suggested previously, a man-hour and equipment hour reports should be kept on daily basis. These reports may be transferred to computer in the technical office so that they can be managed more easily. Below a sample form is introduced;

Title: Daily Report   Date: 01.09.2005

Background and Justification:
Our work is disrupted due to late issuance of work permit (2 hrs delayed)
Idle Crew: 1 Foreman, 4 Steel Fixer, 3 Labor, 1 Helper, 1 Crane (45 t), 1 Low-bed trailer

Outline of Work:
The scope of work is preparation of anchor bolts, reinforcement and formworks of foundation D-405

Related Drawing:
475-Q-RA-361119 Sheet 01-02

Man-hour Spent:

No	Activity name	Crew Size	Hours Worked	∑ Man-hours
1	Anchor bolts	1 Foreman, 1Steel fixer	6 (2)	16
2	Formwork	4 Labor, 1 Helper,	5 (2)	35
3	Steel Erection	3Steel Fixer,3Labor	6 (2)	48
			TOTAL	99 man-hrs

Numbers in parenthesis indicate the overtime

No	Activity name	Equipment	Hours Worked	∑ Eqp-hours
1	Steel Erection	45t Crane	6 (2)	8
2	Steel Erection	Low-bed Trailer	6 (2)	8

Numbers in parenthesis indicate the overtime

No	Activity name	Accomplished Quantity
1	Application of Anchor bolts (A- 36-150)	12 units (116.9 kg)
2	Formwork	40 m^2
3	Steel Erection	3.25 tons

Numbers in parenthesis indicate the overtime

	Originator	Client Representative
Department	Civil	Civil
Division	D-75	D-75 and E-75
Engineer	Ali ILGAR	Stefano Maccari
Signature		

Figure 4.3 Sample Man-hour Report

4.2.3 Direct Manpower Cost Analysis

4.2.3.1 Calculation of Average Working Hours

To calculate Normal Work Days, weekly 6 days are considered and holidays coinciding with working days are deducted. As per below table yearly total working hours are determined.

Table 4. 2 Calculation of Yearly working Hours

	Working Days / Year	Working Hours / Day	Overtime Hours / Day	Normal Working Hours / Year	Overtime Working Hours / Year
Normal work days	312	8	2	2496	624
Sundays or any other non-work day	26	8		-	208
Holidays	5	8		-	40
Total	**343**			**2,496**	**872**

Total Yearly Working Hours	**3,368**

4.2.3.2 Average Salary

Due to absence of data for man-hours per type of worker, the contractor defined a theoretical team having different type workers to execute the work as below;

Table 4. 3 Calculation of Normal Weighted Salary

Description	No. of Turkish Pers	No. of Filipino Pers	No. of Rental Pers	Turkish Wage ($/hr)	Filipino Wage ($/hr)	Rental Wage ($/hr)
Welder	10	10	10	10.50	8.51	24.50
Pipe Fitter	10	10	10	8.25	6.80	14.50
Helper	10	10	10	6.00	3.25	8.90
Piping Crew Leader	3	3	3	11.00	8.55	17.25
Steel Erector	8	8	8	8.25	6.47	13.50
Steel Crew Leader	1	1	1	10.50	8.55	17.00
Millwright	1	1	1	10.00	8.25	16.50
Mechanical Erector	8	8	8	8.25	6.80	13.50
Mechanical Crew Leader	1	1	1	11.00	8.25	17.50
Foreman	2	2	2	20.35	13.16	27.50
Rigger	2	2	2	11.00	9.00	55.00
Weighted Normal Salary				**9.05**	**6.91**	**17.19**

4.2.3.3 Overtime Calculation

As per project records, all Turkish workers received overtime payment on 26 Sundays and holidays. However, for normal workdays approximately, one Turkish worker received 2 hours overtime in every two days. Due to local laws, rental people are not allowed for overtime. For Filipino workers, 50% overtime is applied for Sundays, holidays and normal work days. Overtime payments are determined by the contractor twice as much as wages for normal hours, which was previously determined as $9.05. Accordingly, excess payment of Turkish workers for overtime is calculated as 9.05x2-9.05=$9.05. Therefore, the calculations are carried out as in Table 4.4;

Table 4. 4 Overtime Salary Calculation

Overtime Compensation	Overtime hours for Turkish Workers	Overtime hours for Filipino Workers	Overtime Wage for Turkish Workers USD	Overtime Wage for Filipino Workers USD	Overtime Payment to **Turkish** Workers	Overtime Payments to **Filipino** Workers
Normal	312	312	9.05	6.91	624/2x9.05 =2,823.6	624/2x6.91 =2155.92
Sundays or any other non-work day	208	104	9.05	6.91	208x9.05 =1,882.40	208/2x6.91 =718.61
Holidays	40	20	9.05	6.91	40x9.05 =362	40/2x6.91 =138.2
Total	**560**	**436**			**5,068.00**	**3,012.76**

The contribution of overtime payment to man-hour rates is calculated as below;

Table 4. 5 Weighted Overtime Salary Contribution over Unit Man-hour

	Turkish	Filipino	Rental
Overtime	5,068	3,012.76	0
Yearly total hours	3,368	3,368	3,368
Weighted Overtime Salary	**1.50**	**0.89**	**0**

4.2.3.4 Fixed Cost

Considering the fixed cost items, their contribution to unit ma-hour cost is calculated as below;

Table 4. 6 Contribution of Fixed Cost over Unit Man-hour

	Turkish ($/man-year)	Filipino ($/man-year)	Rental ($/man-year)
Visa	2,450	2,450	0
Translation Cost	135	135	0
Mobilization-Demobilization	1,750	2,950	0
Inland Transportation	75	75	50
Agency Fee	0	1,438	0
Work Permit	100	100	0
Local ID	500	500	0
Blood Test	25	300	0
Vacation Ticket	1,750	0	0
Safety Shoes etc	425	425	425
Others	0	0	0
TOTAL	**7,210**	**8,373**	**475**
Yearly total hours	3,368	3,368	3,368
Average (Cost/Mh)	**2.14**	**2.49**	**0.14**

4.2.3.5 Indirect Cost

When indirect cost items are considered, their contribution to unit man-hour cost is calculated as below;

Table 4. 7 Contribution of Indirect Cost over Unit Man-hour

	Turkish ($/man-year)	Filipino ($/man-year)	Rental ($/man-year)
Food and Accommodation	8,270.00	8,270.00	8,270.00
Transportation	2,125.00	2,125.00	2,125.00
Medical care	1,025.00	1,025.00	0.00
Other	750.00	750.00	750.00
Total Indirect	12,170.00	12,170.00	11,145.00
Yearly total hours	3,368.00	3,368.00	3,368.00
Average (Cost/Man-hour)	**3.61**	**3.61**	**3.31**

4.2.3.6 Weighted Salary

Table 4. 8 Average Direct Man-hour Cost

	Turkish ($/man-year)	Filipino ($/man-year)	Rental ($/man-year)
Weighted Normal Salary	9.05	6.91	17.19
Weighted Overtime Sal.	1.50	0.89	0.00
Average Fixed Cost	2.14	2.49	0.14
Average Indirect Cost	3.61	3.61	3.31
Average Direct Man-hour Cost	**16.30**	**13.90**	**20.64**

4.2.3.7 Weighted Average Direct Man-hour Cost

According to the administrative reports, the nationality distribution of workers is 25% Turkish, 15% Filipino, and 60% Rental. Therefore weighted average direct man-hour cost is calculates as;

WADMHC = 0.25x16.30+0.15x13.90+0.60x20.64 = $ 18.54

4.2.3.8 Excess Cost Due to Increased Man-hours

Calculations for determination of excess man-hour are carried as below;

Table 4. 9 Excess Man-hours

Cumulative man-hours as per Execution Plan	:	1,656,980.00
Revised Scheduled Cum man-hours	:	2,460,604.00
Man-hour Deduction	:	150,000.00
Excess Man-hours	**:**	**653,624.00**

Here, man-hour deduction is done for the consumed man-hours during implementation of new methodology and reworks from which the contractor is responsible in order not to claim them twice.

Finally, the excess cost is determined as;

Cost Impact = 653,624 x 18.54 = $ 12,118,188.96

4.2.4 Indirect Manpower Cost Analysis

Indirect manpower cost analysis is carried out in a way similar to direct manpower cost analysis;

Table 4. 10 Indirect Manpower Salary Calculation

Description	No of Pers	Month	Man-month	Salary ($)
Site Manager	1	20	20	18,750.00
Erect. Chief Superintendent	1	20	20	13,125.00
Draftsman	1	20	20	4,750.00
Office Engineers	4	20	80	6,562.00
Safety Engineers	1	20	20	5,625.00
Safety Technicians	3	20	60	3,750.00
Quantity Surveying Engineers	1	20	20	5,625.00
Quantity Surveying Technicians	1	20	20	3,750.00
QA/QC Engineers	1	20	20	6,562.00
Quality Control Technicians	4	20	80	4,000.00
Mechanical Engineer	7	20	140	8,250.00
Topographer	1	16	16	4,125.00
Surveyor Assistant	1	16	16	2,500.00
Chainman	2	16	32	1,750.00
Computer Operator	1	20	20	3,750.00
Procurement Eng	1	20	20	7,500.00
Warehousing Supervisor	1	20	20	5,250.00
Warehouse Man	1	20	20	3,000.00
Warehouse Man Asst.	3	20	60	1,750.00
Cashier	1	20	20	4,125.00
Accountant	1	20	20	4,125.00
Accounting Clerk	1	18	18	1,750.00
Secretary	1	20	20	1,750.00
Purchaser	2	20	40	2,750.00
Administration Manager	1	20	20	4,125.00
Timekeeper	3	20	60	2,500.00
First Aid Man	1	20	20	2,250.00
Cook	1	20	20	3,750.00
Cook Asst.	3	20	60	2,000.00
Kitchen Personnel	8	20	160	1,500.00
Tea Boy	2	20	40	1,500.00
Guards	3	20	60	1,850.00
Drivers	6	20	120	2,750.00
Camp Manager	1	20	20	4,500.00
Camp Manager Asst.	6	20	120	1,500.00
Weighted Average				**3,857.23**

4.2.4.1 Fixed Cost

Table 4. 11 Fixed Cost Analysis

ITEM	$/man-year
Visa	2,450.00
Translation Cost	135.00
Mobilization Demobilization	2,150.00
Inland Transport.	125.00
Agency Fee	0.00
Work Permit	100.00
ID	500.00
Blood Test	25.00
Vacation Ticket	3,500.00
Safety Equipment	0.00
Total Fixed	8985.00
No. of months in a year	12.00
Average ($/Man-month)	**748.75**

4.2.4.2 Indirect Cost

Table 4. 12 Indirect Cost Analysis

ITEM	$/Man-year
Food and Accommodation	17,740.00
Transportation	4,255.00
Medical care	1,225.00
Other	1,250.00
Total Indirect Cost	24,470.00
Average ($/Man-month)	**2,039.17**

4.2.4.3 Average Indirect Man-month Cost

Table 4. 13 Average Indirect Man-month Cost

Weighted Normal Salary	3,867.23
Average Fixed Cost	748.75
Average Indirect Cost	2,039.17
Average Indirect Man-month Cost	**6,645.15**

4.2.4.4 Excess Cost Due to Increased Man-hours

Table 4. 14 Excess Man-month Calculation

Cumulative MH as per Execution Plan	:	1,986.75
Actual Cumulative Man-months	:	2,541.93
Man-Month Deduction	:	0.00
Extra Man-months	:	555.18

Here, man-month deduction is not done as it is not claimed somewhere else and finally, the excess cost is determined as;

Cost Impact = 555,18 x 6,645.15 = $ 3,689,254.38

4.2.5 Equipment Power Cost Analysis

4.2.5.1 Rates

Equipment costs involve monthly rate of rental equipments, depreciation of owned equipments, maintenance fuels and other costs for inventory. First rate of the equipments are determined as indicated in Table 4.15;

Table 4. 15 Equipment Rates

Description	Type / Capacity	Number of Eq	Month	Equipment - Month (owned)	Equipment - Month (rent)	Depreciation (% per year)	Purchase Value ($/Equip)	Depreciation Cost ($/Month)	Rental Price ($/Month)
Mobil Crane	300t	1	6		6				197,500.00
Mobil Crane	200t	1	8		8				162,500.00
Mobil Crane	80t	1	13	13		15%	1,406,250	17,578	
Mobil Crane	45t	2	17		34			-	41,000.00
Mobil Crane	30t	2	17		34			-	29,500.00
Mobil Crane	20t	2	18	36		15%	721,875	9,023	
Truck Mounted Crane	10t	2	18	18	18	15%	243,750	3,047	13,500.00
Forklift	5t	2	18	18	18	15%	131,250	1,641	11,500.00
Trailer Low Bed	50t	2	10	10	10	15%	487,500	6,094	15,500.00
Tractor Sal	5t	2	18	36		15%	157,500	1,969	
Compressor	350 cfm	1	19	19		15%	148,125	1,852	
Compressor	250 cfm	1	19	19		15%	110,625	1,383	
Water Tanker	7 t	1	19	19		15%	129,375	1,617	
Diesel Generator	250 kVA	2	16	32		15%	108,750	1,359	
Electric Welding Machine	400 A	75	18	1350		25%	14,063	293	
Diesel Welding Machine	20 HP	5	18	90		25%	46,875	977	
Tig Welding Machine	20 kW	4	18	72		25%	46,875	977	
Welding Machine	20 kW	4	18	72		25%	46,875	977	
Pick-up		5	19	95		20%	73,125	1,219	
TOTAL								**1,645,045**	**5,487,000**
Weighted Cost (SR/equip-month)								**3,519**	

4.2.5.2 Other Costs

Table 4. 16 Other Costs for Equipments

Cost Items	($/equip.-month)
Maintenance	344
Diesel, Gasoline, Oil	442
Other Costs	0
Average (Cost/ month)	**786**

4.2.5.3 Average Equipment Cost

Table 4. 17 Average Equipment Cost

Cost Items	($/equip.-month)
Average Equip. cost	3,519
Other Costs	786
Average Overall Equipment Cost	**4,305**

4.2.5.4 Excess Cost Due to Increased Equipment-Months

At this stage the difference between the planned equipment-month and actual equipment-month is required. Although actual equipment-month data is available, equipment-month schedule is neglected during tendering stage. Therefore an assumption should be followed by the contractor, that is, contractor assumes that the ratio between actual man-hours and planned man-hours is applicable for the ratio between actual equipment-months and planned equipment-months.

Table 4. 18 Actual Man-hours over Planned Man-hours Ratio

Cumulative MH as per Execution Plan	:	1,656,980.00
Actual Man-hours	:	2,460,604.00
Man-hour deduction	:	150,000.00
Ratio Actual/Planned	:	1.3945

Ratio Actual/Planned = (2,460,604-150,000) / 1,656,980 = 1.3945

Actual Equipment-Months = 2,071.5

Equipment-Month deduction = 71 (due to equipment use in implementation of new construction technique)

Planned Equipment-Months = 2,071.50 / 1.3945 = 1485.5

Excess Equipment-Months = 2,071.5-1,485.5 -71 = 515

Cost Impact = 515 x 4,305 = $ 2,217,075

4.2.6 The Cost of Additional Material and Changes in Construction Methods

During the construction process, client changed inspection test plans (ITPs) which necessitated renting additional scaffolding. Further sheet piling was obliged in deep excavations for some of the structures. Accordingly, this burden is carried by the contractor and should be compensated.

Additionally, 6,480 cum tower scaffold and 7,200 sqm of suspended scaffold is rented for 9 months. Therefore the additional cost is calculated as;

Cost Impact of Tower Scaffold = 6,480 x 2.47 x 9 = $ 144,050.4

Cost Impact of Suspended Scaffold = 7,200 x 5.75 x 9 = $ 372,600

Sheet piling is applied for 1,500 meters and unit cost of sheet piling is $ 3,500. Therefore additional cost is calculated as

Cost Impact of Sheet Piling = 1,500 x 3,500 = $ 5,250,000

Table 4. 19 Cost of in Additional Material and Changes Construction Methods

	Units	Unit Cost	Total Cost	Manhour	Indirect Personnel	Equipment-Month
Sheet piling	1,500	3,500	5,250,000.0	1,000	0	12
Tower Scaffold	6,480	2,47	144,050.4	46,000	0	15
Suspended Scaffold	7,200	5.75	372,600.0	91,000	0	30
TOTAL			**5,766,650.4**	**138,000**	**0**	**57**

Table 4. 20 Total Cost of Additional Material and Changes Construction Methods

	Total Cost	Manhour	Indirect Personnel	Equipment-Month
Cost impact of new material	516,650.40	137,000		45
Cost impact of new methodology	5,250,000.00	1,000		12
TOTAL	**5,766,650.40**	**138,000**		**57**

Total cost for changes in construction methods and additional material procurement is calculated as $ 5,766,650.40

As stated earlier in this section, total man-hours, equipment-months and indirect personnel (man-month) values should be deducted from excess man-hours, man-months and equipment-months in order not to claim these amounts twice.

4.2.7 Contractor Faults

The contractor should honestly demonstrate in this section, the additional cost and man-hours spent due to problems from which the contractor is responsible. Our contractor has failed in few areas and spent man-hours for corrective action as;

Table 4. 21 Additional Man-hours and Equipment-months Consumed due to Contractor's Faults

Work Description	Man-hours	Equipment Months
Rework	5,000	6
Other	7,000	8
TOTAL	12,000	14

Similar to previous section, since these consumed man-hours belong to contractor, they should be deducted from man-hours, man-months, and equipment months.

Total Deduction for man-hours = 138,000+12,000=150,000

Total Deduction for man-months = 0

Total deduction for equipment-months = 57+14=71

4.2.8 Total Cost of Acceleration Claim

Finally, the additional cost which is claimed by the contractor is calculated by adding all previous costs;

ITEM DESCRIPTION	AMOUNT ($)
Cost Impact of Extra Direct Manpower	12,118,188.96
Cost Impact of Extra Indirect Manpower	3,689,254.38
Cost Impact of Extra Equipment	2,217,075.00
Cost Impact of Implication of New Methodology	516,650.40
Cost Impact of New Material	5,250,000.00
TOTAL Cost IMPACT =	**23,791,168.74**

4.3 DISCUSSIONS

The successful quantification of a construction claim largely depends on the quality of information and documentation maintained from the project. The proposed methodology stands very close to total cost approach but functions better since it deducts the incurred cost due to contractor's fault. It should be noted that, the accuracy of the calculations may be improved if the available data is precise and detailed. Instead of using average unit cost for direct and indirect personnel, and equipment hours their own values could have been used in calculations. However, this thesis tried to concentrate on proposing a general solution to wide range of projects even ones with insufficient data, these assumptions are made to overcome these impediments.

Definitely, this approach has some bottlenecks and various comments may be received from counter-claimants, such as Client may always question the calculations and its assumptions. Further he may;

- Assert that the client is not solely responsible from this total cost and request contractor to prove losses for each impact driving added cost growth.
- Ask contractor to prove his bid is reasonable
- Request contractor to prove his actual costs are reasonable
- Raise mismanagement concept and question all these additional resources were necessary

If the data and documentation are professionally collected, the proposed method functions better and serves in favor of the contractor. Sometimes it is impossible to assign a precise monetary loss to each discrete event in a project where continuing problems compound a contractor's performance difficulties. Although the 'total cost' method must be used with caution, the method should be applied where the nature of the particular loss has made it impossible or highly impracticable to determine damages with a reasonable degree of accuracy and where the loss is substantiated by reliable evidence. The proposed method in this thesis does not miss any unforeseen cost item as it calculates overall cost. However, in cause and effect analysis (individual cost methodology) one cannot demonstrate the direct relation between site congestion and productivity loss, or late delivery of material and necessity of mobilizing more men to complete the project in time, which results in unfair cost allocation in contractor’s point of view.

4.4 COMPUTER SOFTWARE

Computer software is written as a part of this thesis through DELPHI 7 programming language. This software is considered as a guide to follow especially for new engineers and construction practitioners. It is worth mentioning that, the program does not execute complex calculations as the methodology does not require such operations. However, it has a user friendly interface and could be used simply to quantify the resulting effects of acceleration claim in monetary terms. Five components of the simplified approach are entered to that program. In every step, instructions are given to the user, and hence the user manipulates the available data easily.

The software starts with asking project specific data as in Figure 4.4. The details of project data and primary information are entered at this stage.

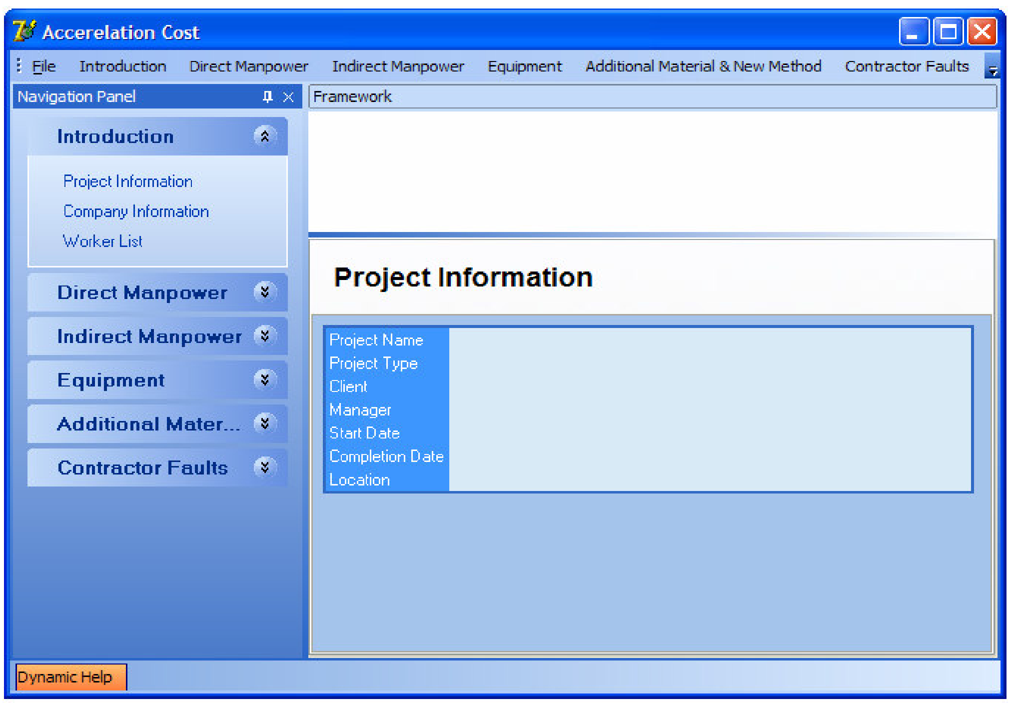


Figure 4.4 Project Information Window

Next step is entering normal working days, holidays, and working hours per day to calculate yearly working hours;

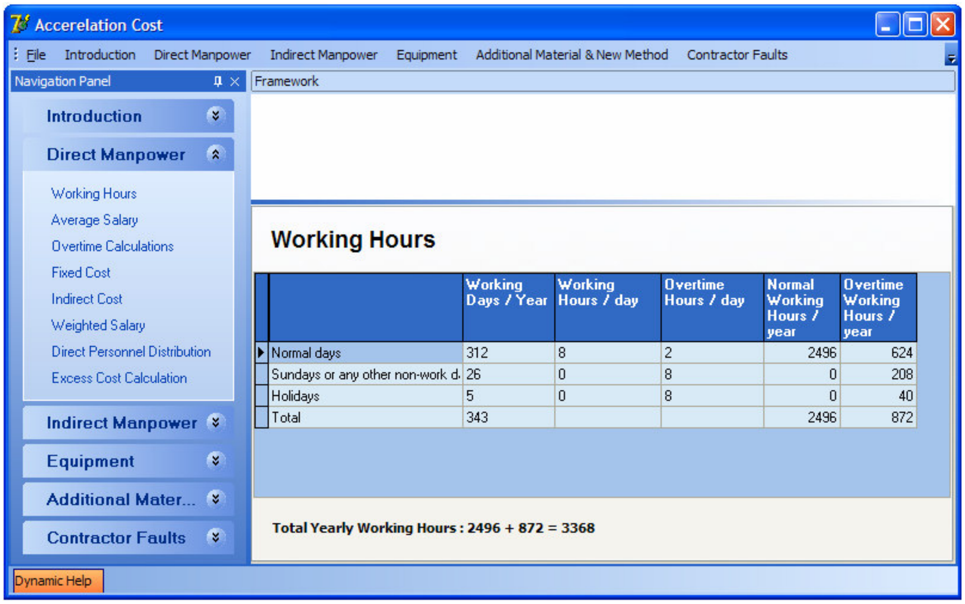


Figure 4.5 Working Hours Window

Following the above task, the software seeks for information in order to be able to calculate the excess cost due to consumption of additional man-hours. The user enters this information in five separate windows. Average salary window is presented below;

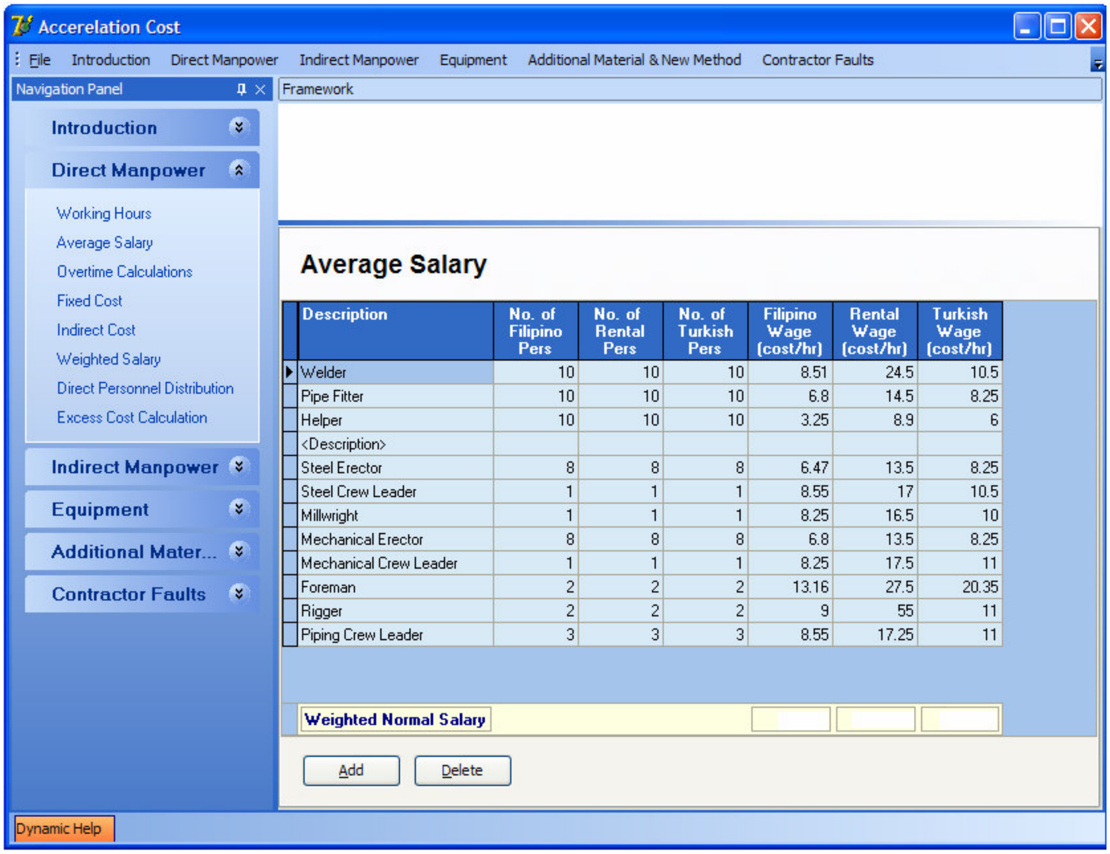


Figure 4.6 Average Salary Window

Thereafter, the user asked to enter information to calculate additional indirect man-month costs. Three different windows are designed to store required data. Below fixed cost window is demonstrated;

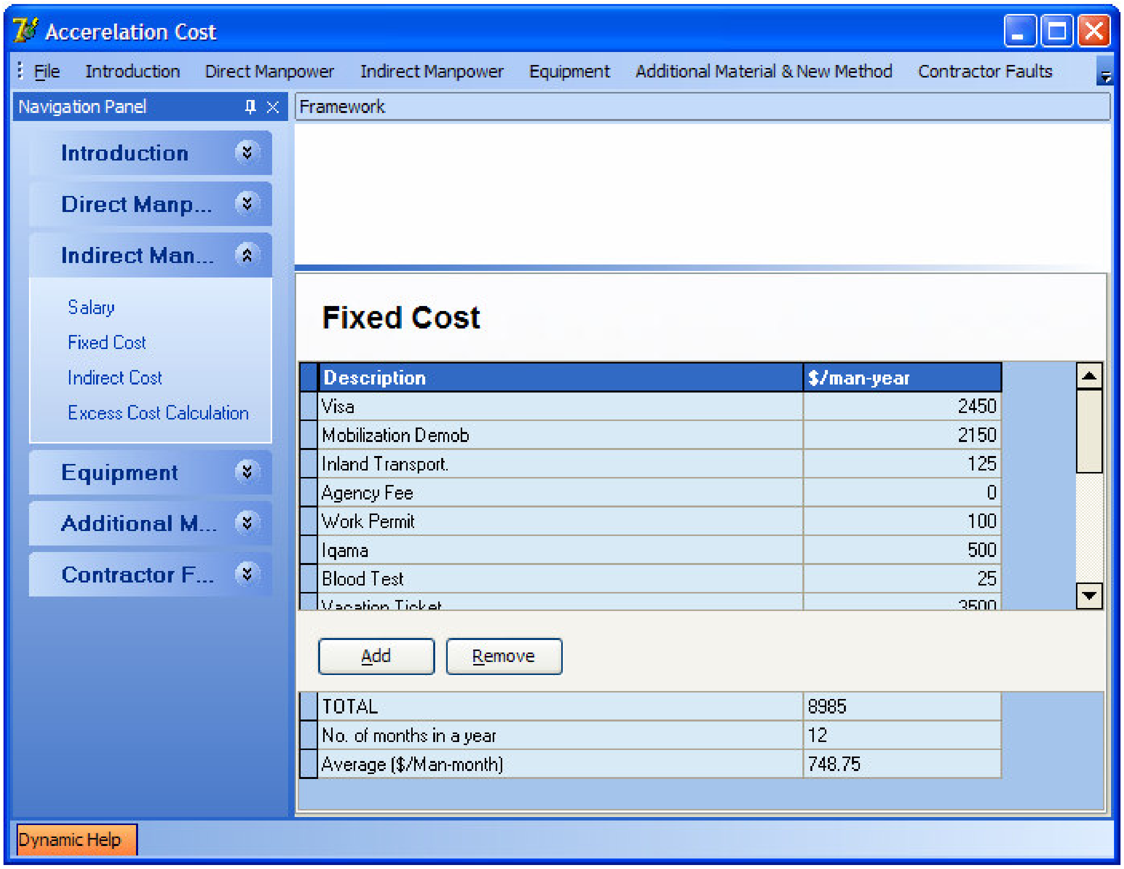


Figure 4.7 Fixed Costs of Indirect Personnel

Quantification of excess equipment power takes the next step in the software. To perform these calculations, average equipment cost, other cost like maintenance constitutes this phase of the software. The user asked to enter information for utilized equipments in project in below Figureure 4.8;

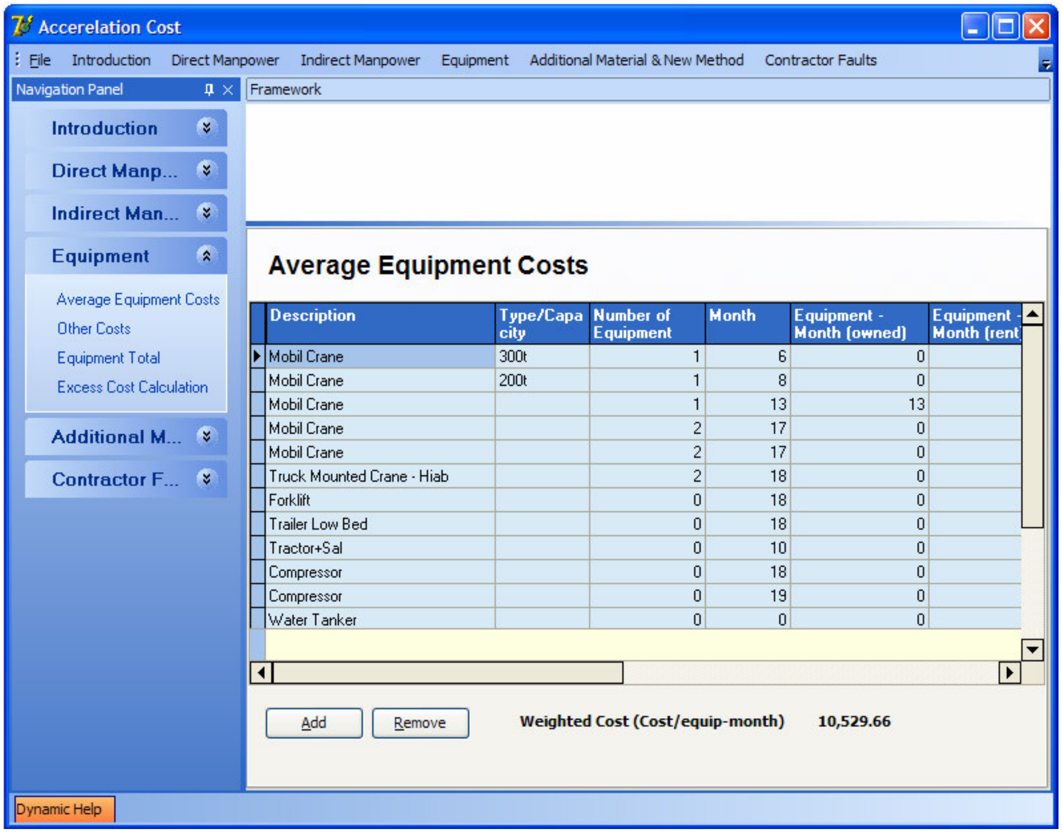


Figure 4.8 Average Equipment Cost Window

During the project execution phase, if any changes in construction methods or any material types, these calculations are achieved in below window of the software;

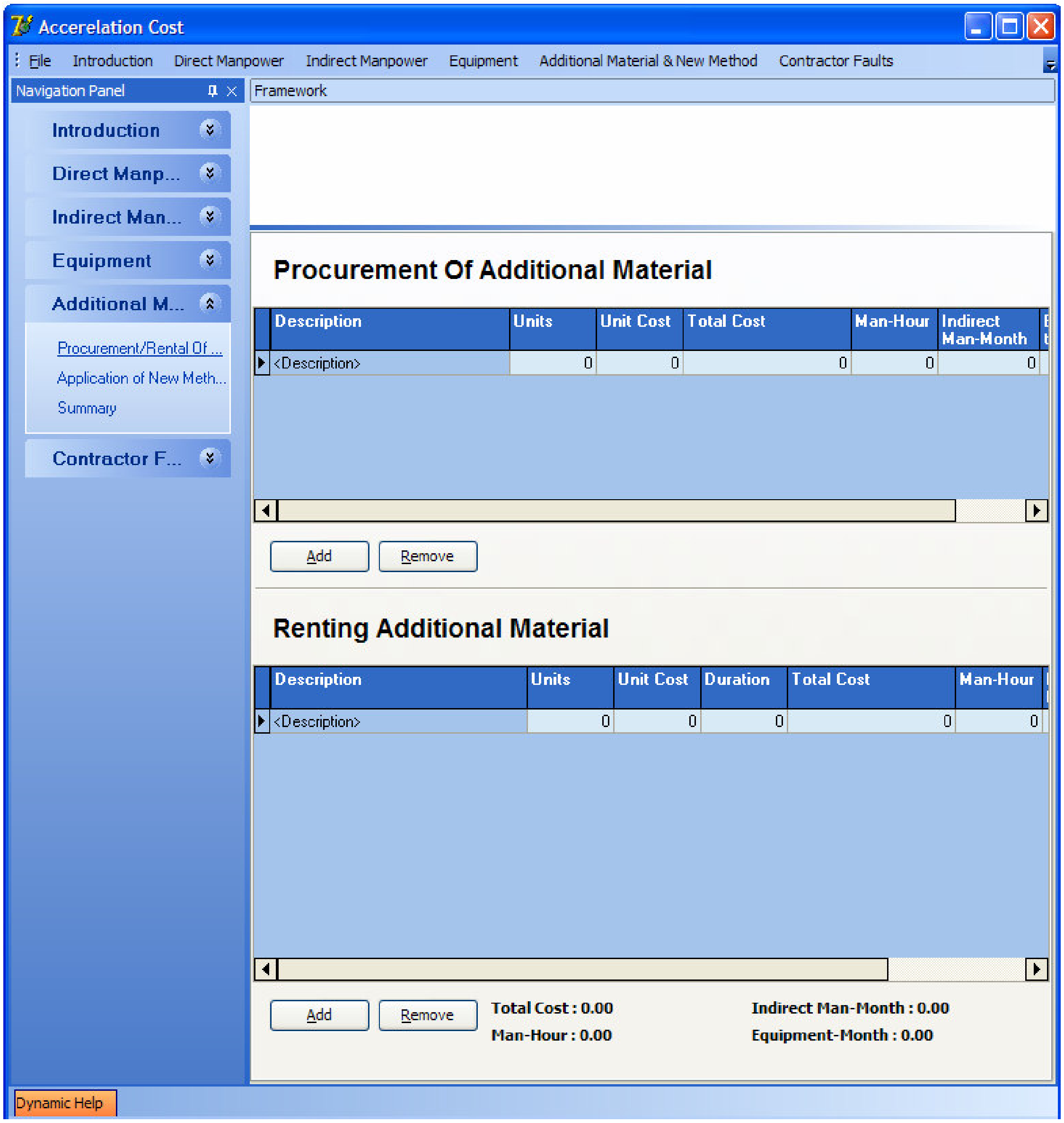


Figure 4.9 Procurement / Renting Additional Material

Definitely, the user should not forget to deduct excess cost that arose due to his faults such as rework. Next window reminds user to deduct this excess cost from total acceleration cost to be requested from client;

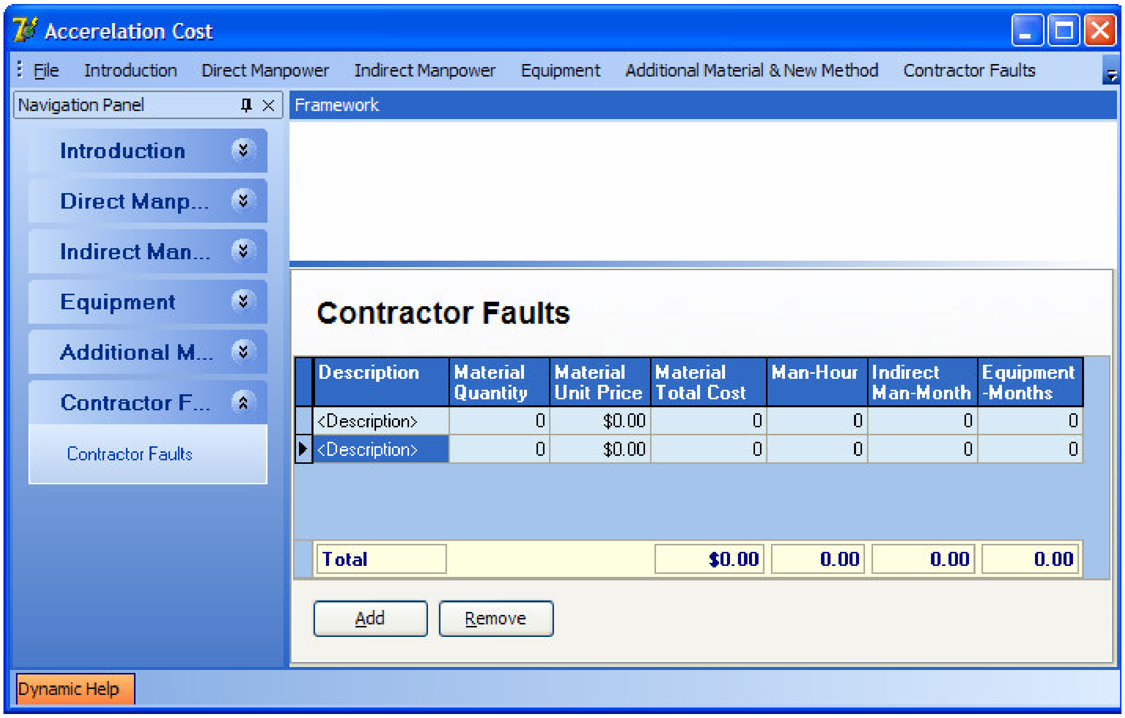


Figure 4.10 Cost Impacts of Contractor Faults

Finally, software summarizes the results and displays the cost to be reimbursed in its last window as shown below;

CHAPTER 5

CONCLUSION

Work changes in construction business are unavoidable and affecting the project both positively and negatively. While these changes aimed to increase the quality of final outcome, they may have severe impacts like increased costs and delays.

Acceleration claims has become the subject of many articles. Mainly an accelerative action could be required either to complete the project earlier or to recover the effects of previously experienced delays. Project managers concentrated their efforts on understanding and implementing valid management and quantification systems to demonstrate effects of acceleration on project cost and schedule. Depending on the size and complexity of projects, through successful claim management, a company may receive 10% - 25% of total project value additionally, due to acceleration activities.

Up to now, various methodologies have been proposed and criticized by researchers for quantification of the effects of encountered disruptions, delays, changes in scope, productivity losses which cause extra burden to the contractors. These methodologies include cause and effect analysis (individual cost method), total cost method and adjusted total cost method. However, as all these concepts involve intangible variables, the calculations may give different results although the same technique is used. That is, due to subjectivity of all these approaches, there is always an open door for the counter claimant to reject the quantification technique.

In this thesis, the reasons that force a contractor to claim for additional reimbursement are discussed first. The concept of dispute has been raised and its driving factors are examined. Parties to the contract in construction business should have a good knowledge about potential sources of disputes in order to resolve them before they result in to bigger discussions. A model of dispute development and resolution process is explained to highlight the fundamentals of claim management concept.

In order to reach satisfactory results in claim management, selection of an appropriate approach for claim preparation constitutes an important phase. Therefore, the framework for claim management is explained in details. In this framework, claimants are guided to follow necessary steps to achieve a defendable and valid claim management strategy like; documentation, identification, notification, examination, presentation and negotiation.

The main concern of this thesis is to find out how construction companies can quantify acceleration cost and manage the claim preparation process. Usually, claim quantification is not a previously planned activity and can not be anticipated at the very beginning of project. Thus, required data may not be collected during the construction process. At this point, if necessary data is not available, valid assumptions should be made in order not to hamper calculations. However, it is proposed that; contractors should act in a way that claims may be encountered in all projects and accordingly, they should document project facts and collect necessary data. Thus, a proactive approach is recommended for claim management. Specifically, in acceleration claims, recovery of owner originated delays and productivity loss due to owner based reasons constitute major causes of cost overruns. Therefore, project managers should concentrate on documenting this information properly, and design a data collection procedure to facilitate calculations later on.

Two different approaches for quantification of acceleration claims are discussed within the context of this thesis; a theoretical approach and a simplified approach. The theoretical approach when applied correctly, gives most accurate and defendable measure of associated costs. The basic principle of this method is to determine cause and effect relations of any disruption to project since they may cause cost increase, project delays (if no corrective action is taken), extra work or change orders. Further, courts favor this model as it satisfies the need to show a cause and effect and quantification of damages at the same time. Although, this approach has various strengths, it requires a complicated analysis in identifying disruptions and their consequences occurred within the project. As stated many times previously, due to the nature of construction projects which are complex and unique, obtaining a comprehensive cause and effect analysis is rather difficult. Furthermore, project may be divided into thousands of activities and indirect consequences of disruptions (ripple effect) cannot be quantified correctly, that is to say, these disruptions cannot be isolated. A review of as-planned and as-built project drawings may reveal the necessary information to accurately quantify the cost of extra or changed works. However, due to excessive changes on a project, or congestion, the contractor may experience lower overall productivity. Besides, acceleration may require organizational change and resource re-allocations in contractor's personnel status which is always questionable by other party. Eventually, this underestimation causes the contractor to carry the burden of additional cost of which he is not actually responsible.

The second model, namely simplified approach, is developed to quantify overall effects of the disruptions experienced throughout the life of project and involves the comparison of planned and actual amounts. Although most of the professionals are aware of the concept, the way comparisons are made differs from one to another. This approach is based on three fundamental assumptions.

- The bid is perfect,
- Recorded costs are reasonable and,
- The contractor is totally blameless for the claimed amount.

Cost components are divided into five different segments; direct manpower cost, indirect manpower cost, equipment power cost, the cost of additional material and changes in construction methods, and finally cost overruns due to contractor's faults. The excess amount between initial estimates and actual values which are increased due to disruptions is considered as total cost overrun for the project. However, contractor should not act opportunistically; rather he should deduct the consequences of his faults properly. Furthermore, as stated in theoretical approach, mismanagement is used as a reason by other party to question the validity of contractor's calculations.

In Table 5.1, comparison of two approaches is presented;

Table 5. 1 Comparison of two approaches (Theoretical vs. Simplified)

Approach	Required Documents and Data	Shortcomings
Theoretical Approach	Notifications for disruptions As-built, as-planned schedules Detailed analysis to determine cause and effect relation Crashing cost of activities	Difficult to determine ripple effects Hard to isolate disruptions Rather difficult to collect required data Hard to prove calculated cost of recovery actions are reasonable
Simplified Approach	Notifications for disruptions Escrow bid documents Man-hour reports Equipment-month reports Administrative records Consequences of changes in construction methods and procurement of additional materials Consequences of contractor faults	Rather difficult to defend Responsibility allocations may be questionable Bid should be perfect Owner should determine the cost from which he is responsible accurately

In this thesis, it is tried to be concentrated on proposing a general methodology that is applicable to a wide range of projects. Accordingly, a computer program is developed to simplify the quantification process. Although these calculations can be carried out through the use of MS Office tools like Excel, the software simplifies the computations and guides the user by minimizing confusion through its user friendly interface. It should be accepted that, this model is not a perfect solution and it cannot be used blindly. The user should be well aware that the outcome of the program might not be receivable always as proper documentation and evidences constitute the crucial part of any claim.

As a conclusion, claim management and quantification of acceleration claims play an important role in running construction business which is one of the main driving sectors of economy. Hence, understanding and application of these two concepts by construction professionals are crucial as construction firms can use this knowledge as a strategic weapon to ensure cost compensation and consequently, achieve the expected profitability levels. Through implementation of a well-developed claim management, and quantification methods, contractors may avoid carrying the burden of additional costs which stem from client based disruptions and delays.

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