DELAY TO PROJECTS – CAUSE, EFFECT AND MEASURES TO REDUCE / ELIMINATE DELAY BY MITIGATION / ACCELERATION

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ABSTRACT :

Delay to projects is one of the foremost concerns of the construction industry in the United Arab Emirates. The delays to the projects are affecting the economies throughout the world. Delay to projects mean the slowdown of development in all other related fields. The main aim and objective of this dissertation is to evaluate the various types of delays and the reasons for those delays that are currently affecting the projects in the United Arab Emirates. Measures from previous researches to reduce or eliminate these delays by methods of mitigation or acceleration are analyzed for the case studies considered for this research.

There are various types of delays which are identified. It is important to identify whether the delay is critical or not as identification of critical delays helps in taking appropriate measures at the correct time. The delay may be non excusable (contractor caused) for which the client and the consultant need to have project management tools to effectively manage the delays or compensable (client caused) delays which are due to the client. The delays may be by either parties and can be concurrent.

The reasons for delays are primarily due to an unreasonable project scope, inadequate early planning and the absence of risk management systems. The contractor further contributes to delay due to lack of resources and labor productivity. Over ambitious estimates, incorrect task assessment ,lack of task clarity, design/ approval delays and interference in the decision making process by the client add on to the delay.

Research done earlier indicates that “changed work complicates a project and invites delays” (Molner , 2007). Delays that are non excusable (contractor caused) “expose a contractor to delay claims of its subcontractors and liquidated damages” (Schumacher , 1995). Delays that are compensable (owner caused) need the support of specialty contractors who need to be nominated at the appropriate time (Gil , 2001).

The mitigation of delays was discussed by application of knowledge management and project learning. The lessons learnt feedback gives important information related to the mitigation measures considered for implementation.

The prevention of delay can be done through mitigation and/or acceleration. It is important to plan/analyze the requirement in detail. This has been done by identifying the risks and mapping resources. The estimation and allocation of works was done to modularize the works and any issues likely to delay the works can be escalated for decisions and discussion.

A detailed case study has been carried out for three projects in the United Arab Emirates. The first case study deals with a project which encountered delays and implemented measures of mitigation and acceleration to reduce the delays. The second case is a project which failed in its objectives of completion in time as well as budget. The third case is success project, where in spite of initial delays the project was completed on time by implementing mitigation and acceleration measures. The methodology implemented is acquisition of key data and justifying by providing adequate reasons regarding the data. Results and analysis for the case studies were structured according to methodology and further detailed into planning, resource, cost and nominations analysis.

The finding from the case studies are that the main delay to the projects are compensable delays (owner caused)as seen case study 1 where the owner delayed the nomination. The findings from Case study 2 are the lack of decisions by the client and commitment to the project affected the project to an extent that the project could not achieve its goals. The findings from the case study 3 are that even if there is an initial delay, it can be overcome by teamwork and contribution from all the stakeholders to achieve success.

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"DELAY TO PROJECTS – CAUSE, EFFECT AND MEASURES TO REDUCE DELAY BY MITIGATION OR ACCELERATION"

1. INTRODUCTION

Projects are envisaged and visualized with the foresight of achieving the primary objective of timely completion. Some projects are planned and executed successfully whereas others get delayed due to reasons, some of which are analyzed and evaluated in this dissertation.

Delay to projects is considered to be one of the common problems in the construction industry. Delays have an negative effect on the project in terms of performance, time and cost. Thus, it is essential to identify the types of delays that normally occur in a project .The types of delays can be broadly split in two categories of delay by the client (compensable delays)and the contractor(non excusable delays).The delays can be identified as critical or non critical and whether the delay is concurrent or non concurrent. The identification of the types of delays leads to the reasons of delay.

The reasons for the delays are identified so that the effect on construction projects can be reduced. The reasons for delays are client and contractor related. Unreasonable project scope and inadequate early planning are the prime delays by the client. The client interference and delay in the decision making process also major reasons for delays. The client in some cases delays the design or changes the design leading to various other changes like design related changes to drawings and their approval by the authorities. The contractor had delays related to overambitious estimates and incorrect task assessment which lead to delays and affect the project. In case of lack of task clarity, an inexperienced contractor or subcontractor may unknowingly delay the works.

The mitigation of delays can be achieved by adopting the process of knowledge management and project learning which gives insight into the various problems and their solutions. In fact the lessons leant feedback from projects is a real eye opener and helpful for others to avoid similar issues.

Prevention of delays by adopting innovative and teamwork helps in planning and analyzing the requirements in detail which will allow the mapping of resources and identifying the risks. The works can then be estimated, allocated and modularized for execution. The issues that can lead to delays need to be escalated, identified and resolved on a priority to ensure that they do not become a reason for delay.

The issue of delay is further researched through case studies. The case study approach is adopted for this research as the issue to a particular project can be analyzed in complete

detail. These case studies have been taken from live projects in the U.A.E. Since one case study will not provide the complete picture regarding the delays, one delayed but completed project , second one is a failure project and the third is a success project. The case study 1 is a completed project which was delayed due to the client but completed by applying mitigation and acceleration measures. The case study 2 is a failure project as the client abandoned the project by putting the project on hold and introducing a new stakeholder. The third case study is a success project. Even though there were initial delays to the project from both the client and the contractor, absolute teamwork and the spirit to accomplish the goal by implementing mitigation and acceleration measures ensured that the project completed in time.

The methodology for these studies takes into account the key data for each project which included the planning methodology, resources monitoring, cost methodology and the critical decisions which are likely to delay the project. The justification for the data considered is provided and further the method of data acquisition and data analysis is detailed to substantiate the methodology.

The analysis and of the data provided for the project is analyzed further for each case study for their planning, resources, cost and decisions processes. The recommendations for each project is given as to what could have been done to mitigate the delays. The knowledge gained in some of the module is applied for recommendations which is applying the knowledge gained in a purposeful manner. Conclusions are listed based on the areas analyzed for the methodology for the case studies to allow for better knowledge management in future.

1.1

AIM :

The aim of this research was to evaluate the various types of delays that occur in construction projects in the United Arab Emirates and the reasons why delays occur and the measures that can be implemented to reduce or eliminate these delays by mitigation or acceleration. To achieve the aim the approach of case studies is considered for this research.

1.2.

OBJECTIVES:

The objectives was to identify the various types of delays and the examine the reasons for project delays. The evaluation of the existing methods for delay mitigation and demonstration of the ability to prevent delays and solve problems. The reason responsible for causing delays are tackled by utilizing the knowledge gained in the various modules and applying them through a scientifically acceptable research methodology.

1) Delay due to late decisions like late nominations by client and Unreasonable project scope & inadequate early planning.
2) Understand the delay due to lack of task clarity and assessment and monitoring tools like key performance indicators(K.P.I's)
3) Calculate the delay due to lack of resources, productivity and overambitious estimates.
4) Define the delay due to inadequate contractor /subcontractor experience.
5) Develop mitigation methods by knowledge management and project learning.
6) Mitigation by lessons learnt feedback.
7) Elimination of delays by acceleration
8) Prevention of delays by planning /analyzing and mapping.
9) Prevention of delay by identifying risks, estimating, allocating and modularizing work.

2. LITERATURE REVIEW

2.1 INTRODUCTION

Delays are of various types and researchers have their own parameters to rate and identify them. Delays have numerous reasons which vary from project to project and the reasons are different and unique for every project. Efforts to reduce the delay by mitigation or eliminate the delay by acceleration are measures that can be or may be applicable in some cases and will depend on the projects being considered for those measures.

Change is the primary cause for a delay. If projects do not have changes then the projects would finish on time as there would be no or little disruptions to the works. The contractors would also like to work on projects where the designs are finalized and there are no changes and disruptions. “In a perfect world, all construction projects would finish on time, without changes or disruptions. Despite the common public perception that contractors cannot wait for the changes to start on a project because that is where they allegedly “make their money”, most contractors would prefer their projects to complete without changes.” (Molner , 2007).

However this is an idealistic situation, in reality changes are inherent to nearly all project of substantial size due to the fact that projects rarely commence after all the designs are completed and approved. It is important that all the key stakeholders for the project agree as to how the changes to the project would be handled and by whom. This is in the interest of the project as beneficial to the owner and the contractor. The continuous striving for improvement makes it necessary to incorporate changes even though they may disrupt the works to a certain extent. However the overall result is likely to be better than the initial after incorporating the changes and the satisfaction of achieving a better final product makes the changes more acceptable rather than no changes at all.

The stage at which changes are proposed to be implemented is important as any major changes proposed when the project is in an advanced stage of progress will complicate the works, impact the schedule and likely to cause delays to the completion. The changes will increase the cost of the project as abortive works, modification and changes will come with a cost. “Changed work complicates a project, invites delays and increases the project cost – all things that make owners unhappy.” (Molner , 2007).

A detailed literature review for the objectives is done to evaluate the types ,reasons of delay and the methods for the mitigation and prevention of delays.

2.2.TYPES OF PROJECT DELAYS

2.2.1 Critical delays and Non critical delays

2.2.2 Non Excusable (Contractor Caused) Delays & Excusable Delays.

2.2.3 Compensable (Owner Caused) Delay & Non-Compensable Delays.

2.2.4 Concurrent delay & Non concurrent delay

Before determining the impact of a delay on the project, one must determine whether the delay is critical or non-critical. Additionally, all delays are either excusable or non-excusable. Both excusable and non-excusable delays can be defined as either concurrent or non-concurrent. Delays can be further broken down into compensable or non-compensable delays.

2.2.1 Critical delays and Non critical delays

Delays can be analyzed based on the criticality of activities in the program. The baseline master program prepared in line with the conditions of contract has a critical path. The critical path is the longest path in the network. The delay to the project occurs when an activity on the critical path is delayed and they have an impact on the successor activities and the overall project. Such activities known as critical activities are important and it should be ensured that he activities on the critical path are not delayed.

When the activities on the critical path are delayed, the delay is reflected on the entire project. Hence, it is required to review the critical activities and analyze whether the re sequencing of works can be done for effective project control “resequencing construction activities is a critical task for project planners for effective project control. Resequencing activities require planners to determine the impact or "role" an activity has on successor activities. They also need to determine the status of activities, i.e., which activities may or may not be delayed” (Koo et al 2007).

It is required to distinguish the function and status of activities which would mean that the planners have to understand the logic and sequence of activities. The critical path method (CPM) identifies the sequence of works based on the precedence logic and relationships and identifies the activities based on the criticality in relation to time. Thus for complex and large projects it is difficult to monitor individual activity logic and sequence and this cannot be done manually.

These limitations of the CPM frameworks are addressed

> “by formalizing a constraint ontology and classification mechanism. The ontology allows planners to describe their rationale for activity sequences in a consistent and intuitive way, whereas the classification mechanism leverages

> the ontology to automatically infer the role and status of activities. The ontology and mechanisms were implemented in a prototype tool. With this tool, users can quickly verify which activities to delay to expedite critical milestone or bottleneck activities, thus making it possible to quickly evaluate and generate sequencing alternatives in CPM-based schedules." (Koo et al 2007).

The critical path guides the overall duration of the project. However in certain cases there are delays to activities which are not on the critical path and have a float. During the progress of the project these activities which were initially not critical get delayed and become critical and form part of the new critical path for the project. There is a debate regarding the issue of float utilization "Under current scheduling practices, total float time is considered "free" and does not belong exclusively to any specific party in the construction process; rather, it belongs to the project and can be used by both owners and contractors to mitigate the potentially negative impact of delays. Utilization of float is, hence, on a "first-come, first-served" basis (De La Garza et al 2007).

The protocol and the principle of first come first served basis utilization of float means that any delay in the later stages of the project will make the party responsible for that delay and the overall delay to the project. Due to these factors, the ownership of the float and its utilization has become a source of disputes when the delays to projects occur.

The concept of pre allocation of float and its management in the project having schedules based on the critical path method is to be introduced. Also, the principles of pre allocation and management of "total float" need to be agreed contractually including the responsibility of any ensuring delay to the project. The concept needs recognition from all parties that the total float is an asset for both the parties.

The process of quantifying the risks associated with delays in construction projects and minimizing them is a major challenge for all the key stakeholders of the project. The float consumed by the non critical activities is a complicated and disputable delay factor while analyzing the delays to the project schedule, duration and cost.

> "Float loss impact in non critical activities is one of the complicated delays to assess on a project's duration and cost. This is due to the fact that the deterministic critical path method cannot cope with such delays unless they exceed the total float values. Further, stochastic analysis, which is used in this research to assess the impact of such delays, is perceived by many planners to be complicated and time consuming. This paper presents a method to control the risks associated with float loss in construction projects. The method uses a recently developed multiple simulation analysis technique that combines the results of cost range estimates and stochastic scheduling,

> using Monte Carlo simulation. The proposed method quantifies the float loss impact on project duration and cost. Least-squares nonlinear regression is used to convert the stochastic results into a polynomial function that quantifies the float loss impact by relating directly the float loss value to project duration and cost at a specified confidence level.” (Sakka , 2007).

The management of projects by the critical path method of scheduling has become a widely accepted method. This method of programming the schedules is also widely utilized for claiming extension of time and analyzing the delays with impact programs.It is required by some contracts to demonstrate the critical and non critical activities after updating the critical path method schedules.

Sometimes the owners try to utilize the float available for non critical activities with the intention to maximize the advantage available. “Owners sometimes appropriate the float time of noncritical activities to further their own interests. In doing so, they risk causing unforeseen costs. If the contract is a cost-plus agreement, these extra costs are usually absorbed by the owner. If the contract is a fixed-price agreement, the contractor will incur the extra costs. In the latter case, these costs may be justifiable delay or impact claims.” (Householder ,1990).

In certain cases if the tender documents clearly allocated the ownership of float to the owner then it may result in a higher bid by the contractors as they may feel the need to allow for these unforeseen conditions.

The allocation of responsibility between the owner and the contractor for any delays to the project is an important factor in delay claims and its analysis. The project program which is made utilizing the critical path method indicates the critical and non critical activities. It indicates the total float for each activity which the amount of time an activity can be delayed without affecting the end date of the project. The ownership of the float is a contentious issue which can be resolved by allocating the responsibility to any or all the parties and agreeing to its utilization.

> “Ownership of total float can belong to; 1) owner, 2) contractor, 3) whoever uses it first, 4) contractor and owner on unequal basis, or 5) contractor and owner on equal basis. Ownership of float allocates risk to the parties and affects the control and flexibility of construction. The apportionment methods are different ways of calculating delays.” (Chehayeb ,1995).

2.2.2 Non Excusable (Contractor Caused) Delay.

Any delay to the project which is solely due to the contractor is regarded as a non excusable delay. It becomes the responsibility of the contractor and entirely his risk for the delay and the owner is entitled to claim any delays to the project in line with the terms and conditions as stipulated in the contract. The claim by the owner in such cases of delay by the contractor are normally related to penalty and or liquidated damages. The owners claim for the contractors delay usually range from delayed commencement of work at site, failure in proper coordination affecting progress of works, inability to finalize, order and procure in time and insufficient manpower to carry out the works in line with the program of works.

Also, in such cases where there is a delay by the contractor and the client also delays his decisions concurrent delay comes into the picture.

> "Both owners and contractors often use concurrent delay as a defense to delay claims. On nearly all projects that are delayed, there is more than one cause of the delay. Where there are two or more independently causes of delays during the same time period, the delay is termed "concurrent." In these situations, the owner and contractor may have dueling claims for delay, each of which will be difficult to prove. As a general rule, the party seeking damages must isolate the causes and periods of delay in order to recover damages for the delay." (Source: http://www.aterwynne.com/files. Project delays, disruptions and changes)

Delays occur in most kind of projects that range from simple building projects to complex projects such as nuclear power plants. It is important to classify the main causes of non excusable delays and highlight the factors that contribute to those causes. The delays by the client are the compensable delays on which the client can take necessary timely action as he has more control over it. The delays by the contractor are non-excusable or non compensable and the contractor has more control and is expected to do whatever is appropriate to prevent them.

Even though a lot of studies have been done regarding the issues of these delays, it is important to note that no major study has been carried to evaluate the reasons of non excusable delays."Understanding the underlying factors that contribute to causes of non-excusable delays would help in identifying and overcoming the problems faced by contractors during the construction process. To assist in identifying the factors contributing to causes of non-excusable delays, the Ishikawa or fish bone diagram has been used as an analytical tool, and a ranking methodology has been devised. As a report of initial findings

of the study,…identifies materials-, equipment-, and labor-related delays as major causes of contractors' performance delays.” (Majid et al 1998).

There are new trends and bad results in construction contracting which offer a review of the problems that occur in the construction industry. These include uncertain site conditions which are covered as part of the contract as the contractor has visited the site, he is aware of the site conditions. The important factor of any embedded power or water lines not visible at the surface shifts the risk to the contractor and any delay resulting from the same is the sole and absolute responsibility of the contractor in line with terms and conditions of the contract. The consequential damages in terms of liquidate damages or penalty or both would eat into the profit margins of the contractor.

> “clauses that give away the contractor's claims and rights to lien the job from the outset. The pressures leading to these trends are primarily economic and have resulted in (among other things) more risk for the contractor. This paper discusses areas of increased risk found in today's construction contracts, the reasons why they have appeared and what a contractor should do to mitigate these "new" risks.” (Shumway et al 2004).

There are some contaminated site remediation projects having certain characteristics that separate them from conventional construction projects including oversight related to authority regulatory processes and lack of information related to underground services and soil conditions. The remedial measure that are proposed for the conditions identified may not be effective to the desired level. The features which unconventional for remedial projects indicates that the innovative methods implemented by contractors may turn out to be more beneficial and successful.

A study of sixty completed remedial projects was done to identify and document the impact of various project management modules and the contracting strategies on project outcomes. The study revealed that the scope variations, delays by various stakeholders, budget overruns, disputes and change orders are frequent in case of remediation projects.

> “Flexible project management strategies, such as turnkey and partnering arrangements, and flexible contracting schemes, such as cost plus fee, were found to be better suited to accommodate such changes. Turnkey and design/construct project structures had the best performance overall of the management structures reported. Mechanisms to promote partnering and team building contributed significantly to project success as defined by budget and schedule.” (Ruff et al 1996).

The contractor has control over the non excusable delays and these delays expose the contractor to claims by the owner or the subcontractors. “Non excusable, non compensable delays are within the control of the contractor; examples include delay caused by late mobilization, late equipment deliveries, or an inadequate project work force. Non excusable delays are not only non compensable but they expose a contractor to delay claims of its subcontractors and liquidated damages (or actual damages if there is no liquidated damages clause) by the owner.” (Schumacher ,1995).

2.2.3.Compensable (Owner Caused) Delay &Non-Compensable Delays.

Here, the owner is responsible for both the time and cost effect of the delay. The contractor may claim the owner interfered with the work, did not deliver owner-purchased equipment or supplies on site as promised, or that the owner’s actions or inaction caused other delays. An owner cannot contract out of its obligation to pay for compensable delay, although it may be able to limit its liability for such delays.

“Any clause in a construction contract, which purports to waive, release, or extinguish the rights of a contractor, subcontractor, or supplier to damages or an equitable adjustment arising out of unreasonable delay in performance which delay is caused by the acts or omissions of the contractee or persons acting for the contractee is against public policy and is void and unenforceable.” (Carl , 2005).

The issue of change order by the client is the most common factor that is responsible for causing a delay to a project. The issuance of the change order affects the work that has been already done. This requires new work to be done, modification to the existing work and /or the removal and the works and installation of the works as per the change order. The delay has to be demonstrated by an impact analysis on the critical path network to claim for additional time and cost due to the delays caused by the changes.

Another factor which comes into the focus due to changes is the delay due to inefficiency damages. As there is no direct method of measuring inefficiency due to its qualitative nature and the difficulty of linking the cause of the productivity loss to the damage. The data available from contractors was the source of information and it appears that there are discrepancies between the claims made by the contractor and the entitlement as per the owner. The study also addresses that a statistical model be developed to quantify the productivity loss from the client sources as daily reports, drawings, specifications and change orders. Also, a model is developed to quantify and validate the loss of productivity due to changes.

> "The productivity loss study analyzed two sets of data that include: (1) variables that predict which of the two parties, the owner and the contractor, contributed to the productivity loss; and (2) variables that predict, from the legal viewpoint, productivity losses which only the owner is responsible for. The study showed the difference between what the contractor asked for and what he/she is actually entitled to. This model can be used by both the owner and the contractor to quantify the productivity loss due to change orders, and to offer an objective approach to reconcile their differences." (Serag , 2008).

The process of nominations involves the client and consultant and the process of nominations is identified at the commencement of the project. The clients are required to finalize the nominations of contractors which are allocated a provisional sum in the contract as the entire scope of works is not finalized. During the period when the nomination is required to be done the client and consultant are engaged in finalizing the scope of works, tenders, selections and approvals which sometimes leads to delay in finalization of the nomination.

The traditional construction procurement contains no special features and it is good for projects having a well established scope of works. In such methods the progress of work is logical and sequential as each activity is required to be completed before the next activity commences. Changes that are done after the project has commenced and during the construction creates problems and it turns out be expensive.

The method of design and build gives the flexibility to the client to sequentially allow the contractors design to be incorporated at any stage with the possibility of scope definition being done at different levels. In such an arrangement the project is benefited due the integration of design and construction done at the appropriate time. The client selects the design and build option for procurement in projects is to reduce the time and cost through a single point of responsibility. The performance related to time and cost relate to factors ranging from scope definition by the client, changes implemented and stages and manner in which those changes are reflected, complexity of the project and effective coordination of the project with key stakeholders. The cost and time performance for the project is affected at the initial stages by the above factors, but the extent of the impact is yet to be done in details. It can summarized that design and build with traditional method is best for cost saving and D/B fast track construction with finalized design and other parameters is best for saving time.

> "Experimentation with the model developed also shows that D/B fast-track construction with fixed design, procurement and construction schedule

is most effective in saving time, whereas D/B with traditional method is best for cost saving." (Chritamara et al 2001).

For the delayed nominations due to late finalization of design, the input required for specialized works at the design stage by specialist contractors will be very advantageous. Contractors in specialized fields have the technical know how and can offer valuable input to the preliminary design and engineering process. However, their involvement in the design process at an early stage is seldom but it has been noticed that this trend is changing and their involvement is increasing at the early stages of the project. According to Gil (2001) "Lean construction theory advocates such involvement. The practice of involving suppliers in product development efforts and manufacturing has proven to be highly successful." Reports on the research that highlighted the contributions of the specialty contractors early design indicated gains in process efficiency and improvement is product quality. These contributions are characterized with examples and their potential opportunities for improvement. It is becoming apparent that organizations are increasing the interaction between the designers and the subcontractors.

Also, specialized subcontractors can be deployed to ensure that the delay to the project is mitigated. The specialized contractors with their vast experience are of problems that can be anticipated and work by taking into consideration that those problems do not occur. "Project risk management requires assessments of project duration and activity criticality. The assessments, however, can be strongly influenced by the dependence between task durations." (Yang , 2007).The flexibility in providing duration for the activities is required when practical data is not available and planners have to rely on subjective estimation.

The selection of the most appropriate contractor is the important to ensure that the best value for money is obtained. "Construction clients are becoming more aware of the fact that selection of a contractor based on tender price alone is quite risky and may lead to the failure of the project in terms of time delay and poor quality standards. Evaluation of contractors based on multiple criteria is, therefore, becoming more popular." (Singh , 2005).

The selection of the contractor in a multi criteria environment is heavily dependent on the uncertain nature of construction projects and the personal decision of the owners. The author presents a systematic procedure based on fuzzy set theory to assess the potential of the contractor whether it is in line with the owner's requirement. "The notion of Shapley value is used to determine the global value or relative importance of each criterion in accomplishing the overall objective of the decision-making process." (Singh , 2005).The

research forms part of a study to develop a fuzzy decision model for construction contractor selection which involves various criteria's and the tendencies of the client. This helps in making the system more systematic and realistic as the assessment of the contractor is done in terms of linguistic rather than as crisp values.

The delays to the construction projects are common and the "most frequent mentioned causes of delays as "unforeseen ground condition", "weather condition", "change by owner", "shortage of technical personnel", "slow purchase of materials and equipment", and "insufficient numbers of equipment". (Zhao , 2007).To evaluate the reasons for the delay, a three dimensional model of causes of delay factors was adopted. The conclusion indicates that delay occurs during the important period of construction stage. The contractor and the client are the main party responsible and the main party injured to the delays. The overall ranking provides useful indicators that can be adopted to mitigate or prevent the delays by the most common contributors.

2.2.4. Concurrent delay & Non concurrent delay.

In these situations neither party is responsible to the other for any costs associated with the delay. These delays are those that are typically included in force majeure clauses – abnormal weather, labor strikes, acts of God, acts of war, etc

The delays that occur in a project are either due to the owner such as additions, alterations, modifications and changes to plans and specifications. The delays where the owner may still be responsible are site conditions which are differing and suspension of works. The delays by the contractor which occur in the same period as the owner will be regarded as concurrent delays. "Delays considered will include those caused by changes in the plans or specifications, occurrence of differing site conditions, holds on the work due to owner-initiated suspensions of work, and so-called 'excusable' delays, all when taking place concurrently with contractor-caused delays." (Ponce de Leon , 1987).

The most important factor for the owner and the contractor in any construction project is the time frame of the project. Still, it is found that many of the construction projects get delayed. "Delays may be caused by the owner (compensable delay), by the contractor (nonexcusable delay), by acts of god, or a third party (excusable delay), or several different kinds of delays may happen concurrently. Because of the many sources and causes of construction delays, it is often difficult to analyze the ultimate liability in delay claims." (Zaki et al 1987).

The delays caused by the owner are compensable delays and can be utilized by the contractor whose delays are non excusable and liable for further action by the owner.

There is a third type of delay which can be attributed to neither the owner nor the contractor. These delays are referred to as force majeure or act of god or third party delay. In projects where there is delay where more than one party is involved it is difficult to analyze the responsibility of the delay. In such cases it is required to analyze on the basis of the baseline master program of works which is referred to as the as planned schedule and compare it with the actual updated program which is referred to as the as-built schedule. What has to be evaluated in this scenario of analysis is the appropriate schedule which can be done by considering all allowable adjustments to the schedule and then what can be concluded is an as-adjusted schedule which will allow for the analysis of the delay and acceleration.

Warrender (2008) addresses the topic of concurrency of delay by referring to a court case in the Outer House of the Court of Session in Scotland. The judge awarded the contractor nine weeks of extension of time against the claim of eleven weeks. “In so deciding, the judge held that the delay in completion was the result of concurrent causes, the majority of which were caused by late instructions or variations issued by the architect and two causes were the result of the fault of the contractor.”

In the opinion of the judge it was immaterial as to which party was the first to delay the works as long as both the parties were causing delays simultaneously. It was considered that as the delay was caused by both the parties and there was no cause by either party which could be considered as a dominant cause and both the parties had failed in their commitment to complete the project in time.

According to Ostrowski (2006), the most discussed topic an attorney and a scheduling expert discuss is the topic of delay as it is a widely used term and in most cases it is often misunderstood. Coming to an agreement, as to what the term actually means is difficult even though the project participants use the term of concurrent delay as and when they feel and this is primarily due to confusion caused as there is no consistency in its determination. Is seems like an easy task to decipher of analyzing two or more delay events occurring simultaneously but ends up being more complex than a Gordian’s Knot. Hence it is crucial while evaluating and analyzing the concurrency of delays that all the relevant factors like the critical path , total float and non compensable delays are taken into consideration.

The problem of concurrent delay as a common but complex problem as it has to deal with an important issue of float management. The analysis of the concurrent delay has to take into consideration all aspects of the delay that have occurred in the project. “All events causing schedule delays and potentially impacting the schedule or causing disruption on productivity, must be tracked, documented and related to specific work

package and activity.” (Massimoluigi et al 2007).The analysis of the delays cannot be done unless a suitable critical path scheduling system which is effectively utilized on site and is governed by the relevant clauses of the conditions of contract.

A slightly different perspective is presented by Huot (1991) , “Designing and building major projects at the same time to accelerate their completion is known as concurrency.” In such an environment it is important to understand the term of concurrency and the effect of this on the cost of the project due to the fact that the various factors that would come into play due to the design and construction happening at the same time. The impact of such factors on the technology that would required to be deployed and the people that would be required to achieve the targets and the environment o be conducive for all the interaction that will take place between the parties.

With the systems in place it will be possible to control the impact of the concurrency and its related costs in fast track projects. A confirmation regarding the owners requirements need to be frozen and the project scope needs to be clearly defined and agreed prior to the commencement of construction. This will help in preventing changes, delays and cost overruns and thus improve the quality.

2 .3REASONS FOR DELAYS.

The reasons for delays are project specific and vary from project to project. We identify the delays generally as well project specific.

Projects have a variety of reasons to experience delay. An investigation to find out the reasons for the delays was conducted in Hong Kong where a questionnaire was developed on factors that were identified in previous findings. The analysis of the findings indicated the difference in perception of the factors that was between the key stakeholders of the project. “There was general agreement about the relative importance of delay factors such as unforeseen ground conditions.” (Kumaraswamy et al 1998).

The delays can be controlled by improving productivity and factors that affect productivity are dealt with the purpose of further increasing productivity and thereby reducing delays. The conclusion of the investigation is ranking of the factors and factor categories that are considered by various project stakeholders. The areas of disparity between the stakeholders is indicated by their experiences, prejudices and ineffective communication. Thus the project scope factors can be supported by effective communications between all stakeholders.

According to Abdalla et al (2002), projects encounter massive delays and thereby overshoot the initial time and cost estimates which in turn result in extensive delays providing a platform for claims and disputes. A survey done with the objective of finding the most important reasons for delays as per the traditional contracts indicate that “contractors and consultants agreed that owner interference, inadequate contractor experience, financing and payments, labor productivity, slow decision making, improper planning, and subcontractors are among the top ten most important factors.”

2.3.1 Unreasonable project scope.

Generally projects do not have an agreed scope of works document agreed at the start of the project. Even though the scope is identified in the contract documents, it is always possible for parties to interpret in the ways that are suitable and beneficial for them.

Change as defined by Hanna et al (2007) “as any event that results in a modification of the original scope, execution time, or cost of work, is inevitable on most construction projects due to the uniqueness of each project and the limited resources of time and money available for planning.” The factors that may result in a change can be changes or errors in design, scope addition or uncertain or unknown substrata conditions. The changes made entitle the contractor for the variation and the impact to the program in line with the change.

The various types of changes that can occur in a project are outlined including the financial aspects regarding each change. Further an overall impact analysis claim program will determine the final cumulative delay due to all the changes, modifications and additions to the project. Not withstanding the claim for the changes the contractor is also contractually required to do his part and contribute to mitigate the delays which has to be considered in the potential overall impact claim program.

How important is the scope definition can be evaluated from Song et al (2005) “a poor scope definition in an engineering design project disrupts project rhythm, causes rework, increases project time and cost, and lowers the productivity and morale of the workforce.” It is clear from the above description that scope of work is not restricted the actual execution specifications but commences from the engineering and design stage which allows for the smooth progress of the project to the construction phase. Any changes to the design involves rework which may be abortive, modifications and or additions to the scope of works. This in turn increases the time required for the rework itself and thus the cost, decreasing the productivity due to the interruption of work flow and affecting the morale of the workmen to a certain extent.

The measurement of the project scope based on quantities indicates the productivity that can be utilized for estimation, control, measurement and monitoring of outputs. A proposal of a conceptual model which is the quantitative engineering project scope definition (QEPSD),within a computer aided design environment. The QEPSD measures the project scope by defining the design categories and complexity to the specific discipline. The result of this method led to increased utilization, improved project definition and productivity.

In case where there is a reduction of scope it has to be to have the acceptance of the owner. “Scope reduction involves identifying areas of the project scope of work that can be reduced in quality, quantity, or both in a manner that is acceptable to the owner.” (Todd , 2008). Reduction of scope of work can be for the quality of finishes as well as the quantum of work and can even include substitutions of materials and equipments, such that they help in reducing the cost of the project and they may be an alternative but not an equal substitute. The example of pitched roof water disposal system to be reduced to areas only in front of the entrance or ceramic tiles replaced by vinyl tiles.

Another aspect that can be considered for scope reduction is scope deferral which consists of areas that can be delayed and completed in future. Only the necessary elements need to be installed like the structural elements can be completed as a shell and core and the finishes can be done later.

2.3.2 Inadequate early planning.

The primary task before the commencement of any project is as the saying goes " Plan the work, Work the plan". It is of utmost importance for any project to commence with the full planning to ensure the successful execution of works.

According to Thomas et al (2007), "Planning is an essential function of project management." But, it is seen that the medium and small sized contracting companies do not take it as a priority and end up doing a job where there is little planning. If the planning is done from the tender stage or bidding stage then it will help in reducing the costs, allow realistic schedules and labor productivity. Limited guidance for contractors is available regarding effective planning as planning is considered as a macro level function for the owners. A detailed micro level planning process for the contractors is described herewith.

It is important to commence the planning by assessing the contract risks and develop a initial summary plan. The next step would be to develop plans for site layouts and identify the sequence of works to further develop detailed operational programs. The design and construction strategies need to be reconciled and if required the initial plan should be revised and communicated to all and finally enforce the final program.

The entire process can be illustrated with network and chart figures indicating the integration of subcontractors to ensure that the work flow is maintained and done efficiently. The schedule can also be expedited by working concurrently and assessing the options for different work techniques. Since these are simple steps it should give positive results.

The importance of pre project planning and its effect on the success of the project has been recognized even though the process varies with organizations "pre project planning process varies significantly throughout the construction industry from one organization to another, and from one business sector to another." (Gibson et al 2006).

The factors that may be applicable for a small contracting company will be very different from the requirements of a large corporate construction group. Even the requirements of the construction industry and other industry requirements would be different. The project performance can be enhanced for any industry by ensuring that a thorough pre project planning has been done.

The owner has to have sufficient strategic information to decide whether to commit the resources and take the risk for the project. Pre project planning is the interface between business and engineering and is also referred to as feasibility study or conceptual or front end planning. "It is an owner's responsibility that it be performed adequately" (Gibson Jr et al 1995). However, engineering consultants also carry out these functions for the owner.

2.3.3 Lack of risk management systems.

The issue of risk management is a complex one as risk management has various levels and it is important to understand and attend to all these levels to allow for an effective risk management system.

According to Weighell (1999), risk management consists of four levels- business strategy, venture, project and function level. The business strategy generally deals with the competition, investment, relationship, performance and constraints on future strategic steps. The venture level is responsible for the revenues and operating cost. The project level deals with risk associated with delays to design, engineering and construction. The functional level caters to the supply chain management, plant operations, quality and asset issues.

An important risk taken by contractors is the non availability of accurate sub strata information which may be related to provisions, live cables, water pipelines and other services. Any of the above if discovered when the project commences will delay the works as the services will have to be relocated. If the services are live services then it would be a further time consuming process. “Remedying site conditions that are materially different from those specified in contract documents is a common source of delay for contractors.” (Siddiqi et al 2006).The study conducted to identify factors that would allow the contractors to handle the delays due to differing site conditions indicated that 70 percent of the delays occurred due to the absence of timely and sufficient communication. The absence of trust between the owner and the contractor caused 20 percent of the delays and the balance delays were due to various causes. The impact of the delays due to differing site conditions was found to have reduced following the unstinted follow up by the contractor. The study arrived at a conclusion that a communication at important levels and with an urgency was required to deal with such delay causing factors. The risk linked to such factors would require the durations of all delayed activities to be reviewed to reduce the delay.

According to Bauld et al (2008), the allocation of risks in construction projects is towards the supplier and this increases the cost of government projects compared to the private sector. Despite the fact that governments or municipalities being large customers generally end up paying more as they want to insulate themselves against any possible risks and ensure price certainty. “In a construction project, risk may be defined as the possibility of economic gain or loss relating to a particular aspect of the construction

process. Simply stated: Price to the customer = supplier's cost of supply + risk assumed by the supplier + profit.”

In cases where the design is done by the client appointed specialist consultant the risk of the design and other risks are managed by the client..The proper allocation of risk among the key stakeholders of the project can be done on the basis of who can best manage that risk. “The term "manage" means to anticipate, price for, and avoid or mitigate the risk.” In traditional contracts the inadequate design and modifications are high risks for the client whereas in design and build contracts the contractor bears the risk. If the risks are allocated to the contractor then it may reduce the quality and the number of bidders. Also, an over emphasis on the price may cause to overlook the technical and financial capability of the bidder, **(refer Appendix 1).**

The risk management of risk due to subcontractor is getting more and more difficult. The difficulty ranges from the getting the subcontractors to perform their contractual obligations including on and off site works. Some have difficulty with the subcontract agreement and some cannot furnish the performance bond. Some have difficulty in providing the program of works and some cannot confirm the delivery dates of materials. Some have trouble coordinating with other subcontractors and some want to delay the works at the slightest pretext

The most important factor is to maintain control of the project with keeping the progress as per the program, quantity checks, timely meetings for coordination. The bottom line is to be in control of all the subcontractors.According to Bowcott (2005), “If you're not on top of your subcontractors and are unaware of what they're doing, they could get ahead of you.”Also, you have to be alert in case if any subcontractor quotes lower than 25 percent than the other bidders. It is important to evaluate the quote and get the details and resist the temptation to award the subcontract to this lowest bidder. It may be possible that the subcontractor may have come with some innovative ways to quote so low, but, the probability of something being missed out from the quote is more likely. A full review of the quotes that is lower by 10 percent or more is normally done by top contractors. After the review if it is felt that something has been missed out, then, the contract should not be awarded to such a party.

Also, in some subcontracts there is a requirement of subcontractor’s subs where the control of funds is crucial for effective progress of works. It is important to ensure that the funds are transferred at the appropriate time to ensure the completion of the job.

Another risk management action plan would be to take urgent action when you notice warning signs that would become visible from a contractor in trouble. In case you

see such signs , be prepared to implement a plan to manage the risk that would otherwise be too late and difficult to manage.

2.3.4 Lack of resources & Labor productivity.

The manpower is the most important factor in the successful completion of any project. In case of projects where there is a lack of manpower then it also affects the productivity of the existing workforce as they would be required to undergo long working hours which would reduce the productivity. “poor construction productivity is commonly caused by a lack of resources at the crew level. Providing proper resources is an important planning issue, requires significant effort, and is necessary to properly manage a construction project.” (Pappas et al 2003).

Effective management can reduce the delays and save on costs by up to 20% as per the data available for the United States. Also, research shows that some projects by deploying innovative management methods get better output. These methods merit attention as they dispel the common perception of achieving better outputs. The innovative management methods and procedure need to be evaluated and documented for the process of improved productivity through qualitative and quantitative assessments. The methods indicated that the elements of communication, empowerment, metrics, planning and training were the main factors that helped in achieving the results.

In case of large projects the preliminary design is prepared and only after the approval of the owner the detailed design and engineering is done. It is understandable that the designers would not be willing to deploy manpower unless the project is confirmed. On the other hand once the project is given the go ahead there is not adequate time for the design and engineering process which gives rise to delays on large scale projects. “An adequate number of persons must be assigned to the engineering and/or construction stages of today's large projects in order to assure timely completion.” (Dwight ,1980).

The number of persons required for the entire project duration based on the productivity assumed for the project scope can give the status of the requirement at any stage of the project. There are various methods of determining the status of the project and the trend toward mini –milestones are now commonly used for many projects. The reporting system for the progress of works is also shifting from the engineer to the technician level. The concept of earned value has become a proven fact and is implemented in most projects due to its advantages related to schedule and productivity monitoring. However the target schedules are an area of concern as a lot development

related to the resource loading and float allocation need to be done. Man leveling has been done by many firms but very few have actually carried it out on live projects with an in depth analysis of the requirement for all types of direct and indirect manpower for all stages of the work.

According to Lee et al (2005), a delay claim occurs when the actual date is delayed compared to the contractual completion date and hence it is important to decipher the cause of the delay since there are various factors that may cause delays. One important factor which we will analyze is the delay due to loss of productivity or lost productivity. Despite being a major cause of delay, few analysis of converting the lost productivity into delay duration have been done. The difficulty in quantification of disruption which results in loss of productivity causes the friction between the owner and the contractor. A method to calculate the delay duration caused by loss of productivity is proposed.

The analysis of delays should take into consideration productivity change and constant productivity. The projects have normally a combination of repetitive activities and non repetitive activities. “Learning curve theory, therefore, can be applied where the work activity is repetitious, continuous, and essentially identical” (Jae-Seob , 2006).This method of delay analysis appears to be a more practical choice for calculation of the delay in terms of activities which are repetitive and can be considered as part of a learning curve with improvements over a period of time compared to the non repetitive activities which will be analyzed with a constant productivity.

The overall efficiency of the work process adds to the conventional project management by providing access to mangers of large plant constructions, retrofits and modification projects. The lean production achieved by reduced man hours required to achieve the product highlights the efficiency of the dynamic construction process. “The term "total project productivity" (TPP) is proposed to describe a management system for the design, planning, and use of the overall construction work process at maximum efficiency.” (Picard , 1998).

The total project productivity (TPP)is a process based on statistical analysis and strives for continuous improvement by objectively measuring the productivity. The satisfaction of the customer being the priority, the focus is to continuously improve ,take necessary and corrective action to achieve the desired quality and credibility thereby raising the cost consciousness among the work force and reduces wasted time at an affordable cost.

There is decrease in efficiency by around 30 percent or more when the time is wasted by the workmen when waiting, on-hold, travelling and idling. Also, when attention is not paid to small details, delays occur and result in loss of efficiency and productivity upto 50 percent. The efficiency improves up to 60-70 percent in case of early work access and stabilizes to around 80 percent. Efforts should be made to encourage such positive changes such as smooth work flow, reduced travel, easy access to materials and tools and good assistance for workmen.

The importance of ensuring that the people are organized and properly equipped ensures that productivity can be achieved. “productivity does not mean making people work harder; it involves ensuring that workers are properly organized, equipped, and trained to work more effectively.” (Williams , 1980).The workers are broadly classified into direct and in direct manpower. While the productivity of the direct manpower can be monitored it is the indirect manpower that should be controlled and the concept applied to both. The problem lies with the underutilization of the resources and the workers in all categories. The main reasons can be summed as inadequate communication, defensive labor policies and the infirm management responsible for the inefficiency. It must be noted that pay is not the only reason that is sought by the workers but appreciation, recognition and a sense of contribution to the society is very important to the extent that there must be a sense of purpose in work.

The monitoring of productivity during construction at any point and the forecasting the probable productivity based on previous project profiles is getting popular. The productivity profiles for various trades will differ depending upon the activities and will follow the typical s –curve pattern. Any deviation from the profiles can be viewed as areas for concern and need attention.“Scheduling overtime is very costly, so alternatives should be investigated. The preferred, lowest cost method is to improve the productivity of the existing labor force. One of the most effective ways to raise productivity is to focus on work planning” (Forrest , 1985).Thus proper and effective planning followed by efficient monitoring are required solve the problems related to productivity.

2.3.5 Over-ambitious estimates and incorrect task assessment.

In projects which are in the design and tender stage where there is an urgent requirement of the estimated cost, there usually thumb rules are applied for providing the estimates. Such estimates are usually based on quantity takeoffs from the available drawings and details. An incorrect task description or assessment may result in an incorrect or overambitious estimate which may either derail the project or make the project too costly and uneconomical for the owner.

In design and build projects the owner usually requires the contractor to establish a firm-fixed price for a project that has not yet been designed. The owner also finalizes the duration for the project. “In the traditional design/bid/build (DBB) system, quality is fixed through the plans and specifications. Thus, in DBB, with schedule and quality fixed, the cost of construction is the factor in which the owner seeks competition. Conversely, in DB, with cost and schedule fixed, the scope and hence the level of quality is the main element of competition.” (Gransberg et al 2004).

The owners have requirements and approaches for the design and build projects which are quality by qualifications, evaluated program, specified program, performance criteria, specification, and warranty. These requirements and approaches of the owner need to be understood and evaluated by the contractors while preparing their proposals so that their proposals are in line with the owners and will make it easier for evaluation and taking the decision.

The accuracy of estimates are vital for any project specially at the preliminary stages. These estimates would enable the owner to take the crucial decision of whether to undertake the project at all or not. “The importance of accurate estimates during the early stages of capital projects has been widely recognized for many years. Early project estimates effect the most basic decisions about a project: whether it will be undertaken at all; how large it will be; how elaborate, sophisticated and durable it will be; and how much it will cost.” (Ciraci et al 2009).

These initial costs for the projects are important for the owner’s and project team. From the owner’s perspective these will help in evaluating the vital business decisions ranging from asset development strategy, resource requirement and commitment for future projects and potential project screening. In case of inaccurate estimates the opportunities may be lost , effort wasted and in some cases lower than anticipated returns.

For the project team, success is generally guided based on the planned v/s actual cost of the project. In case of inaccurate initial estimates, project have found it difficult to

come of those situations and problems would range from the failure to award the contract due to high quotes or very low quotes may make it embarrassing ,design issues, delays and inadequate facilities.

An accurate cost estimate done at the initial stage can avoid many problems. These estimates can be accurate to the range of ± 20 percent accuracy and suggestions have identified 45 factors that can influence accurate estimates. The important elements of these suggestions are who was involved in preparing the estimate, how the estimate was prepared, what was known regarding the project scope, factors considered while the estimate was prepared. From the above factors it was known that he most important factor that governed the initial cost estimate was the availability of information regarding the project scope.

The decisions made at the design and planning stage of a project is influenced by the pre tender cost estimate. The project details which are responsible for the accuracy of the pre tender estimate and ways and means to make the estimate realistic and more accurate are considered. The author has used a quantitative approach to address this research problem. Analysis of data from various projects through quantity surveying firms indicated that the pre tender estimate is dependent on project size and the main structural element.“The estimates of smaller projects are more biased than the estimates of larger projects. It was discovered that pre-tender building costs are more often overestimated than are underestimated. Overestimated forecasts are incorrect by a larger amount than underestimated forecasts.” (Aibinu et al 2008).

The data analysis have indicated that the accuracy of the pre tender cost estimates have not improved over time and the accuracy of these estimates are not satisfactory. To increase the accuracy of these estimates it is required to incorporate and simulate past estimates, probability estimation and experience gained in the estimation of previous projects, including the quantity surveyor at an early stage, reducing quantity surveying and cost engineering skill turnover and incorporate market sentiments.

There are theories such as the neo classical micro economic theory which makes two suggestions such as an analytical tool for construction cost estimation and full cost pricing which is the normal procedure of pricing by construction firms. However both are exclusive theories in their own right and only one can be correct. It can be concluded that the theory no one is more correct based on the analysis of evidences in the research literature. In disequilibrium there are differences in behavior, however there is not much difference between them in equilibrium when it is viewed from a practical point of view.

Based on the differences and “the endemic nature of uncertainty in the industry in general makes the task of estimating costs and prices difficult in practice.” (Skitmore et al 2006). Thus, this theory provides a sensible analysis for the pricing and is more close to the market than economics.

2.3.6 Lack of task clarity.

The projects are usually having amounts that are reserved as a provisional sum for some section of the works as the client or the designer is unsure as what would be the actual requirement. These works usually involve specialist inputs and cannot be finalized at the initial stage itself. In some cases the client deliberately reserves the amount to decide at a later stage how the money has to be spent. This gives rise to an uncertain scope of work where there is no clarity regarding the task to be carried out. Even the baseline program of works prepared at the start of the project cannot detail the activities due this lack of task clarity.

The lack of task clarity can give rise to errors as adequate details will not be available and hence changes may be required to rectify the errors or incorporate the additional details as per the new information made available. This has an impact on the cost in terms of cost overruns and time in terms of delay which affects the performance of the project. It is important to realize the impact such errors and changes and work to mitigate their negative effects on the project, this paper presents a system dynamics-based construction model, which evaluates the dynamics of change management including the aspects of quality, scope, request for information an decisions for change approval and their subsequent affect on the project. The developed model integrates other traditional network based tools to make it more applicable to the real world construction projects “this paper concludes that: (1) realism should be added to schedule planning; (2) an efficient coordination process is needed; (3) proactive contingency plans need to be taken into consideration; and (4) integration of network-based tools and system dynamics-based models can contribute to management of errors and changes.” (SangHyun et al 2007).

There is an increasingly alarming situation that is developing due to the inconsistencies that are being noticed between the design that is finalized and the final construction that is actually done in case of large building projects and the causes for the same are identified and analyzed. To achieve the objective of collecting the information on

the potential reasons for the discrepancies, a survey and responses from 27 contractors was conducted at the design and construction interface of the project.

It was observed that

> "the involvement of designer as consultant, communication gap between constructor and designer, insufficient working drawing details, lack of coordination between parties, lack of human resources in design firm, lack of designer's knowledge of available materials and equipment, and incomplete plans and specifications were considered as the most important causes of the project design and construction interface inconsistencies." (Arain et al 2006)

The least important reasons of inconsistencies between the professionals at the design and construction interface were the involvement of the contractor at the conceptual and design development phase, the government regulations, project management professionals, weather conditions and nationalities of stakeholders.

2.3.7 Design delays & Approval of drawings.

The construction projects are envisaged based on the conceptual design and drawings. If these conceptual design are not converted to actual designs and drawings including the structural feasibility and practicality then it would necessitate changes to the original concept design which would impact the perspective of the project itself. It would also affect the program for the project in terms of timely completion and thus the cost of the project.

The construction industry is recognizing the need for timely and efficient completion of projects. Due to the fact that unexpected problems arise due to design change and affect the construction process thereby leading to cost escalation and time delays, it is required to evaluate the primary causes for delay to ensure that the cost and time are within the parameters.

This paper identifies the principal factors for delays and determines their relative importance as viewed by the various groups involved based on 83 previously identified delay factors. It was observed that there was "a strong consistency in perception between clients and consultants, for example as to the importance of the 'poor site management and supervision' delay factor and the 'contractor-related' delay factor category." (Chan et al 1996).Also, there were strong disagreements between the key stakeholders like the contractors and client and or consultant and this was related to the ranking of the factors responsible for the delays. Based on the observations it was suggested to implement effective project management for better results.

The delays due to design changes can help in avoiding construction claims and disputes and it also requires an adequate knowledge and understanding of the conditions of contract related to the causes of claims. This paper investigates the causes of delays on 130 public projects of varied categories in Jordan and to allow adequate quantitative data to evaluate the project prior to its award. The results concluded that “the main causes of delay in construction of public projects relate to designers, user changes, weather, site conditions, late deliveries, economic conditions and increase in quantity.” (Ayman , 2000). These factors have a detrimental impact on the project’s success in terms of the timely and contractual completion. Effort to give attention to the factors identified in the study will help in mitigating the risk of contractual disputes.

The variables that have an impact on construction time and cost overruns for high rise projects in Indonesia were identified, ranked as per their apparent significance and rate of occurrence. “Inflationary increases in material cost, inaccurate material estimating and project complexity are the main causes of cost overruns. The predominant causes of delay are design changes, poor labor productivity and inadequate planning.” (Kaming et al 1997). The variables that are considered for cost overruns and delay are grouped into factors and their relationships are analyzed with factor analysis techniques.

The decisions that are made during the conceptual design stage and briefing of the building project is important for its successful completion. An important decision that is required to be taken at the early stage and which can have a major impact at a later stage is related to the selection of the structural frame. Considering the importance of a finished building, the selection of the structural frame should be unarguably clear and emphatic. The final decision on the structure to be selected has to be based on the structural frames ability to perform against the criteria for it has been designed for the scheme. However it has been observed that “the heuristics underpinning such decisions tend not to be explicit and thus, are difficult for inexperienced clients to understand (Soetanto et al 2006).

This article reports on the research, which determined the criteria used by the stakeholders including client organizations, design professionals and contractors while selecting the most appropriate structural frames. The research revealed stark differences in perceived priorities by the stakeholders and may cause friction and debates between the designers and construction professionals and the client himself if the details are revealed in the design stage. However, it is required for such difference of opinion are known and debated at the design making stage to allow for more appropriate designs in future.

The delays that are recurring in construction projects are comparable across most of the developing countries including “several factors pertaining to local industry, socio-economic and cultural issues and project characteristics also contribute to construction delays.” (Toor et al 2008). The survey conducted on a project in Thailand to explore the major problems for delay indicated problems related to designers, consultants and contractors were the foremost. Other issues causing delays were related to design delays, inadequate resources and manpower, inefficient contractor performance and financial difficulties and planning and scheduling deficiencies

Problems related to multicultural and multilingual environment resulting in communication gap, excessive participants in the project and presence of foreign designers and contractors were the least problematic issues. These findings can be of help for project managers in developing countries including reforms in the procurement, stakeholders and value chain management systems.

2.3.8 Owner interference & decision-making process.

The successful completion of the project in terms of cost and time has an influence which can be a positive factor as well as a negative factor is the decision making process which is greatly influenced by the owner. Sometimes the owner’s influence is also construed as the owner’s interference.

According to Annoymous (2004), “Owners, particularly those new to construction, are often so intent on cutting costs and speeding up schedules that they expect that hiring their own contractors will work miracles. A/Es need to know the legal and financial ramifications when advising owners in such situations, especially if a general contractor (GC) is involved.”

There are requirements for the success of every project which are the project parameters and performance indicators. Organizations have been developing systems to provide much needed assistance to those involved in the process by providing data on one approach such as strategic needs analysis in the early critical stages of the project. A total of six research studies based on this analysis were done and this has resulted “in the development of a series of decision-making attributes that capture the key characteristics relevant to the project inception stages.” (Smith et al 2008).

This paper identifies the best and the worst performing attributes as identified by the stakeholders and concludes that it is difficult and challenging to work in the initial stages

with briefing workshops which will lead to practical implementation problems if the approach is ambitious as it is in this case. Data regarding how to overcome these lacunas is provided in this paper.

The conventional system of engineer-procure –construct (EPC) system of contract is no longer considered the best for power plants construction. It has been replaced by Alliance contracting which is a viable and proven alternative to the conventional contracts.

A survey in real estate and construction revealed that complex projects worth more than $100 million were more involved in disputes and the major causes of these disputes were related to the owner /contractor interference, overwhelming change orders and errors and omission by the engineer/architect.

In the EPC contracts the entire risk of the project completion is the contractor's responsibility, it results in a conflicting relationship with the possibility of contractual disputes and claims, conflict that would harm the success of the project in terms of timely completion and financial overruns. Due to these problems a new and fresh alternative "is the project alliance contract, which consists of a proven project delivery method that aligns the interests of the owner and the contractor to build the project in a collaborative way, without disputes and without major claims that often result in litigation." (Grynbaum , 2004).

In projects when there are the requirements of nominations to be done by the owner, the owner has the authority to perform construction with the owner's own workforce and award separate contracts. However, if there is a delay from the nominated contractors, the main contractor can claim for the delays. The coordination of the works will be required to be done between the main contractor and the nominated subcontractors and it should be in line with the agreed construction schedule. However the responsibility for coordination will lie with the owner and it is the architect/engineers responsibility to inform the owner about the same and this should not be a problem if the owner has handled projects of similar nature. The owner can also appoint a construction manager to do the same but the cost saving would then not be possible, **(Refer Appendix 2).**

According to Neap et al (2004), the principles of value base project management are highlighted and the client's role, responsibility and contribution of the client /owner is investigated. The client has to ensure that the requirements and objectives are conveyed and understood by all parties. The client has to select consultants, designers, contractors and suppliers. It is important that these actions are performed at the appropriate times and in the correct manner. The objectives set by the client will ensure the optimization of

quality, cost and schedule. The owner is not only the investor but a significant stakeholder who contributes to the project in a manner that ensure the successful completion of the project, **(Refer Appendix 3).**

2.3.9 Inadequate contractor & Subcontractors experience.

In case of projects where there are contracts that are awarded solely on the basis of the cost then these projects are likely to suffer delays as proper of evaluation of the subcontractors has not been done. The subcontractors who have quote low or simply missed out on any items will fail to perform thereby delaying the project.

In fact the owner may end up losing more money if the project is delayed and the returns expected from the project get delayed. Also, by deploying the contractors or subcontractors without checking their credentials and performance, the owner is risking the quality of the project and his reputation

Subcontractors are often faced with the spectre of financial difficulties in case of delayed payments which may result in the failure of the subcontractor. This paper investigates the primary causes of business failure and to identify strategies for preventing failure. A variety of construction professionals were interviewed regarding the causes and whether the causes were dependent on the size of the firm and what strategies could be adopted to reduce the risk of business failure.

There were some external factors that were responsible for the profitability of the firm which were related to the economic factors but most of the causes related to the business functioning of the company and the absence of a workable business proposal. “The primary causes of business failure identified were insufficient capital/excessive debt, lack of managerial maturity, lack of early warning measures, increase in project scope, poor billing procedures, failure to evaluate project profitability, unfamiliarity with new geographical areas, and poor use of accounting systems.” (Schaufelberger , 2003).

It has been noted that inexperienced or first time owners of small projects will select a designer or contractor who is not qualified to handle that work. “The risks involved in choosing an inexperienced designer include unfamiliarity with contract furnishings and little knowledge of the strict fire codes specifying the types of fabrics required in hotels and motels.” (Fox , 1991).

The professional designer will have access to contract vendors who would have the relevant information regarding all the required codes of practice for the specific projects. An inexperienced contractor working on a hotel project may not know the loss of revenue for a hotel for one night and may delay the works to an extent that the project revenue loss is enormous. In case of knowledgeable contractors, adequate acceleration measures will be made in their programs if needed.

Projects that experience delays and exceed the time and cost estimates provide a fertile ground for disputes and claims. This paper gives details of the survey which identifies the most important causes of delays for traditional type of contracts in construction projects from the consultants and contractors perspective and they “agreed that owner interference, inadequate contractor experience, financing and payments, labor productivity, slow decision making, improper planning, and subcontractors are among the top ten most important factors.” (Odeh et al 2002).

The delays to construction projects cause financial losses for project stakeholders and this paper describes how the Bayesian belief network is implemented to calculate the probability. A questionnaire survey revealed sixteen factors and eighteen cause –effect relationships were obtained from these factors to develop a belief network model to be tested on two realistic case studies. The “study revealed that financial difficulties of owners and contractors, contractor's inadequate experience, and shortage of materials are the main causes of delay on construction projects.” (Van et al 2009).

2.4 MITIGATION OF DELAYS

Delays to the projects can be reduced by applying measures which can be reflected as mitigation of delays. This mitigation of delays is possible only by re-sequencing of the works where ever possible and without increasing the resources and manpower. The works that can be achieved without any additional cost to the project is the mitigation.

The mitigation of delays can be possible by also applying the knowledge gained through previous projects experience and these can be implemented where ever their application can be suited for any specific requirement in the process of project learning. Such knowledge management will help in mitigating delays and the awareness of such knowledge through lessons learnt feedback can in fact be helpful in preventing the delays itself.

2.4.1 Knowledge Management.

The knowledge management is the utilization of knowledge gained in numerous projects and various situations to tackle a specific problem. “Knowledge Management refers to the collection of processes governing creation, storage, reuse, maintenance, dissemination and evaluation of Knowledge in a particular situation or problem solving context.” (Hsiao et al 2003).The knowledge gained can be implemented by various people who can improve the construction systems and thus save time and cost of solving problems.

The study proposes a method of utilizing a collaborative based approach to collect and implement the knowledge gained by the engineers and the project. This approach can enable the participants to have overview of the knowledge available and missing from their projects and evaluate their knowledge suitably. The application of knowledge management for construction projects is evaluated in this study and a concept and system of construction collaborative based knowledge management is developed. This system is then applied in select cases of building project to check the methodology and effectiveness of sharing knowledge in construction. The knowledge can be stored and used in future for projects in the construction phase by implementing the knowledge based mapping and web technology.

Knowledge management is a new concept in information systems area whereas knowledge management is well recognized in the intelligent information systems. The study “proposes a new and practical methodology to capture and represent engineers' Knowledge and project knowledge by using Knowledge Breakdown Structure Maps (KBSM) approach.” (Chen et al 2004).

2.4.2 Project learning.

In some projects situations develop and the action can only be taken based on the available information which is project learning and improving with time. This is called as the learning curve usually applied to works which are undertaken for the same time. Initially the outputs and results are low and gradually improvements are noticed as the activities are repeated.

There is a universal concurrence that the delay in construction projects is a common phenomenon worldwide. Project delays are generally related to the inadequate project knowledge management.

There is universal agreement that construction delay is a common phenomenon in the construction industry worldwide. Poor or lack of project knowledge management continues to plague the construction industry, especially in relation to project delays. “Knowledge management is used to reduce the impact of construction projects delay using a project learning approach.” (Hamzah et al 2008).The development of a delay mitigation model was developed by data collection in three different phases as initial survey, case studies and interviews.

The positive impacts to the projects programs are due to the project learning approach. The delay phenomenon in the construction industry can be improved by an excellent leadership and integrated dedication of all the key project stakeholders. All the key factors of mitigation namely knowledge management, project learning and lessons learnt are incorporated in the conceptual model and the results indicate that the best way to meet the requirements of the owner and the market is by applying the project learning in line with the project program and this can be done by maintaining the contractor’s core proficiency .

The Architecture, Engineering, and Construction industries have a vital role in the completion of various infrastructure and facilities projects ranging from residential to

industrial, from transportation to energy, from water supply to waste management and communication systems. It has an important responsibility in maintaining their excellence, reliability and endurance.

While playing such a vital role in the progress of the industry it also has many negative effects such as environmental effects and dilapidation, depletion of natural resources, waste generation and its disposal. It has been noticed that the traditional responses to such issues have been slow and ineffective. The efforts to reduce these impacts have proved to be expensive has do not find favor among the key players to implement the same. The industry has been endeavoring to define the characteristics of sustainable development, the processes and the resources required to achieve the same.
To achieve the objectives “decision-makers need to integrate sustainability at all stages of the project life cycle, particularly the early funding allocation, planning and conceptual design phases.” (Hansen et al 2006).

The success of the sustainability need the industry to define, plan and design and then procure, construct operate, maintain and implement the more sustainable building technologies and systems. Thus the project learning would help in bettering the development of sustainable systems. To satisfy these needs, there is a requirement of a model having the elements of vision for sustainability at all levels and then the implementation at the strategic, planned and operational level and having specific principles which provide the base for the vision and the road map.

These factors for sustainability will also have challenges as it is a complex field as it is rich, vast and varied as well as active and mature programs that have evolved over the years thereby providing the much needed project and industry learning.

The projects are planned at the initial stages by preparing baseline master program of works. The projects which are planned in uncertainty are provided with an integrated methodology which is developed specifically for such construction projects. This methodology is based on a computerized risk management that allows for the classification, scrutiny and quantification of the major risk factors and their chances of happening and their effect on the project activity durations. “Using project management estimates of the marginal cost of activity starting time disruptions, a heuristic procedure is used to develop a stable proactive baseline schedule that is sufficiently protected against the anticipated disruptions that may occur during project execution and that exhibits acceptable make span performance.” (Schatteman et al 2006). The implementation of this methodology on real time projects and demonstrates that the positive program generated by the planner outperforms the program which are done on conventional programming

software packages in terms of applicability and completion in line with the project completion date.

The mitigation of delays in construction projects by resorting to crashing of the balance activities is a very usual phenomenon especially when the delay to the projects is caused by the contractor. While locating an activity for mitigation by crashing the planner and the project manager would have to take into consideration the resource availability, cost escalation, affect on quality, safety parameters and other impacts on the program. In practice managers and planners would take their decisions based on their past experience and personal opinion. Surveys were carried out in Hong kong to identify the factors relevant to the selection of activities for crashing and the importance of those selection factors for mitigation of delays. The results indicate that 'safety', 'chances of success', 'resources availability', and 'time for implementation' are the most influential factors when selecting construction activities for crashing." Surprisingly, 'cost' was regarded as one of the least important factors by clients and contractors in this study." (Ng et al 1995).

2.4.3 Lessons learned feedback.

The lessons learnt during the projects need to be recorded so that the difficulties faced by the project team and way those difficulties were tackled would be of immense help and guidance to the future projects of similar nature. The negative aspects of the lessons learnt would be more than the positive as the report prepared by the contractor would highlight the delays due the owner, designer and consultant. Likewise the report prepared by a consultant would identify the inefficiency and delays by the contractor. Whatever may be the case the report would be helpful in identifying the pitfalls for the future teams handling such projects.

In projects where delays occur the personnel who are in charge of the construction should implement measures to mitigate the impact of program delays in order to improve the productivity, save cost and time, safeguard against disputes and preserve their professionalism. Earlier the information available on mitigation the effect of delays was not adequate. In order to ensure that the projects are completed on time and within the budgeted cost, an system has been developed which can be implemented on any project and it is designed to work within the parameters of the project and still achieving the optimum results.

> “Four techniques are combined in sequence to produce a process that directs courses of action for mitigating delays. These techniques include: 1. a modification impact evaluation, which resequences project activities with a minimum amount of disruption, 2. resource constraining, which redefines schedules according to projected resource limits, 3. project expediting, which assists in reducing project duration systematically, and 4. value engineering, which attempts to overcome unnecessary costs and design inefficiencies.” Wesley (1986)

These mitigation techniques allow for the re-sequencing of the delayed activities so that there is little disruption and allowing for resources to be within limits as projected during the baseline program. It allows for expediting the project by reducing the project durations which can be achieved by reducing the activity durations systematically and lastly but implementing value engineering by implementing the alternatives having same specifications but lowered cost. Thus the lessons learnt would require the future projects to evaluate value engineering for all projects and save on unnecessary cost without affecting the performance of the project.

The construction projects that are undertaken are done with the best of intentions. They encounter problems when there are delays to the program, unforeseen cost escalation and overruns, shortfall in budget, defective quality of material and workmanship, confused scope of works and third party meddling. Such conditions can also affect relationships, spoil the reputations and may lead to financial privation of the key stakeholders. Such traumatic circumstances frequently happen all the key stakeholders or some of them are not able predict the future and hence cannot visualize the effects of their action or non action regarding the decisions until there is a serious delay to the project. At that point of time it is difficult to recover, however it may not be too late. This paper merges several techniques that that evaluate the health of construction projects and key milestones to be monitored. The paper “presents a spectrum of proactive and pragmatic control techniques that have been successfully used to identify, assess, prioritize, and mitigate various problematic conditions, and to heighten project performance.” (Kalayjian et al 2001). The above techniques are implemented by promoting the compilation and elucidation of significant project information and assisting the project team to enhance their combined decision making potential.

The development of large engineering projects depends on the cooperation of various specialists. These specialists have their perceptions and view on numerous issues

and these views when do not align with the overall perspective lead to clashes and conflicts and if these conflicts are not attended to at an early stage then they may become serious issues which may affect the design finalizations, making them more expensive and cause delays to the design and construction process and thereby leading to compromises in the ultimate result. This paper presents “research on the representation, use, and communication of design rationale for conflict mitigation in a collaborative environment.” (Pena-Mora et al 1995).

This research is based on the analysis that the perspective of the designer is reflected in their design justification and a system for demonstrating the same from the point of characterizing and controlling the design intent evolution, artifact evolution, the association between intents and between intent and artifact. The design justification system needs to get its information in a non interfering manner and a system for conflict mitigation through negotiation between key stakeholders through dynamic computer support.

The quest to reduce the project duration and delivery time has made the construction professionals implement the overlapping of the design and construction activities. It is possible to overlap the design and construction activities to a certain extent, however undertaking the design and construction works in a illogical sequence can give rise to momentous risks. The mitigation of these risks can be done by undertaking more logical overlapping of activities in the design stage and construction stage. The aim of this work is “to determine the factors that contribute to the sensitivity of construction activities.” (Blacud et al 2009).

Experienced construction specialists state that the level of change, the time required for delivery, modularity and the interface of the components are the factors that indicate the sensitivity in construction activities to upstream design changes. These factors help in analyzing the sensitivity of an activity which can help the implementers reduce the risk when planning the overlapping of design and construction activities.

There are actions that can be undertaken by the owner to tackle the issues of delays in construction projects. The delay to the project from the owner starts from the initial stages and the contractor is required to prepare aggressive recovery schedules in the early stages of the project which has a high probability of failure. The author suggests solution to the problems and ways to mitigate the delays. The key suggestions are to undertake the project planning from the tender stage and ensuring that the contractor implements effective measures for the project planning and monitoring and control. The problem becomes more acute when the project is located overseas as the basis for the bid

become different. The owner has to play the role of the real engine and make provisions for the contractor to plan,monitor and execute the works in an efficient and coordinated manner. (Casinelli , 2005) **(Refer Appendix 4).**

The construction industry is not only the nation's backbone but it is also an indicator of its competence and efficacy. Since there is always the factor of risk and complications which are intrinsic to construction projects as well as the diverging interests of the key stakeholders, disputes and claims are expected in the construction industry. The frequency of the disputes and claims have increased to an extent that the annual cost of such disputes and claims is $5 billion. The main aim of the dissertation was to "develop an integrated and coherent methodology for mitigation of construction disputes through both, multi-agent based simulation concepts and risk management modeling principles." (El-adaway et al 2008)

The research carried out has come up with an innovative method for construction claims and disputes by implementing a logical induction decision and thereby creating a multi agent system to suggest legal discourse. A new method using portfolio insurance has been developed to address the issues of risk in the construction sector. The contractor claims are tackled by utilizing a risk retention method to mitigate the negative effects. By undertaking the above measures the positive effects would be reflected on the project and all the parties concerned.

In projects there are lessons to be learnt from the environmental aspects which will provide a greater insight into the mitigation procedures that can be implemented and the management systems that can be successfully deployed to achieve these results. "The effectiveness of environmental impact assessment depends largely on fully implementing cost-effective mitigation and other management measures to prevent significant environmental degradation." (Sanchez et al 2005).

Thus the effect of the environmental impact can be assessed by implementing the management systems and close monitoring. Their role was discussed in this paper related to a highway project in Brazil. A follow up procedure was implemented rigorously to ensure the success of the mitigation measures and the results were successful and the total cost incurred were 1.4 % of the total project cost. Thus it can be recommended that the mitigation can be achieved by implementing the management systems as an important element and checklists and audits would be realistic solutions to ensure the rules are enforceable, verifiable and manageable. It can be concluded that the mitigation measures coupled with external monitoring and control can ensure its successful implementation.

The projects where this is a lot of decisions to be taken and the duration of the project is short would require the decisions to be reduced to enhance the project schedule and to undertake a continuous improvement process from engineering to the EPC phase. Normally the client's estimate for basic engineering is in the *range* +/- 10%,and this is applicable for appropriation of large projects. In this particular case the +/- 10% variance in the "estimate was replaced by a Monte Carlo risk analysis, which gave the range of possible capital cost outcomes for the projects." (Vanderwerf , 2003).

The paper describes two approaches taken for the construction of the model of the estimate as the information for analyzing the risk with importance of co-relation between the information to the risk model. In the absence of recognition of these dependencies the variation to the total project cost will be minimal and may lead to incorrect conclusions from the risk analysis. A design and build contract to further mitigate the project cost was implemented which included incentives for the contractor to under-run the material and labor aspect of the budget.

2.5 PREVENTION OF DELAYS

Delays can be prevented by applying methods which can be implemented from the project commencement itself like planning and analyzing the requirements in detail which will allow the mapping of resources. The risk can be identified to allow the estimation and allocation of works which is required to be modularized. Escalation of issues at the appropriate times also ensures that the delays can be prevented.

The prevention of delays is possible when all the project stakeholders work as a team to ensure the success of the project. It is also important for the client to employ a proactive consultant, freeze the design and details before the commencement of the project and employ good reputed contractors for the project.

2.5.1 Plan/Analyze the requirements in detail.

The construction industry has to implement new ways of working to be competitive to meet the demands of the clients. Working in collaboration is essential for the design and construction teams during the complete lifecycle of the project. In construction “it is now recognized that good collaboration does not result from the implementation of information technology solutions alone, the organizational and people issues, which are not readily solved by pure technical systems, need also to be resolved.” (Shelbourn et al 2007). The collaboration between individuals related to different fields is a more difficult task and it does not happen by implementing techno solutions. The requirements of the construction sector are gathered through literatures, interviews and questionnaires to develop a methodology for the working in collaboration effectively for the construction sector. The main issue emerging from these analysis is the that the softer issues need more attention than the issues related to technology to ensure that the plan and implementation of collaborative working is more effective in projects.

The planning and analyzing the details can be done by interactive planning which includes an integrated program that defines key milestones, constraints and identifies the major issues that may affect the project. Further, a detailed project execution schedule needs to be developed in coordination with the project team that includes inputs from the team members. This will enable to get a commitment from the project team and everybody will have the knowledge of the requirements. Special attention has to be given to the coordination of inter discipline works and their sequence. The responsibilities have to be identified for the project. The interactive planning is not a onetime occurrence, there has to

a constant interaction between all parties at the various stages of the project, (Baar , 2002) **(Refer Appendix 5).**

The works in high rise apartment buildings where the individual clients have separate and specific requirements makes it difficult for the finishing works to be done. Normally the works should progress in a sequence upwards floor to floor. But due to these requirements from the clients the cycle is broken and the sequence of works cannot be maintained as the decisions taken by the clients will be arbitrary and not have consideration for the project sequence of works. This results in longer time taken to complete the individual apartments and this has an effect on the progress of works resulting in delays as per the program, budget overruns and general dissatisfaction regarding the process which also includes abortive, additional and modification of works from all the key stakeholders. In light of such issues the “Application of lean construction principles to this problem has led to development of a management model that adopts pull scheduling, reduced batch sizes, and a degree of multi skilling.” (Sacks et al 2007).

With the application of lean construction principles the works can be done by people having multiple skills so that works do not suffer due to lack of manpower and small teams can be deployed in various areas so that the works can progress simultaneously thereby achieving a shorter time cycle than the normal time taken in programs. The implementation of the above measures help in ensuring early delivery of the customized apartments including reduced time requirement for completion and delivery and thus improving the cash flow. The model was initially proposed as a theory then simulated using a management simulation game and then implemented practically.

2.5.2 Map available resources

The key to successful completion of any project is the optimum utilization of the resources and by achieving the productivities as planned in the schedule. Also, the deployment of the required resources at the appropriate time is absolutely essential in the success of any project. This mapping of resources for a project is the key to any projects success.

In every project, there are key determinants for the performance of the construction program of works and these range from the project manager, project team, planning and monitoring team and cost control team. The study evaluated the objective data on completed projects using neural network method an arrived at five key determinants namely “(1) time devoted by the project manager to a specific project; (2) frequency of

meetings between the project manager and other project personnel; (3) monetary incentives provided to the designer; (4) implementation of constructability program; and (5) project manager experience on projects with a similar scope.” (Kog et al 1999).

These key determinants and their effective utilization will determine the success of the construction program. The most important issue in the key determinants is the time dedicated by the project manager to the project as his presence will help in taking decisive action to ensure that the project is performing within the parameters of time and cost. The frequent meeting between the project manager and the project team will ensure that the focus is maintained and monetary incentives to the designer will ensure the smooth floe of information. The program will be monitored for any issues that may affect the performance and cause delays and the project manager’s experience on a similar project will come handy in such situations.

For effective project planning and control, resource management has been a very important subject. Since the availability of skilled manpower is scarce and whatever is available has to be utilized in the most optimum manner the project management techniques are getting more and more resource oriented. In most of the construction management planning software the focus is not on resource management. The main issue is that the resource planning is done separately from programming activities. In a program prepared for any project, first the activities are scheduled then the resource constraints are applied. In programs, thus since the activities and resources are planned separately in a sequential order, the program plan the activities even when there are no resources available to execute those at that time or the activity itself is delayed unnecessarily whereas the activity duration could have been simply stretched by reducing he requirement of resources. This leads the project team to being misled and misinformed on the baseline master program of works and later becomes the reasons for delays and claims.

This paper takes into consideration the above aspects and “presents the Resource-Driven Scheduling (RDS) approach where the activity scheduling and resource scheduling are combined into a single process. This framework provides a flexible and comprehensive way to integrate the scheduling aspect and the resource planning aspect in project management.” (Yeong , 1991).As this system is a more practical way as it represents how the project staff consider and function.

The projects programming literature treats the duration of the activities as probabilistic whereas in actual scenario the activity durations are uncertain due to the fact that the resource required by those activities are also uncertain. This paper indicates the

measures to “provide the means for contractors to optimally allocate their skilled workers among individual tasks for a single project.” (Vaziri et al 2007).

Compared to the normal use of program with activities having durations, control policies are developed by allocating planned resources to the activities that capture the uncertainty related to the duration of the activities and the effect of the resource distribution to those durations.

Some projects require the resources to work as a team to ensure its success and also it is possible to make teams in a project man make them compete with each other. The application of “business process reengineering and organization planning philosophy, this study focuses on human resource planning in construction management process reengineering (CMPR) to develop a team-based human resource planning (THRP) method for deploying laborpower.” (Cheng et al 2005).

The THRP method has dual rationale in the utilization of the original resources on the utmost number of projects and the range of resources required for expected number of projects in the future. This method has four phases of process reengineering, data preparation, human resource allocation and simulation. By utilizing the THRP method, a construction company can design and allocate resources to a team based organization and these can also include cross functional processes. The savings due to CMPR can be evaluated by comparing the utilization of the human resources before and after the implementation of CMPR. Thus, the optimum resource requirement can be assessed and subsequently deployed to achieve the changing circumstances of a company’s expanding potential.

The success of large scale /mega projects require detailed planning by the management, engineers and the project team which is a complex and time consuming effort . While analyzing the status of mega projects in today’s environment it is important to note that the time delays and cost overruns are significant problem faced by both the client and the contractor. The primary problem is the lack of complete scope for the project which affects the planning thereby causing delays. Computer simulation is a dominating tool for evaluating scenarios which are considered dynamic and complex as the repetitive process is analyzed and the approach is appealing and helps the decision makers recognize various options by evaluating the vast amount of information.

Thus, “computer simulation can be used effectively to analyze the resource loading and manpower requirements needed to complete a task in a given time frame, based on

current progress levels. This paper discusses a special purpose simulation (SPS) tool for optimization of manpower forecast loading and resource leveling.” (Hanna et al 2007).

2.5.3 Perform training and knowledge transfer.

The projects completed on time or otherwise are a source of valuable information for the people who would undertake a similar project. The information would be transfer of knowledge for the benefit of those who otherwise would encounter problems similar to those encountered by the earlier counterparts. Also, people who have encountered situations which needs to be known, so that others can take benefit from it can be done by performing training in such specific issues and matters.

In projects the decisions made by the site personnel are important to the success and failure of the project. The decisions made on the field by the team dictates, whether the profit margins are gained or lost hence the knowledge of planning and scheduling should be integrated at the field level. “Profit margins are gained or lost by the field decisions, so the knowledge of planning, scheduling and managing project cost should be integrated into the field at all levels of supervision.” (Koch , 2008).

It is important ot note that training alone cannot guarantee the transfer of information to the site personnel but by demonstrating the practices of the company and giving examples where the employees can relate to their own experiences can raise confidence levels. Research has indicated that a person who is confident is to participate and excel in his field. This paper offers a representation for the employers to evaluate the requirements of the firm and the employee’s benefits of training and knowledge accrued that can be implemented in managing the project programs and cost.

There are companies where the experience of the estimator plays an important role and is a valuable asset for every construction company. “For a reliable cost estimation at the conceptual stage of a building project, the missing data and information, otherwise needed for a detailed cost estimate, have to be substituted by the knowledge of an experienced cost-engineer.” (Bjornsson et al 1994).

Thus, the experience of a senior cost estimator comes to the aid of budgeting during the conceptual stages of the project and the decisions are based on his experience. There is a possibility that the estimator may have a bias towards some aspects of budgeting or the selection of cost objectives which can result in an estimate which may not be accurate and optimal.

2.5.4 Identify risks.

For every project whether it is a mega project or a small sized project the identification of all the risks for that project is essential in initial stages. This will help in developing action plans to meet those risks and the make all the stakeholders aware of their effects if not attended to at the initial stages itself.

A realistic procedure is recommended to work out the size of the program for a project or a budget for an unforeseen risk at any stage of the project.“The size of the budget is a function of the number of risks expected at the specified confidence level. The number of risks used for developing the contingency budget depends on the total number of risks to be considered and the estimated probabilities of occurrence of the risks.” (Khamooshi et al 2009).

The risks that are determined will also indicate whether impact may be major or marginal and the budget to be allocated accordingly. When the risks for a specific project are more than 20 or the exact number of risk that are calculated by a binomial distribution will be tabulated to indicate the exact number of risks. The findings indicate that a certain amount of budget should be allocated for small risks in a project which in any case would materialize. The exact number of risks would depend on the risks acceptance by the company.

The risks that have to be identified and analyzed for any project from the list of probable risks is a problem where the decision lies with a multi group regarding where to attribute the risk which is a problem. “Conventional approaches to risk identification and risk analysis separately tend to be less effective in dealing with the imprecise of the risk analysis individually.” (Mojtahedi et al 2008). Since the impact of the risk analysis done individually for each risk may not give the cumulative effect, the risks analysis is not effective from the overall perspective. This paper aims to present a new method to identify and analyze the risks concurrently by the application of the a “multi attribute group decision making (MAGDM).” With this method the classification of the risks is done by identifying the potential risks in a breakdown structure similar to the work breakdown structure.

The identification of risks is done for a project to evaluate the risks a project faces but the identification of the risks itself is a challenge. “ although risk management is considered an integral task in project delivery, particularly in a public private partnership (PPP) project, construction industry practitioners experience challenges in its implementation, especially with respect to risk event identification and selecting responses to individual risks.” (Nelms et al 2008).

The identification of the risk is a structured process which can be explicit and implicit with the implicit risks being common and hence making way for unpredictability and non optimal choices. Risk drivers arise from the various elements of the project including what has to be built and how will it be built and the effect of the various factors surrounding the project like environment, organization and contractual parameters. Representation of these elements can gain from the concept of profiling which can be the most ideal way to elaborate the components that form part of the project in terms of valid characteristics and their as planned and as built standards.

The paper also elaborates the profiling the different aspects of the project and how it can help in locating the risk drivers, related risk occurrences, estimates of the probability of occurrences and the impact if the risk actually happens. Once the information related to the risk drivers for a risk event is known, suitable risk responses can be implemented in the form of transfer, avoid, mitigate and acceptance can be determined including their effectiveness in mitigating estimated likelihood and results.

Risks and uncertainty are intrinsic for all projects. The success of any project is determined by the fact as to how the risks associated with the project are managed throughout the entire lifecycle of the project. “The application of risk management equips team members with the ability to develop a formal process of systematically identifying, analyzing, and formulating an effective risk management strategy. A risk management strategy will mitigate the potential for loss and monitor risk events from the conceptual development of the project throughout its life cycle.” (Gawad et al 2008).

The risk management system will help in getting the much required information related to the risks and deriving a strategy to manage the risks and thereby the potential losses to the project. Thus risk management can be considered as a process for the development of strategies to maintain project performance that would be acceptable to all project stakeholders. The key to effective risk management and mitigation of risks is the aptitude to analyze the probable risk events and rank them to evaluate their potential impact.

The management of the projects includes risk management as its vital element as all projects face various types of risks. The identification and analysis of the risks is the key element of risk management. “Risk Identification is discovering, defining, describing, documenting and communicating Risks before they become problems and adversely affect a project.” (Barati et al 2008).In this paper the author presents an competent risk

identification process which is analyzed at all the key points to improve the risk management

2.5.5 Estimate and allocate.

The estimation for any project is the key to profitability and the growth of the company. Accurate estimates will help in realizing the outputs with the proper allocation of resources that are required for the project. Thus the estimate for any project has to be accurate to the last detail to ensure competitiveness in the market.

The ability of accurately forecasting the cost of delivering a project is the key to a cost based competition. The literature on cost estimation has focused on specific estimation methods as broad techniques and not much consideration has been given to the distinct requirement of each project. The author attempts to highlight the important factors for an effective estimation at different stages of the project. “Drawing from organization control theory and cost estimating literature, this note develops a theoretical framework that identifies the critical factors for effective cost estimation during each project phase of a conventional construction project.” (Liu et al 2007). The main logic is that with the progress of a cost estimate, the programming of the activities and the output measurement can be done in a better manner and the result will be that input oriented control will shift to output control.

2.5.6 Modularize work.

Projects undertaken have to prepare a schedule of works in which the activities have to sequenced in a logical manner to demonstrate as to how the works would be undertaken. The aspect of allowing a logical sequence of works to proceed in the modular way, is the best way to ensure the success of any project.

The project duration is normally fixed when the contract is signed. The details related to the individual activities durations are based on the elements like the quantities and other variables which can impact the estimate for the duration of the activity. The author of this paper presents a methodology which “simulates the combined impact at each progress reporting period, refines activity duration estimates, produces a reliable estimate of the expected delay during the progress reporting period, the project completion time and the probability of achieving it.” (Ahuja et al 1984).Thus the progress of the project and its evaluation are various stages indicates whether the duration allowed for the activities are

adequate or need revision or corrective action to ensure that the project remains on schedule.

The project should implement a system that would integrate all the elements of the work and ensure that these are monitored for the performance. The author “presents a system that supports project time and cost control in an integrated manner.” (Moselhi et al 2004).According to this system, the process of project delivery is represented by object oriented modeling and these are designed to map the same. The resources utilized in each control object is represented by eighteen key parameters and sensors to identify the difficult sectors having non satisfactory results. The implementation of this system is done through a computer system and periodic and cumulative project performance reports are produced to provide the status of the project from all aspects. The results that are generated are analyzed with an example from the literature to evaluate its compliance and features.

Every project is unique in its own right in terms of the time ,place and cost are never the same for any two projects. Hence, the response to every project needs to be unique in its own right. The literature for the implementation of construction projects indicates that flexibility can be an important factor in a projects success. The search for alternative solutions to manage the projects has proposals recommending for a “room to maneuver” to ensure the successful completion of the project. But, the debate regarding the flexibility and rigidity in managing projects is very much alive and kicking. It is noticed that “Rigidity in schedule specifications and constant monitoring and adherence to original plan offers its own charm of predictability. At the same time, unrealistic assumptions can create severe problems in execution and can even erode the credibility of management.” (Pundir et al 2008).

Thus, the project manager has to address the issues regarding the form of approach for the project. A project can either be managed by a rigid or flexible approach and the right balance for flexibility and rigidity, and the conditions under which the manager can opt for flexibility.

The works that are of repetitive nature in a project can be project in a format which is known as line of balance(LOB) and these are usually better than the conventional bar charts and network diagrams for the purpose of repetitive construction, but its use is not widespread. The author identifies the major limitations of the LOB methodology and then

eliminates them by a computer program called repetitive unit scheduling scheme(RUSS) and an effective algorithm which facilitates its implementation is developed.

> "A tool that handles logical and strategic limitations caused by the particular characteristics of repetitive activities is provided. A learning model is developed and incorporated into LOB calculations. The program is designed to optimize resource allocation by using multiples of the natural rhythm of activities. An optimum crew size that guarantees maximum productivity in an activity is used throughout the LOB calculations to achieve cost-optimized schedules." Arditi et al (2001)

Thus the implementation of the line of balance is expected to optimize the resources allocation and maximize productivity. The nonlinear and discrete activities are also included in the LOB calculations. The RUSS projects the LOB diagram for all the individual path in the network and such a system should make LOB more appealing to the contractors.

2.5.7 Escalate issues.

The project has numerous decisions to be taken and some are interlinked in such a way that without the decision being taken on one issue the other issue cannot progress. In such a case if the decision is pending from the client then it will be required to highlight the issue at an appropriate time to ensure that there is no delay to the project. Unless and until the issue is escalated the client would not action the issue with an urgency and this may lead to delays to other works as well delay the project.

The issues related to quality and cost are essential for any project."Cost and quality are inseparable issues on any project. The generally perceived notion that 'quality' has a direct bearing on 'cost' to the owner is generally valid assuming all procedures are well managed and executed by all parties." (Duttenhoeffer , 1992).

There are numerous stages in a project where a bad quality of works can result in rework or abortive works and increase the cost unless all the stakeholders understand the importance of quality. The typical areas which can lead to cost escalation are related to the owners acquisition of the property, financing the project, planning and engineering through the consultant and construction and maintenance. The design by the consultant can significantly affect the project and it is advisable to have a quality management program that includes all features of the professional's involvement to ensure the desired results.

In projects , to ensure the success from all aspects the author proposes the following Steps to be undertaken

> “ (1) `Win-win' environment. The expectations of the owner must be met by the capability of the contractor. The owner will minimise their risk only when the contractor minimises their risk. The owner must know that the contractor can perform, and the contractor must meet the owner's expectation while making a profit.
>
> (2) Maximum value. Performance must be considered along with price.
>
> (3) Self-motivation of contractors to increase performance. Contractors must be motivated to do better construction on every job regardless of the owner's expectations.
>
> (4) Free market system. Contractors must compete based on price and capability or performance.
>
> (5) Minimise the difference of perception and expectations. The expectation level of both the owner and contractor must be identified, with the selection of the contractor with the closest expectation that the owner can afford as the `best value'.
>
> (6) Minimum control. Management theory has proved that external control by the owner and attempting to increase the contractor's capability (false expectation caused by bias) are ineffective, costly and increase risk.” (Kashiwagi et al 2002).

From the above points it is clear that a win win environment has to be created where everybody feels comfortable and is motivated to perform to gain the maximum value. The control has to be minimum with broad guidelines and as a free market system which will help in minimizing the differences of expectations and perception of all parties.

The construction projects are generally susceptible to delays and cost overruns as compared to the baseline master programs and tender estimates thereby causing huge losses to all key stakeholders. However, in seldom cases the variations cause the viability of a project to be jeopardized as compared to the baseline plans. Thus, it is important to develop systems that would identify the expected variance to the time and cost of the project as compared to the baseline plan.

As per the proposal, “The proposed forecasting approach adopts multiple regression techniques and further utilizes neural networks to capture the decision-making procedure of project experts involved in schedule monitoring and prediction.” (Al-Tabtabai et al 1997). The application of the proposals were applied to a live project and were found to be acceptable and were implemented.

SUMMARY

Delay occurs when the critical activities are affected. This delay is either non excusable(contractor caused) or compensable (client caused) and mostly the delay is concurrent.

The delays to projects is primarily emanating from the client due to various reasons like project scope not being finalized at the initial stage, delay in nominating subcontractors at the appropriate time.

Delay due to inadequate early planning can be avoided if the client implements risk management systems. Delays are also a result of over ambitious estimates, lack of task clarity, resources , inadequate contractor selection and labor productivity as analyzed by Williams (1980) “productivity does not mean making people work harder; it involves ensuring that workers are properly organized, equipped, and trained to work more effectively”.

Mitigation of delays can be implemented through knowledge management, project learning and the lessons learnt feedback.

The delays can be prevented by implementing measures of planning/analyzing the details, mapping available resources ,identifying risks, estimating ,allocating and modularizing work by escalating issues as per (Baar , 2002) "inter active planning." It is the facilitated process…of an integrated project schedule, which highlights logic through work processes, defines key constraints, defines key milestones, and last but not least, identifies major issues that may affect the project.

CHAPTER 3.CASE STUDIES:

3.1 INTRODUCTION

Projects are conceptualized and implemented with the primary aim of completion in time. Delay to the project is a failure to implement project management principles. However in certain cases the delay is from the primary stakeholder himself(refer case study 2).The aim of the case study approach is to evaluate live and/or completed projects which are undertaken in the U.A.E. and understand the types of delay, reasons for the delays and measure to mitigate and eliminate the delays.

There are various types of delays to projects and having numerous reasons for every project. Also, every project is unique in its characteristics, priorities and value and benefits. Delay to projects are also a result of various factors related to that project and every delay in a particular project also has various factors and elements which require a detailed study and analysis.

A survey with some people may provide some insight into some types of delays for some type of projects and the reasons for those delays. It may not give the entire picture of delays and its reasons ,implications and measures taken to mitigate delays for a particular delay or many delays for a specific project. Also, complete information related to the delays may not be available for various reasons which may again affect the analysis and the results.

Also, a survey is basically gathering information from various sources carrying out a theoretical analysis and deriving results and conclusions. A case based study is done on a live and/or completed project which evaluates the entire project and all factors that were responsible to the delay and all the mitigation or acceleration methods adopted to recover from those delays.

A case based study of different live projects having experienced different types of delays and different reasons for delays would provide a deeper insight into the problems. Since , these delays have actually taken place ,the reactions and solutions would provide a clear idea as which of the theoretical solutions have been implemented or which of the theoretical solutions have failed to succeed.

3.2 CASE STUDY 1 : DELAY

This project CASE STUDY 1 had all the delay factors like delay from the client, consultant and contractor like

a) Delay in nominations
b) Delay to progress (progress curve).
c) Delay to Cash Flow Curve.
d) Delay to KPI'S(Key Performance Indicators)

The delay to the project was 10 months due to the delay in nominations which was the critical delay .Finally the project was completed 6 months beyond the original completion date with partial mitigation and partial acceleration of 4 months.The client granted the extension of time for the delayed period even thought the entitlement was more than the actual time required for the completion of the project.

3.3 CASE STUDY 2: FAILURE

The project CASE STUDY 2 illustrates the delays that affected the project and even after the planned completion of the project , the project ended up being on hold with a new stake holder and thus resulting in a failure as none of the objectives could be accomplished.

3.4 CASE STUDY 3 : SUCCESS

This project is a success case study. This project succeeded in all its objectives even though there was a strict timeline, initial delay and other constraints. The recovery parameters of acceleration and mitigation of delays were wisely deployed to eliminate all the delays and ensure the success of the project.

3.2 CASE STUDY 1 : DELAY

Case Study 1 is a multi storied project which experienced delay in the key performance index (KPI'S),the progress curve was delayed, delayed nominations and finally due to the above delays the cash flow was affected.

We are going to address a problem which can be considered to be arising from internal factors. The project has section of aluminum /glazing works which are required to be nominated by the Client/ Consultant as per the conditions of contract.

The client has nominated an aluminum /glazing company, which is a client group company.

There has been a delay in the nomination of the works package. This delay in nomination is likely to delay the completion of the project.

The main problem is that the nominated company does not have any production facility and resources (manpower) in the UAE. Hence, in this particular project, we have a planning and a resource management problem. We are going to analyze this issue and the impact of the delay on the overall completion of the project.

Also, we will highlight measures to mitigate the delays by providing specific planning and resource management techniques.

A. PLANNING PROBLEM (K.P.I's were Delayed)

1) No Detailed plan/program for the work package
2) Design facilities are not available within the country.
3) Design approvals including third party approval not considered while quoting for the project.
4) Material submission / approvals delayed.
5) Shop drawings submission / approvals delayed.
6) Lack of production facility in the country.
7) Planning affected by non working periods in the country of manufacture.

B. RESOURCE MANAGEMENT PROBLEM (Progress was delayed)

1) No manpower resources of the aluminum company to execute the installation.
2) No engineering and supervision resources to monitor the works.
3) Skilled Manpower which is experienced in executing similar work from Europe is too expensive.
4) Manpower will be required to be recruited locally at a premium which is not allowed for in the labor budget and also the need for training them to the new system.

C. COST MANAGEMENT PROBLEM(Cash flow affected)

1) Budget.
2) Inflation.

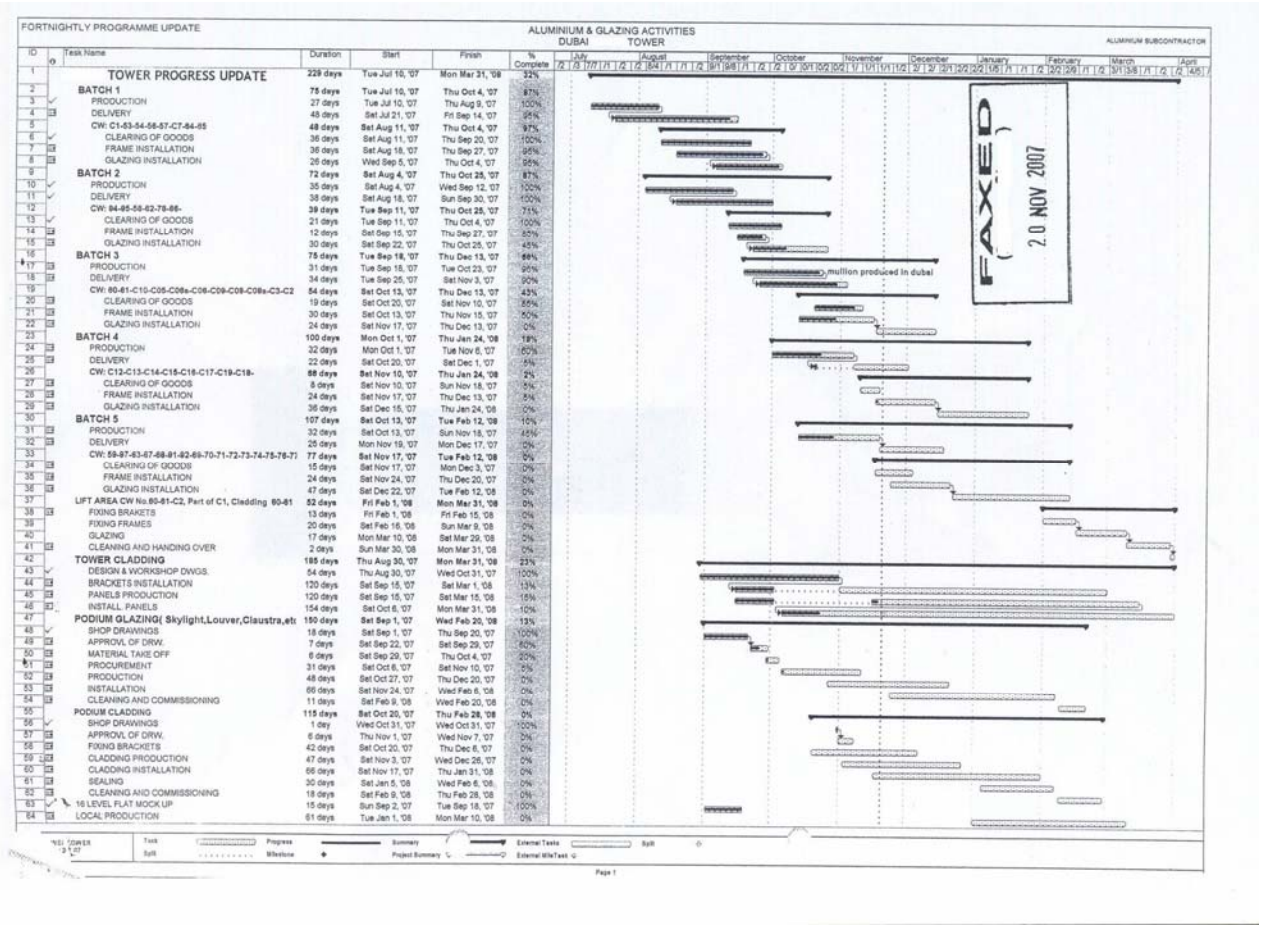
D. Nomination Delay.

There has been a delay in the nomination of the works package. This delay in nomination is likely to delay the completion of the aluminium and glazing works and its successor activities.

3.2.1 PLANNING PROBLEM

3.2.1.1. No Detailed plan/program for the work package.

The program for the works package was delayed and only after much insistence the program done by the aluminium subcontractor on M.S. Project, (Figure 1) whereas the Baseline Master Program of the main contractor was done in Primavera Project Planner.



(Figure 1) CASE STUDY 1(Planning gantt chart)

Also, the program was not detailed enough for effective monitoring and also since the production facilities were outside the country ,information provided was not verifiable.

3.2.1.2. Design facilities are not available within the country.

The nominated company has design facilities abroad and no local representation. For any design related issues / clarifications the local representative is required to communicate with the design team in Italy, thereby delaying the approval process of the design itself.

3.2.1.3. Design approvals including third party approval.

As the company was proposing a new system of installation, the design and the suitability of the system itself was subject to approvals, verifications and confirmations to give confidence in its implementation.

Since, there was a contractual requirement regarding the design to be approved by a third party consultant, the process was not given priority by the subcontractor. The process of finalizing the third party consultant and seeking their approval of design came into the picture only after it was brought to the notice of the aluminum/ glazing subcontractor that this is a requirement as per the specifications and the contract. The consultant had to wait for a long period for the third party approval who took their required time thus further delaying the approval of design.

3.2.1.4. Material submission / approvals delayed.

The submission of the materials was delayed. Since, a new system was being proposed the approval of materials like the aluminium section was required to be done. Materials like glass and aluminium metal cladding were not provided with samples as per the architectural requirements. Delay in procuring specific samples to obtain the approvals delayed the entire process. Also, in case of glass samples the color of the sample glass was not as per requirement thereby affecting the subsequent process of procurement, manufacture and delivery.

3.2.1.5. Shop drawings submission / approvals delayed.

The process of drawings preparation and approvals were delayed as the preparation of drawings were being done in Italy and the pace of drawings submissions was delayed.

Also, the comments by the consultants on the drawings would not be attended quickly as hard copies were commented and there was no provision to incorporate the changes locally thereby delaying the entire approval process. The procurement process was delayed due to the delay in the drawings approvals process.

3.2.1.6. Lack of production facility in the country.

The production facility is located in Italy. Hence , delay in nomination, material submission and approvals, shop drawing preparation, submissions and approval ,delay in procurement ultimately affected the production process.

The main factor resulting in delay was that the extrusion for the aluminium was to be done locally and then the extruded material was to be exported to Italy for fabrication and production at the Italy factory and then again re exported back for installation.

This meant that the process required the export of the raw material and re-export of the finished product as reflected in the flow chart.

The production process was also affected due to the summer break in Europe where production is affected for a period of 6 weeks.

3.2.1.7. Planning affected by non working periods in the country of manufacture.

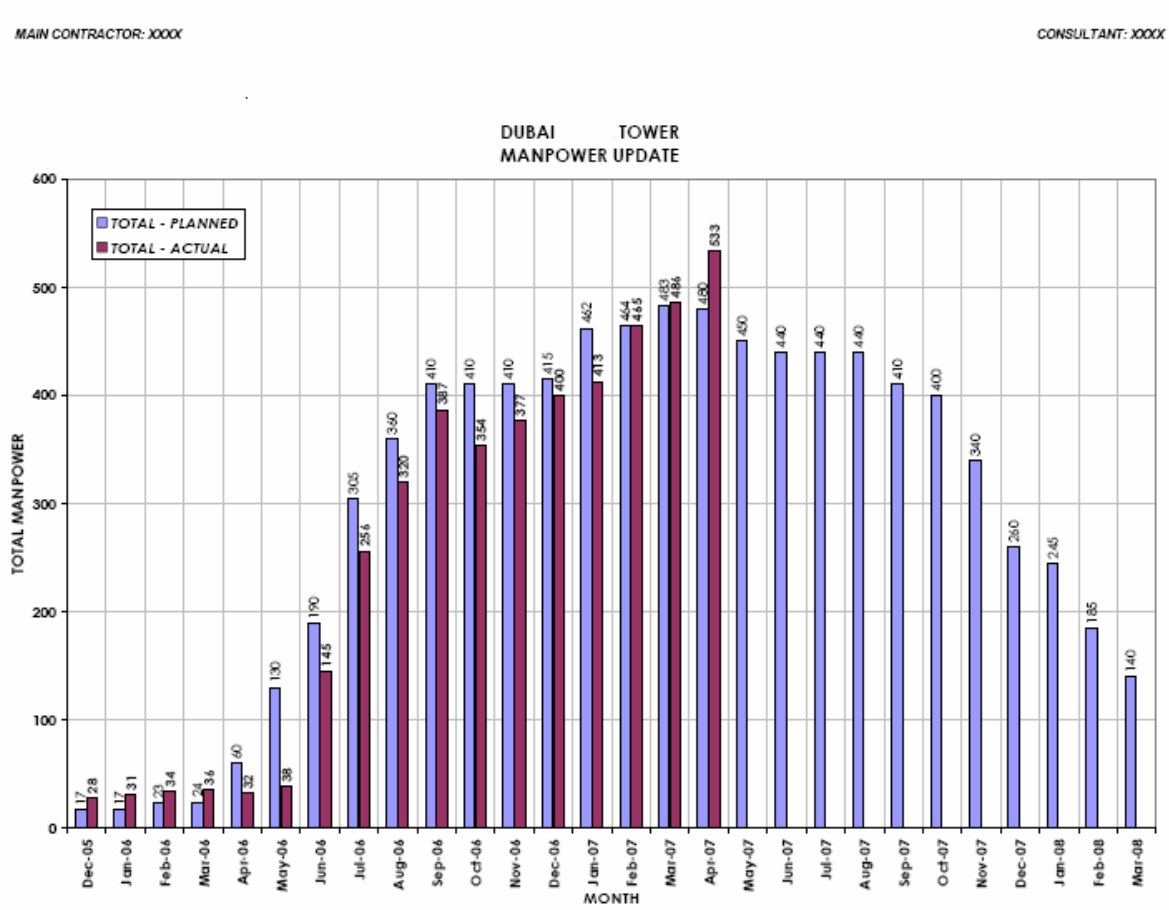
The production of the aluminum /glazing in the factory was initially delayed and further the production was affected due to the summer holidays in Europe in falling the month of august. This affected the production of the sections, frames, mullions, tranforms and curtain wall glazing.

Since the materials have to be packed and shipped ,it requires a further 6 weeks to reach the destination.

3.2.2. RESOURCE MANAGEMENT PROBLEM

3.2.2.1. No manpower resources to execute the installation.

The company does not have any manpower resources in the local market and since it is newly established company. The lack of resources affected the progress of works even though the overall manpower from the main contractor was less than planned for the major part of the project as reflected in the following manpower histogram(Figure 2).



(Figure 2)CASE STUDY 1 (Resource chart)

The problem started when the local subcontractors were quoting installation charges which were not in line with the budget considered for the installation. Hence, the process of locating an installation subcontractor within the budget was inexorably delayed.

This further added to the initial delays and the delays went on increasing and no mitigation was possible until the problem of manpower required for execution was resolved.

3.2.2.2. No resources to monitor the works.

The staff required for monitoring and coordinating the works were newly recruited and were not aware of the requirements. Moreover, the lack of coordination between the local staff and the head office was further affecting the progress of works.

No progress status were being provided to the local staff regarding the procurement, production and delivery.

Hence monitoring of the progress of works related to the design, materials and shop drawings submission was affected and a clear picture was not available at regular intervals thereby reducing the confidence of the consultant regarding the performance of the aluminum subcontractor.

3.2.2.3. Skilled Manpower from Europe

Skilled Manpower from Europe who are aware of the installation process and the method of execution are expensive and not accounted for in the resource management plan.

3.2.2.4. Manpower recruited locally:

Manpower if recruited locally will be required to be given training for the new installation system which will require time, affect quality and will result in low initial productivity thereby resulting in further delay.

3.2.3. COST MANAGEMENT PROBLEM

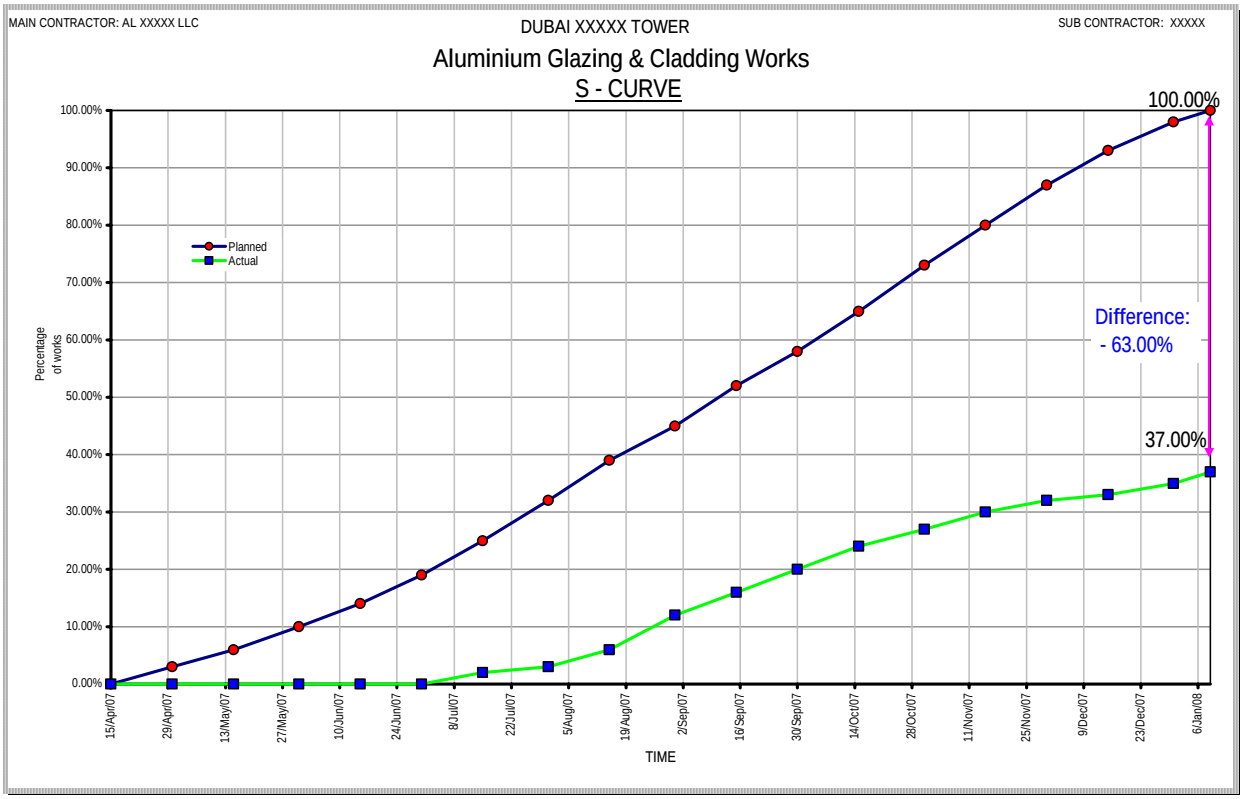
3.2.3.1. Budget.

The works will not be possible to be achieved as per the budget due the delay factors which have contributed to the time, resource and cost planning for the project. (Figure 3)

Also, certain element of works was quoted not taking into consideration the specification requirements, the alternatives of which was not accepted by the client/consultants who wanted the specifications to be adhered to.

3.2.3.2 INFLATION

The prices of materials and manpower have risen since the project was awarded and due to the delay in design, submission, approvals and production.The prices were also affected due to the boom in the construction industry at that time.



(Figure 3) CASE STUDY1 –Cost problem

3.2.4 Nomination Delay

There has been a delay in nomination of the aluminum/glazing works.

The aluminum/glazing works subcontractor is a client group company.

Since the client wanted to allocate the specific work package to his group company it took time as the quotation form the group company was much higher than the competitors.

Also, since the subcontractor was proposing a different system it was not in line with the project specifications. The delay of nomination was affecting the entire project as the nomination was a critical nomination.

3.3 CASE STUDY 2: FAILURE

Case Study 2 is a project comprising of basements, podiums ,2 multi storeyed towers and all associated external and internal works.

The project has to be handed over to 5 star hotel operator. The client has appointed a project design and supervision consultant, a project management consultancy firm, an interior design firm and a contractor.

The hotel operator has his own design teams and professionals who are going to provide their requirements for the project.

We are going to discuss and review the delay due to the following which have resulted in the failure of the project to complete in line with the contract duration.

1) Delay in design finalization,
2) Delay in finalisation of Hotel Operator.
3) Delay due to new requirements of hotel operator
4) Delay in nominations of subconsultants
5) Delay in nominations of subcontractors
6) Delay due to lack of agreement between parties.
7) Delay due increase in cost due to late decisions
8) Delay due to abortive works as per the new requirements.
9) Delay due to change of the primary stake holder.

The contractor was interacting with the current client, the future hotel operator, a number of design and supervision consultants. Also, the design for the project is not frozen, the hotel operator and client are still making changes and have not frozen the project requirement details. This is an important reason and the project may be affected due to late finalization of design and requirements. Also, the inputs from a range of specialists ranging from interior designers to restaurant operators to banquet hall specialist and many others are required to allow the works to be done without any delay.

3.3.1 Delay in design finalization.

The finalization of the design for the hotel was kept pending till the hotel operator was finalized to incorporate their requirements. This delay in design finalization affected all the works including the shell and core finishes like the blockwork as the layout of the rooms in the hotel was itself pending finalization.

3.3.2 Delay in finalization of Hotel Operator.

The client entered into negotiations with various hotel operators and in the process the work was progressing without any finalization of hotel operator.

Many decisions related to the services and provisions were kept on hold for ant of requirements and decisions. The major design for the interior works were on hold thereby delaying the nominations of major sub consultants and subcontractors.

3.3.3 Delay due to new requirements of hotel operator

The representatives of the hotel operator wanted new requirements as per their hotel group specifications.Thus, the preliminary design prepared by the lead consultant and the subsequent design prepared by the interior designer were required to be modified as per this new requirement.

This resulted in a major delay as all the design works ,concept drawings and detailed drawings done till date was to be redone and this will involve additional time and cause an irrevocable delay.

3.3.4 Delay in nominations of sub consultants

The nominations of sub consultants was delayed as the design itself was delayed and any design sub consultants were subject to preliminary finalization of design. Also, sub consultants were not being finalized as their scope was not defined.

3.3.5 Delay in nominations of subcontractors.

Nominated subcontractors were delayed for critical items like I.D.finishes which is the main backbone for any hotel project.

Also, the progress of the interior subcontractor was affected as the hotel operator, lead consultant and the specialist subconsultant like the interior designer took time to agree to the final design.

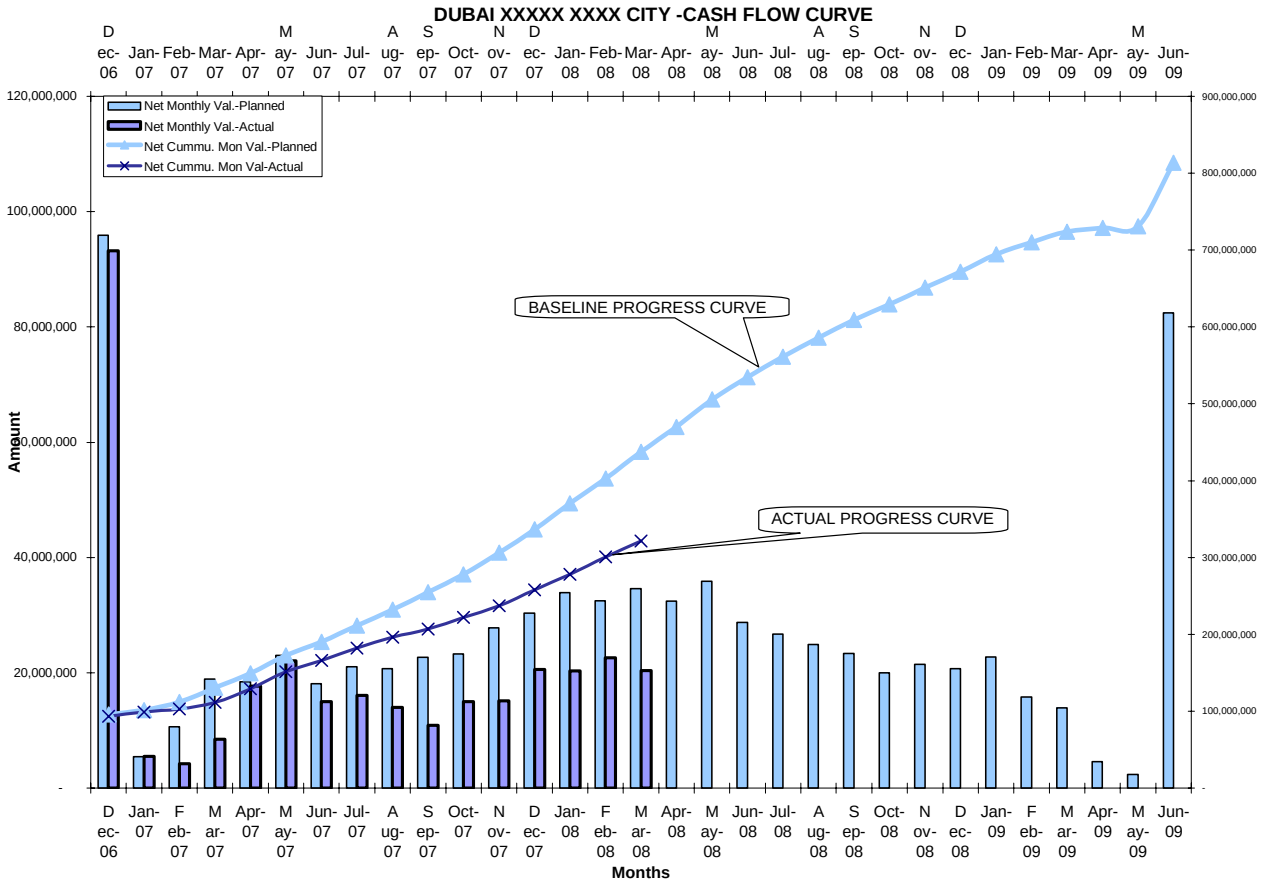
3.3.6 Delay due to lack of agreement between the consutant, hotel operator, specialist sub consultants, id designer and suppliers

As the revised design was being prepared, the requirements of the hotel operator were conflicting with the design of the lead consultant and the interior designer. The new requirements also required major changes to the structure of the building itself. This was strongly opposed by the lead consultant and the interior designer.

3.3.7 Delay due increase in cost compared to the budget due to late decisions.

As decisions regarding the finishes were being made in line with the new design , it was observed that these works were part of a provisional sum which was allocated to be utilized for these works.

The quotes received for the works were much higher than the budget.The late decisions resulted in an increase in cost and dealy in taking the decisions affected the progress of the works as reflected in the cash flow curve shown in (figure 4).



(**figure 4)case study 2- cash flow chart**

3.3.8 Delay due to abortive works as per the new requirements.

The changes to the design resulted in abortive works. These abortive works required additional time for removal of existing works and redoing the same as per the new design. This resulted in further delay to the works as well as additional cost.

3.3.9 Delay due to change of the primary stake holder

A major change occurred when the client sold the project to another conglomerate have business interest in the hospitality industry. The new stake holder

wanted to evaluate all the existing terms and conditions of the contract and renegotiate with all the concerned parties before taking over he project.

This resulted in further delays and the project was on hold for a certain period. Hence the project can be considered to have failed in its primary objective of completion within the specified and budget.

3.4 CASE STUDY 3 : SUCCESS

Case Study 3 is ABC Village –Phase 1 located in Dubai, a project that has been successfully completed in spite of all delays encountered by successfully applying the mitigation and accelerations techniques.

The 1st phase consisted of two stages with 8 blocks in the first stage and 4 blocks in the second stage. There is a common basement for parking. The other works include the Main plaza, auditorium, food court and landscaping works. The project had a completion milestone to allow universities and institutes to commence their operations.

The project milestones and objectives are listed down for a clear understanding of the various elements of the project.

The assessment of the project at the planning stage is done through risk analysis by identifying the major constraints that may arise in the project. Then the major success factors are enlisted to analyze the success rate of the project. Also, risks associated with constraints evaluated along with the risks associated with success factors to have a balanced view of all the probabilities Value planning is done by identifying stakeholders for the project. Then, the possible outcomes each stakeholder can want or get is identified and value added by all outcomes and rank the stakeholders.

3.4.1 **MAJOR MILESTONES:**

3.4.1.1FIRST STAGE COMPLETION: PHASE 1 - 9.5 MONTHS

3.4.1.2SECOND STAGE COMPLETION : PHASE 1 - 13.5 MONTHS

3.4.2 **MAJOR OBJECTIVES:**

The major objectives of the project were

1. Completion of 8 building blocks in stage 1 to allow fitout works by respective clients. This was most critical as any delay would result in the academic year being lost.
2. Access to fitout works of the 4 building blocks in stage 2 to allow commencement in line with the new academic year.
3. The other major objectives were to complete the auditorium structure to allow commencement of finishes.
4. The completion of landscaping works by a nominated subcontractor.
5. The supply of permanent power to the project was an important objective.

3.4.3 MAJOR CONSTRAINTS

1) The major constraint was the limited time of 9.5 months for the 8blocks of stage 1 including the entire basement completion.

2) The second major constraint was the limited time of 13.5 months from the start date to complete the 4blocks of stage 2.

3) Another major constraint was the dewatering problem due to close proximity to the sea and the areas to be dewatered.

4) The supply of power for the project including Testing & Commisioning.

5) Any changes required by the client/customer affecting the completion.

3.4.4 MAJOR SUCCESS FACTORS

1) The major success factor is the commitment from the client to ensure that the project completes on time

2) The nominations and approvals by the client have been promised to be as per the program of works.

3) The major factor of the success is due to the expertise of the consultant and contractor in similar projects.

4) The contractor has the manpower and resources to achieve the required rate of progress.

5) Upon completion ,the campus would be the first in the region to provide such a facility for educational institutions and universities from across the world.

6) It would attract people from the entire region and become a regional hub for education and research.

3.4.5 RISK ASSOCIATED WITH CONSTRAINTS.

1) Due to the fast track nature of the project, unavailability of materials and equipment on time may affect the completion.

2) Massive requirements of resources from various contractors and their management would be a real challenge for coordination.

3) Any changes in power requirements from client / customer will affect the power on as procedures to be followed to provide additional requirement will have to go through the entire process again.

4) Any structural changes to the project during the construction will affect the project completion.

5) Any changes made for any long delivery items will adversely affect the project completion.

3.4.6 RISK ASSOCIATED WITH SUCCESS FACTORS

1) The commitment by the client to go slow on the project due to less than expected response may affect the project.

2) Any delay in nominations by the client due to increase in cost w.r.t the budget will affect the completion of the project.

3) The contractor may be having multiple projects and may not be in a position to deploy additional workers as per the requirement.

4) Any additional works or changes may not be agreed by the contractor in the same time duration and as per the same boq rates.

5) Price fluctuation in the market will make it difficult for the client & consultant to get a better deal when they would require changes.

3.4.7 MITIGATING & RANKING THE RISKS

The listing of the risks associated with constraints and success and the impact of these risks and the probability of occurance will determine the mitigating action for each risk.

The risks and the probable impacts for each risk are reflected in table1.

S.N	RISK	IMPACT	PROBABILITY	IMPACTx PROB	MITIGATING ACTION
1.	Due to the fast track nature of the project, unavailability of materials and equipment on time may affect the completion.	H	H	H H	FREQUENT MONITORING OF SCHEDULES
2.	Massive requirements of resources from various contractors and their management would be a real challenge for coordination.	H	M	H M	MANPOWER HISTOGRAMS TO BE MONITORED CLOSELY
3.	Any changes in power requirements from client / customer will affect the power on as procedures to be followed to provide additional requirement will have to go through the entire process again.	H	M	H M	CHANGES TO BE TAKEN IMMEDIATELY TO MINIMISE DELAY
4.	Any structural changes to the project during the construction will affect the project completion.	H	M	H M	CHANGES CAN BE LOCALISED TO AVOID DELAY

5.	Any changes made for any long delivery items will adversely affect the project completion	H	L	H L	ENSURE ORDER IS PLACED AS PER PROGRAM
6.	The commitment by the client to go slow on the project due to less than expected response may affect the project.	M	L	ML	GOOD MARKETING STRATEGY NEEDED
7.	Any delay in nominations by the client due to increase in cost w.r.t the budget will affect the completion of the project.	M	L	ML	SCHEDULE FOR NOMINATIONS TO BE MONITORED
8.	The contractor may be having multiple projects and may not be in a position to deploy additional workers as per the requirement	M	L	ML	ENSURE COMPLIANCE OF PLANNED MANPOWER HISTOGRAM
9.	Any additional works or changes may not be agreed by the contractor in the same time duration and as per the same boq rates.	L	L	LL	VARIATIONS TO BE DEALT WITH AS PER CONTRACT
10.	Price fluctuation in the market will make it difficult for the client & consultant to get a better deal when they would require changes.	L	L	LL	RELIABLE PARTIES TO BE CONTACTED

TABLE 1-CASE STUDY 3-MITIGATING &RANKING THE RISKS

LEGEND: H – HIGH
M – MEDIUM
L - LOW

3.4.8 VALUE PLANNING.

Value Planning is the title given to value techniques applied during the concept or planning phases of the project. It is used during the development of the brief to ensure that the value is planned into the whole project from its inception. This is achieved by addressing and ranking the stakeholders requirements in order of importance. Hence the following steps will elaborate the steps to carry out value planning,

1)Stakeholders in the project.

2)Possible outcome, each stakeholder can want/get.

3)Value added by all outcomes and rank to the stakeholders.

1) STAKEHOLDERS IN THE PROJECT.

The major stakeholders in the project were

i)The Client

ii)The Consultant

iii)The Contractor

iv)The institutions and universities who had already booked space in the phase 1 of the project.

v)Students who had taken admissions in the institutions and universities for the academic year.

vi)DEWA : Dubai electricity and water authority, which is responsible for the supply of power and water to the project.

vii)Infrastructure Contractor who is responsible to ensure that all roads and pavements are done in time to ensure trouble free vehicular movement.

2) POSSIBLE OUTCOME ,EACH STAKEHOLDER CAN WANT/GET.

I)For the Client:

i)Since the project is the first of its kind in the region ,successful completion of the project in time is top priority.

ii) Handing over the premises to the universities and institutions to commence their fitout works in time to start with the academic year.

iii)Income on investments will start immediately after possession is given to the respective customers.

iv)Successful completion may result in exploring expansion plans and future developments.

II)For the Consultant:

i)Design as per Arabic architecture to blend with modern amenities would be a challenge.

ii)Client may want /suggest changes which may affect the project completion.

iii)Late Client nominations would become costly as many long delivery items require the approval of client in terms of cost & specifications.

III)For the Contractor :

i) Any changes to the works by the client may delay the contractor

ii)Revision to design may require modifications to the works.

iii)Basement construction for the entire project is part of stage 1 including finishes which is a massive task.

IV)For the Universities /Institutions :

i)Academic year should not be lost due to late delivery of premises.

ii)Late handover will result in financial losses

V)For the Student Community

i)Late handover will also affect the student’s academic year.

ii)Students may also be affected due to non availability of seats in other institutions/universities in case the project completion is delayed.

iii)Hostel Facilities will be affected.

VI) Dewa –Dubai electricity and water authority

i)The power required for the project should be supplied in time to allow testing & commissioning.

ii)Power is required to allow universities & institutions to commence operations

VII)Infrastructure Contractor:

i)Infrastructure for access to the project is important as any delay in providing the infrastructure would discourage institutions to consider alternatives and affect the movement of traffic.

3) VALUE ADDED BY ALL OUTCOMES & RANK TO THE STAKEHOLDERS.

The value added by the outcomes are listed below and ranked in order of importance.

I)CLIENT :

i) Successful completion of the project in time will increase confidence of the customers in the project.

ii) Credibility will be enhanced after providing the universities and institutions the premises to commence in line with the academic year

iii)Client will start to generate income immediately after handing over the premises.

iv)Increased Confidence to explore future projects and developments

II)Consultant:

i)The architecture reflecting Arabic designs would help the nation take pride in the project and identify it with the cultural heritage of the country and the blend with modern amenities would help integrating the cultural and modern values.

ii) The consultant’s expertise would add value to the project as any changes to the project by the client would be dealt in a professional manner.

iii)Ensuring the nominations are done in time to ensure approvals and delivery are well within the project schedule.

III) Contractor :

i)The client can get changes required by the contractor if he identifies them early in the project.

ii)Modern /innovative methods of construction can be deployed to ensure faster work progress.

iii)Contractor will be able to utilise resources for other projects after successful completion of the project.

IV)Universities & Institutions:

i)Universities can benefit from the successful commencement of the academic year.

ii)Also, due to timely completion ,all parties would be avoiding financial losses.

V)Students :

i)Students will benefit due to start of academic year.

ii)Students do not have to search for alternatives in case of project completion on time.

iii)Hostel facilities can be utilized .

VI) DEWA :

i)Power on for testing & commissioning will help in handing over the project in time.

CHAPTER 4 : METHODOLOGY

4.1 INTRODUCTION

Delay to projects are a result of inaction on part of the key stakeholders in the project. The client as the main stakeholder does not nominate a critical subcontractor an the project gets delayed(case study1).The contractor has no design and decisions and the resources are idle which result in delays(case study2).

The methodology for evaluating the delay to a project is by acquiring all the information related to the project and its success and failure. This key data is related to the planning of the project. The plan that is to be achieved will require resources and cash as part of the requirements. Another major element is the decisions by the client in nominating the key and critical subcontractors which will be required to perform for the successful completion of the project.

The key data will required to be justified for its merits and will have to be tested to verify its usefulness and importance. The method of the data acquisition is important and should be verifiable and substantiated. This data is then analyzed by various methods for accuracy and implementation.

The methodology adopted in this research is to identify the key data required for managing the issues of delay and utilize the knowledge gained from some of the eight modules especially the subjects dealing with the topic of the research which are as follows.

4.2 KEY DATA

4.3 JUSTIFICATION

4.4 DATA ACQUISITION

4.5 DATA ANALYSIS

4.2 KEY DATA

4.2.1 PLANNING – K.P.I's (KEY PERFORMANCE INDEX)

4.2.2 RESOURCE – PROGRESS CURVE

4.2.3 COST -CASH FLOW CURVE

4.2.4 DECISIONS –NOMINATIONS

The reasons for delays to projects will be considered based on live project conditions and the measures to provide the solution to the problems will be from the knowledge gained in the modules and steps taken to implement them to mitigate /eliminate /prevent those delays.

4.2.1 PLANNING -K.P.I's(KEY PERFORMANCE INDEX)

In any project whether small or big, there are important milestones identified at the start of the project to evaluate the progress at various stages of the project. These are known as Key Performance Indicators (K P I's). It is important to have milestones for various stage sof the project as these would provide a clear perspective regarding the important milestones of the project.

4.2.2 RESOURCE -PROGRESS CURVE

The project is monitored through a programme of works which is a set of activities linked together in a proper sequence to evaluate the time required to complete the works in line with the contract duration.

This programme is then loaded with resources in man days and curve is generated from the man days for all activities for monitoring the progress of works. This curve is called as the progress curve. The project is monitored for progress, by a progress curve generated at the beginning of the project to highlight the rate of progress for the entire duration of the project.

The progress curve can also be generated by giving weightage to the engineering and construction process. This is normally done for a design and build projects. Large scale complex projects can also be done with this combination of weightage, but the criteria for the allocation of the weightage is decided at the start of the project.

4.2.3 COST -CASH FLOW CURVE

The cost curve or cash flow curve or the gross valuation can be used for monitoring of progress of works, but it is not as accurate as the mandays progress curve. This is the cash flow curve or gross valuation curve based on cost and not on the basis of mandays weightage for the activities of works.

4.2.4 DECISIONS -NOMINATIONS

In large projects, due to the changing circumstances and requirements it is likely that the decisions taken by the client are delayed. More so if the project is a design and build project. In other projects also, the client expects to take decisions according to his criteria and priorities. It is important to note that the successful completion of any project is related to the decisions by the client at the appropriate time in line with the program of works.

4.3JUSTIFICATION:

The justification why the information mentioned above is required is as follows

4.3.1PLANNING -K.P.I's(KEY PERFORMANCE INDEX)

KPI's are required as they can be monitored are timely intervals to ensure that there is no delay to any of the stages of the project.

If these KPI's are critical then any delay in these will delay the the works and have an impact on the project completion date. If any K.P.I is delayed it will give the opportunity to take urgent action and thereby either eliminate the delay by mitigation or acceleration.

K.P.I's ensure that the there is no scope for any delays due any of the factors that may cause delay, whether it is decision from the client or pending approvals from the consultant or delay by from the contractor.

4.3.2 RESOURCE -PROGRESS CURVE

This progress curve is generated from mandays because the other parameters like the K.P.I's can be monitored only at when the it has elapsed, whereas the progress curve is required to be monitored frequently for progress meetings, reports etc.

The progress curve also indicates the status of the project ,whether it is ahead or behind the baseline by comparing the original progress curve.

The progress curve also indicates whether the any delay to the progress is due to inadequate resources and which section of works needs the resources and for which activities.

4.3.3 COST -CASH FLOW CURVE

The cash flow for any project is the lifeline as uninterrupted cash flow is required for the success of any project.The value of work in cost is also a critical indicator for the works to be carried out for the project. Any delay for any activities or the billing will immediately reflect on the cash flow of the project.

This is suitable method for evaluating the progress of works in small to medium size projects. However in large and complex projects this is not be a suitable method to monitor progress as it does not identify the critical path and reasons causing the delay.

4.3.4 DECISIONS –NOMINATIONS.

The client may want to change an important decision like he may opt to replace a nominated contractor later in the project as some other party may be willing to execute the works at a much lower cost.

From the client's perspective this may make good economic sense but from the projects point it could spell disaster. The client would not have considered that this decision could delay the entire project. Hence, the requirement of decisions by the client ib line with the program as per the specified dates of nominations justifies the requirement.

4.4 DATA ACQUISITION

4.4.1 PLANNING – K.P.I's(KEY PERFORMANCE INDEX)

The data acquisitiom for the planning issues like the Key performance index is the updates of the baseline program. The key performance index is listed as milestones in the program and updated periodically.

4.4.2RESOURCE – PROGRESS CURVE

On a weekly or fortnightly basis the progress of works at site is recorded and the progress is discussed and agreed with the project team. Then the progress percentages are verified and agreed with the consultant.

The progress of works is recorded for both the engineering and construction activities and the baseline master program of works is updated.

4.4.3 COST -CASH FLOW CURVE

The Cash Flow curve is normally monitored on a monthly basis as the billing for the project is done every month.

The progress of works recorded for the updating the program is utilised for the cash flow update as the bill is updated.

4.4.4 DECISIONS –NOMINATIONS

The nominations are part of the baseline master program of works which is monitored periodically. The nominations have to be communicated to the contractor by the consultant through the client as the process of nominations is dealt by the client and consultant. Hence information related to the nomination is forwarded to the contractor upon successful selection of the subcontractor.

4.5DATA ANALYSIS

4.5.1 PLANNING – K.P.I's(KEY PERFORMANCE INDEX)

The K.P.I's are part of the baseline master program as milestones for section of the works. The dates are identified and are linked to the works. The program is updated periodically. These program updates will reflect the status of these K.P.I's .Any delay to any of the activities will reflect a delay to the K.P.I. milestones. It will ensure that any delay reflected is immediately identified and furthur course of action by the respective agencies can be formulated.

4.5.2RESOURCE – PROGRESS CURVE

The updated program of works which is resource loaded will indicate whether the progress of works is inlinewith the baseline master program of works. The progress curve for the project is monitored periodically and plotted against the baseline progress curve.

Any delay compared to the baseline curve is probed furthur by analyzing the details of progress for activities on the critical path of the project.

4.5.3 COST -CASH FLOW CURVE

The cash flow update is compared to the baseline cash flow curve and the information is useful to evaluate whether the cash flow is line with the projections.

The information for the cash flow update is from the program updated percentages which are applied to the respective activities in the bill of quantities.

4.5.4 DECISIONS –NOMINATIONS

The dates for the nominations are planned as per the program and upon updating the program any due nominations are finalised and any nominations pending will reflect a delay.

Nomination if critical and not finalized will reflect a delay on the project and will need to be taken up on a priority.

Also, delayed nominations would be dealt with contractually by making extension of time claims pursuant to the conditions of contract.

CHAPTER 5 : ANALYSIS AND RESULTS

5.1 INTRODUCTION

The analysis of all the factors mentioned in the case studies and the methodology will be further analyzed and the results of those analysis will indicate as what was the measure taken to implement the measures like mitigation and acceleration. Example: regression analysis is implemented for case study 1 planning analysis and is successfully implemented on the project.

The analysis takes into consideration the factors that have resulted in the failure of the project in terms of the resource management and cost management. Example: Recovery cost curve proposed to recover the delays based the cash flow analysis.

The decisions by the clients are analyzed in each project and the nalaysis and results indicate that the client as the primary stakeholder holds a greater responsibility for the success or failure of the project. Example –case study3 , where the client motivated the contractor to mitigate the delays and the other delays were eliminated by implementing the measures of acceleration which helped in completing the project in time.

The analysis and results for the case studies would be structured according to the methodology.

5.2 CASE STUDY 1

5.2.1 PLANNING – K.P.I's(KEY PERFORMANCE INDEX)

5.2.2 RESOURCE – PROGRESS CURVE

5.2.3 COST -CASH FLOW CURVE

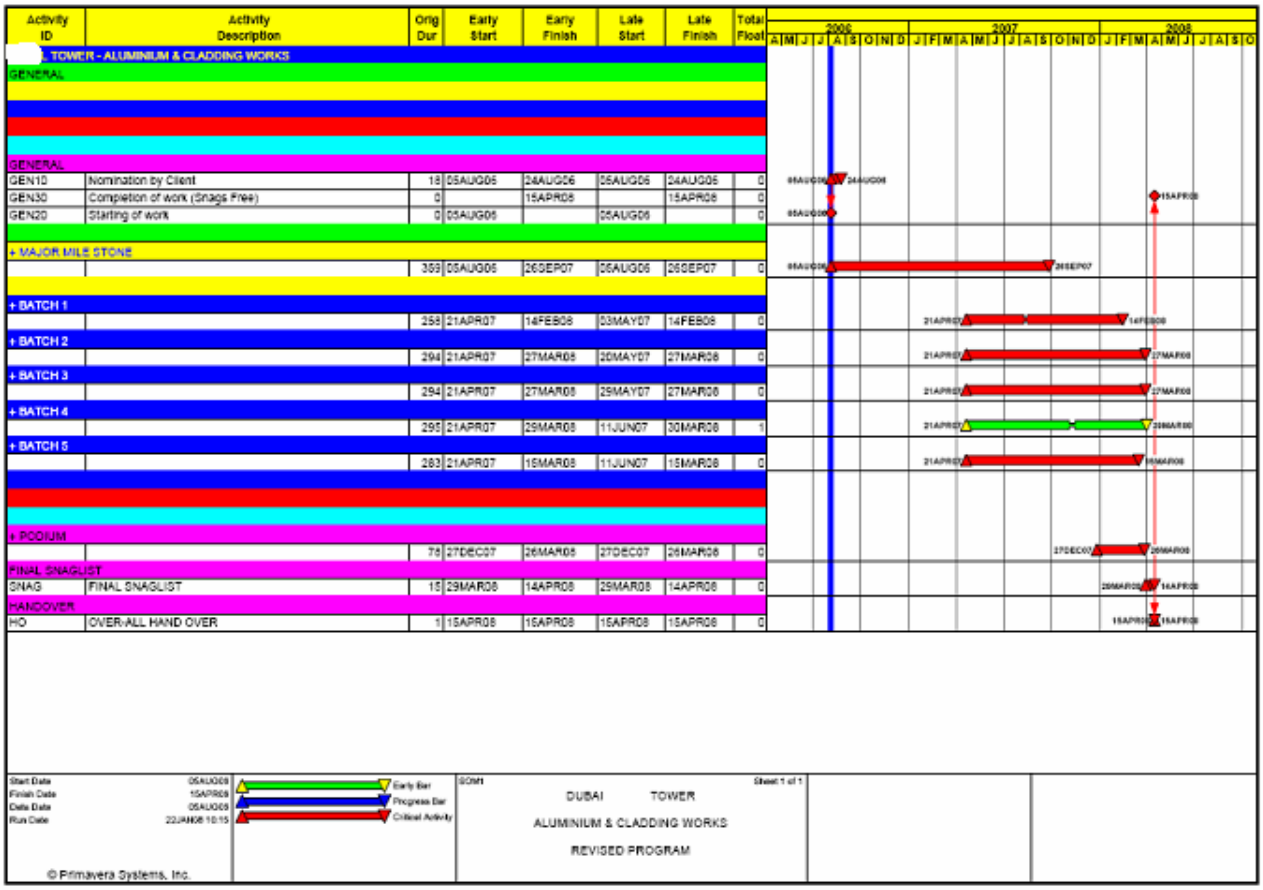
5.2.4 DECISIONS –NOMINATIONS

5.2.1 PLANNING ANALYSIS & RESULTS

5.2.1.1. No Detailed K.P.I's /plan/program for the work package.

The main contractor had to prepare a detailed program using primavera project planner incorporating all the interfaces between the design, materials, shop drawings and installation and allocate K.P.I's for the work package.

A summary program of works is indicated in (figure 5.)which indicates the aluminium /glazing program.

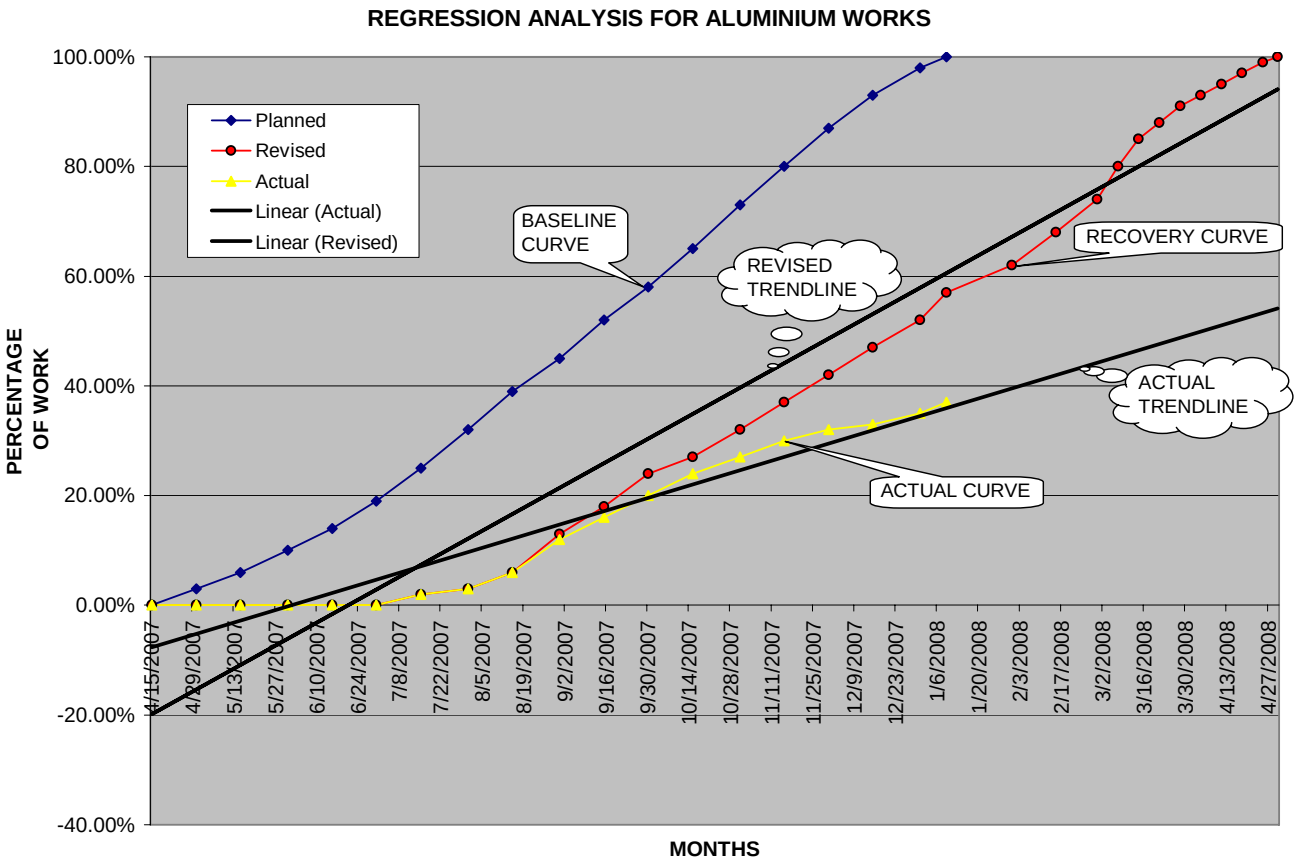


(figure 5.) case study 1-planning program

This program included the works in sections /elevation / quantities /outputs required. This program would be monitored and updated on a fortnightly basis.

A regression analysis for aluminum /glazing works were proposed as indicated in the (figure 6.)This regression analysis demonstrated the comparision between the baseline curve, the revised curve and the actual curve with the trendline for the actual and the revised curves.

It can be deduced from the analysis that even after proposing the recovery curve the progress of works in not conforming top the requirements and is getting further delayed.



(figure 6.) case study 1-Regression analysis

The Scope of works were broken down elevation wise and every element of work was programmed .

5.2.1.2. Design facilities

The selection of the third party consultant should commence along with the commencement of the design so that the third party consultant is on board by the time the design is completed and ready for submission.

It is recommended that the design done at the head office in Italy should be forwarded to the third party consultant along with the project consultant so that precious time is saved.

5.2.1.3. Design approvals including third party approval.

Design coordinators should be available in the country to substantiate and clarify the design aspects to the project and third party consultant until the process of design approval is completed.

The approval of the design by the project consultants will not materialize until they have the approval from the third party consultant. Hence, the third party consultant contact should specify the time frames within which they will review the design and comment and

give the necessary approvals. Since the third party consultant is appointed by the aluminium /glazing subcontractor they should appoint a third party consultant which meets their time requirements.

5.2.1.4. Material submission / approvals.

The materials submission related to the extruded material should be done on a priority as the extruded material has to be exported to Italy for fabrication/production.

Material samples like glass and metal works can be procured locally or airlifted in case of specific requirements to avoid delay.

5.2.1.5. Shop drawings submission / approvals.

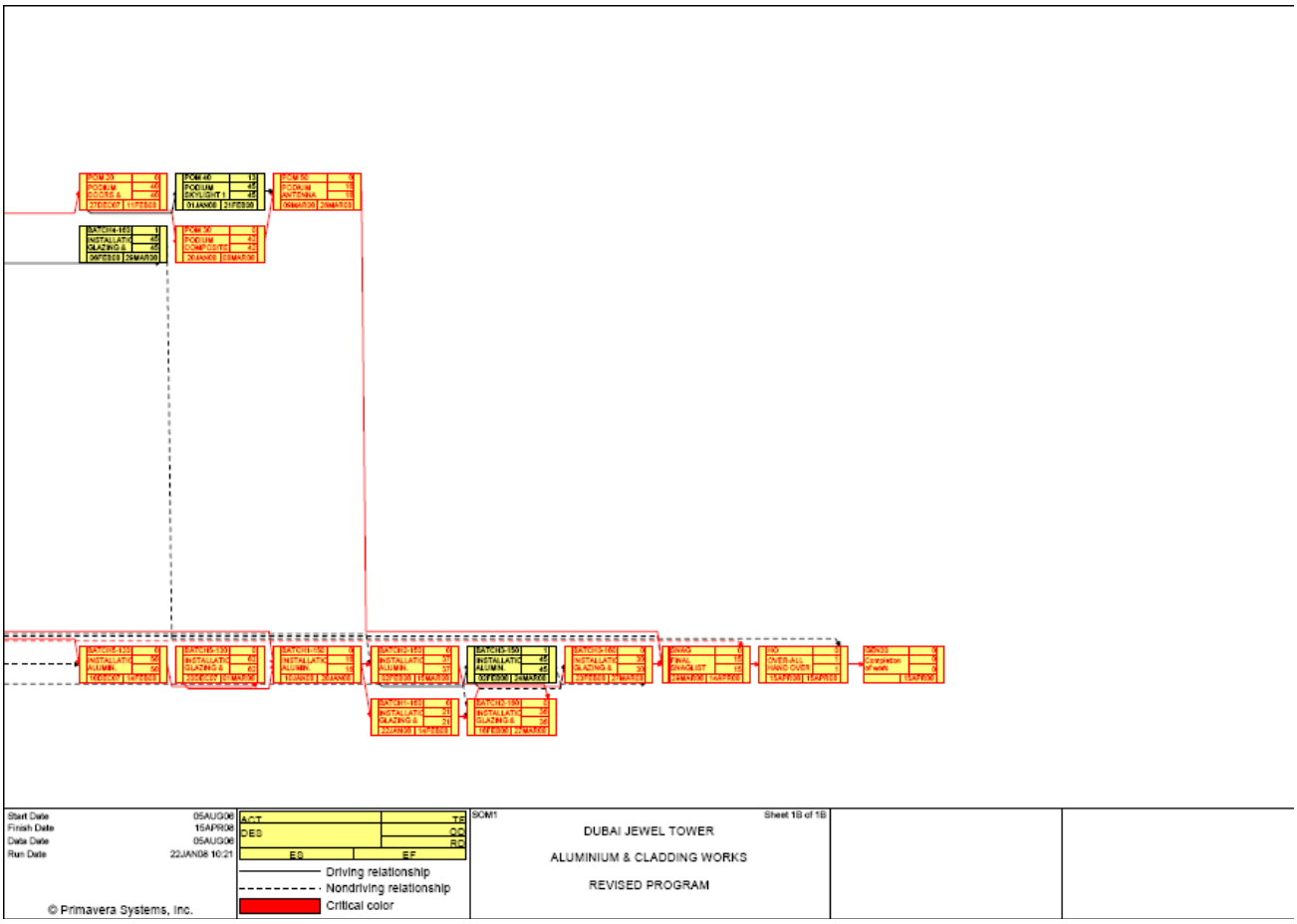
Preparation of drawings can be split between Italy and employing a local subcontractor for drawings. The delay that occurred in incorporating the comments by the project consultants which took time to be sent to Italy could have been resolved by the local subcontractor who would have been assigned that responsibility, thereby saving a considerable amount of time.

5.2.1.6.Lack of production facility in the country.

The extrusion from the local manufacturers and then exporting to Italy was one of the factors which can be improved by extruding the material from an Italian/ European supplier. It would have reduced the time required for exporting to Italy.

However the production of the metal cladding can be outsourced to a local manufacturing company in the U.A.E. as that production is not done in Italy. This will the metal cladding to be manufactured in Dubai and will involve no additional for delivery and installation can commence within a very short time, thereby mitigating the delays partially recovering as per the recovery plan indicated in (Figure 7 & 8).

(figure 7.) **Case Study 1- PLANNING PERT CHART**



(figure 8.) Case Study 1- PLANNING PERT CHART

5.2.1.7. Planning affected by non working periods in the country of manufacture.

The manufacture process cannot be done as there is a summer break in Europe. The option of completing the manufacturing process which is done locally for the metal cladding works can be expedited and those works can commence within this period. This will reduce the burden on the resources (manpower) which is discussed in the next section.

RESULT.

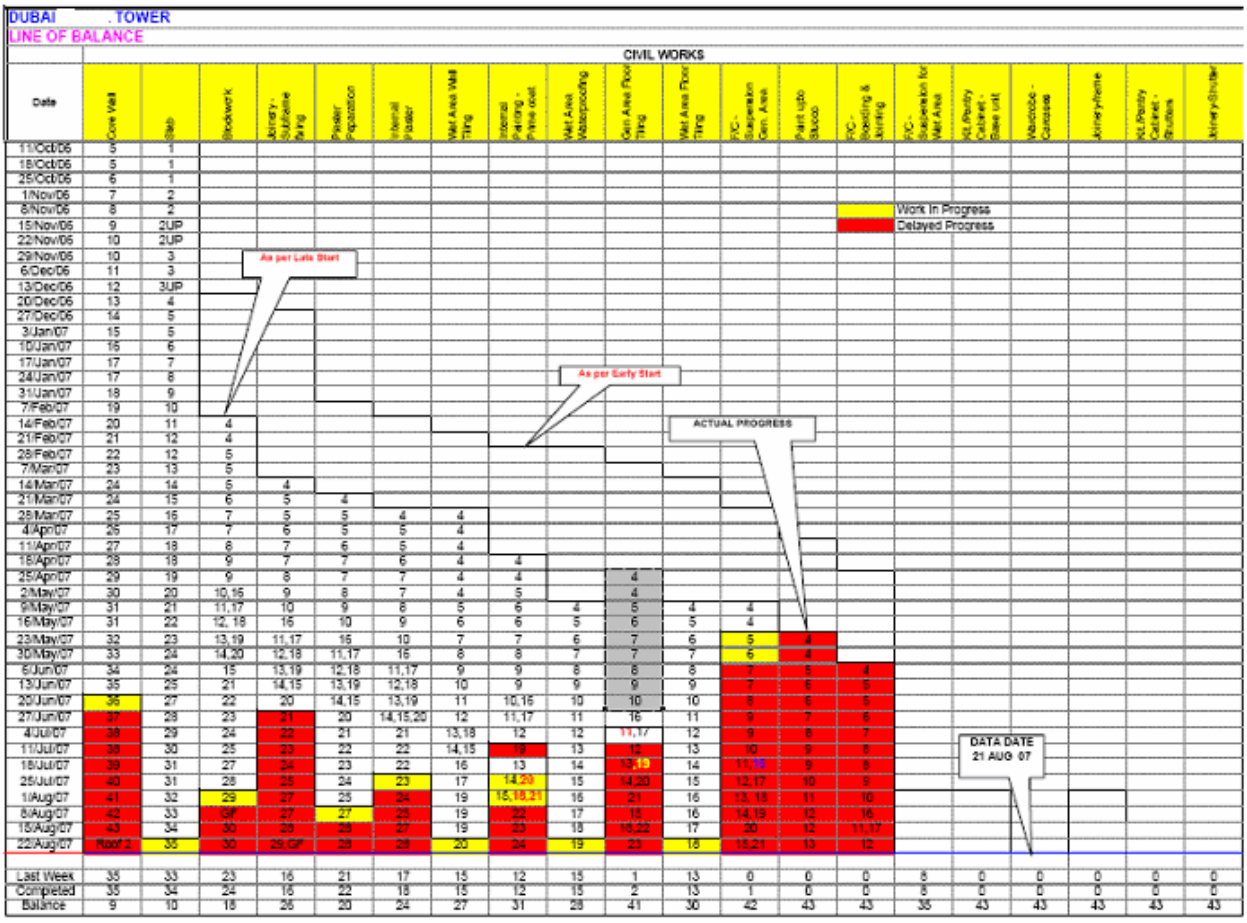
The resulting factor was that the subcontractor was supported by planning techniques of k.P.I's, regression analysis, revised and recovery programs.This helped the project to reduce the delay and complete to the satisfaction of the client.

5.2.2 RESOURCE MANAGEMENT ANALYSIS & RESULTS

5.2.2.1. No manpower resources to execute the installation.

The company can recruit subcontractors and offer a portion of works which can be done to reduce the overall delay, even though the installation charges may not be in line with the budget. However these will still be cheaper compared to the option of skilled manpower for installation from Europe.

Also, the Line of Balance (LOB) is a planning technique which can be used to monitor and control progress as shown in(Figure 9).



(Figure 9). Case Study 1- line of balance(Resources)

5.2.2.2. No resources to monitor the works.

Staff from the Italy office needs to have a presence including deployment of permanent staff till the completion of the project. Skilled locally recruited staff having work exposure to multinational companies can be good in coordination and execution.

5.2.2.3. Skilled Manpower from Europe.

Skilled manpower from Europe can be hired to achieve two objectives; namely training and part section of works.

The manpower from Europe would be experienced in this form of installation and would achieve good productivity thereby mitigating some of the delays to the works.

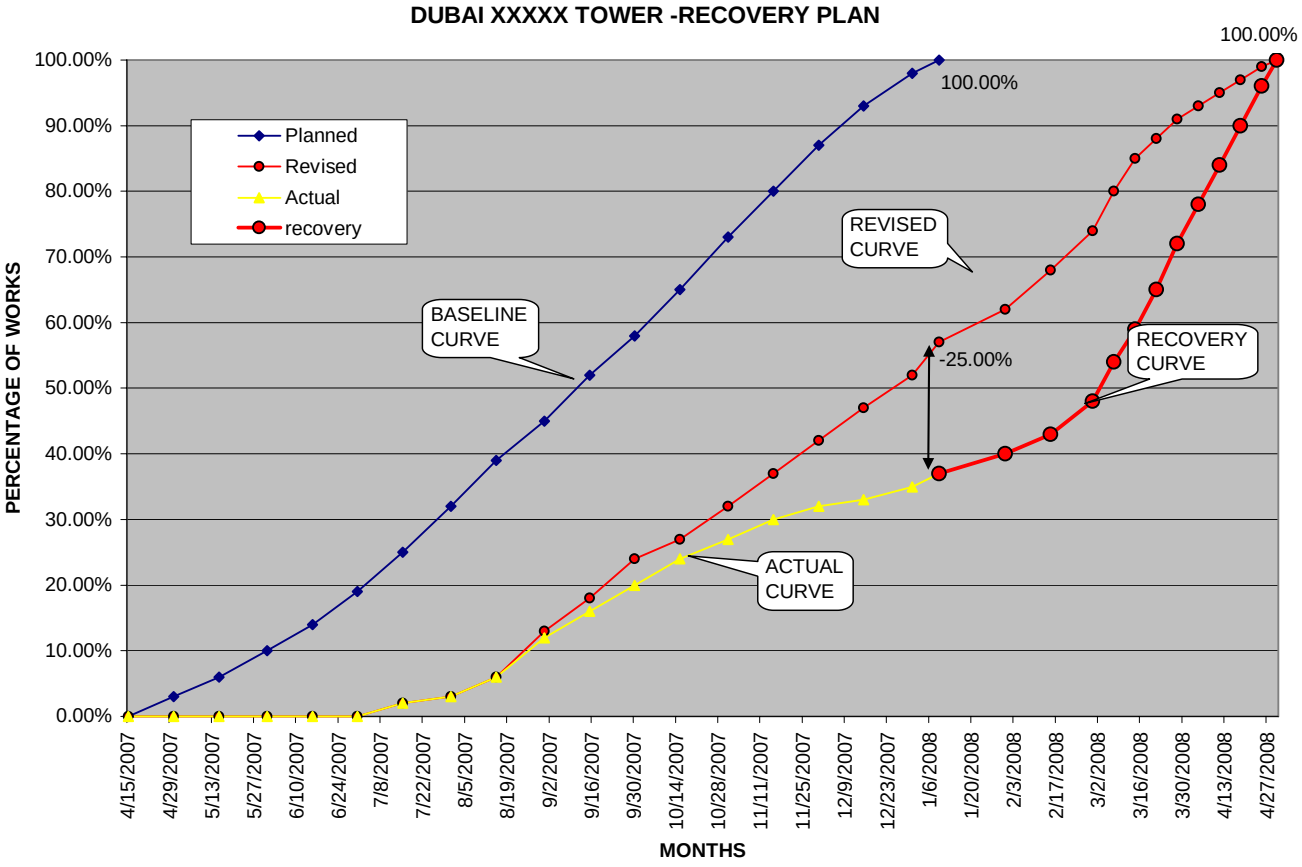
5.2.2.4. Manpower recruited locally.

The manpower recruited locally can be skilled and exposed to similar work packages to ensure good productivity and quality.

Also, subcontractors specialized in these works can be deployed to ensure that the delay to the project is mitigated.

The details of the progress of works and its delay even after the revised program was issued were due to the lack of required manpower which has to be obtained locally to meet the targets.

The proposal to employ subcontractors or specialist installers for completing the balance works is required as the criticality of the works can be called as supercritical and the duration remaining to complete the balance works is a challenge as indicated in the recovery curve as per (Figure no 10).



(Figure no 10).Case Study 1- Resources

RESULT:

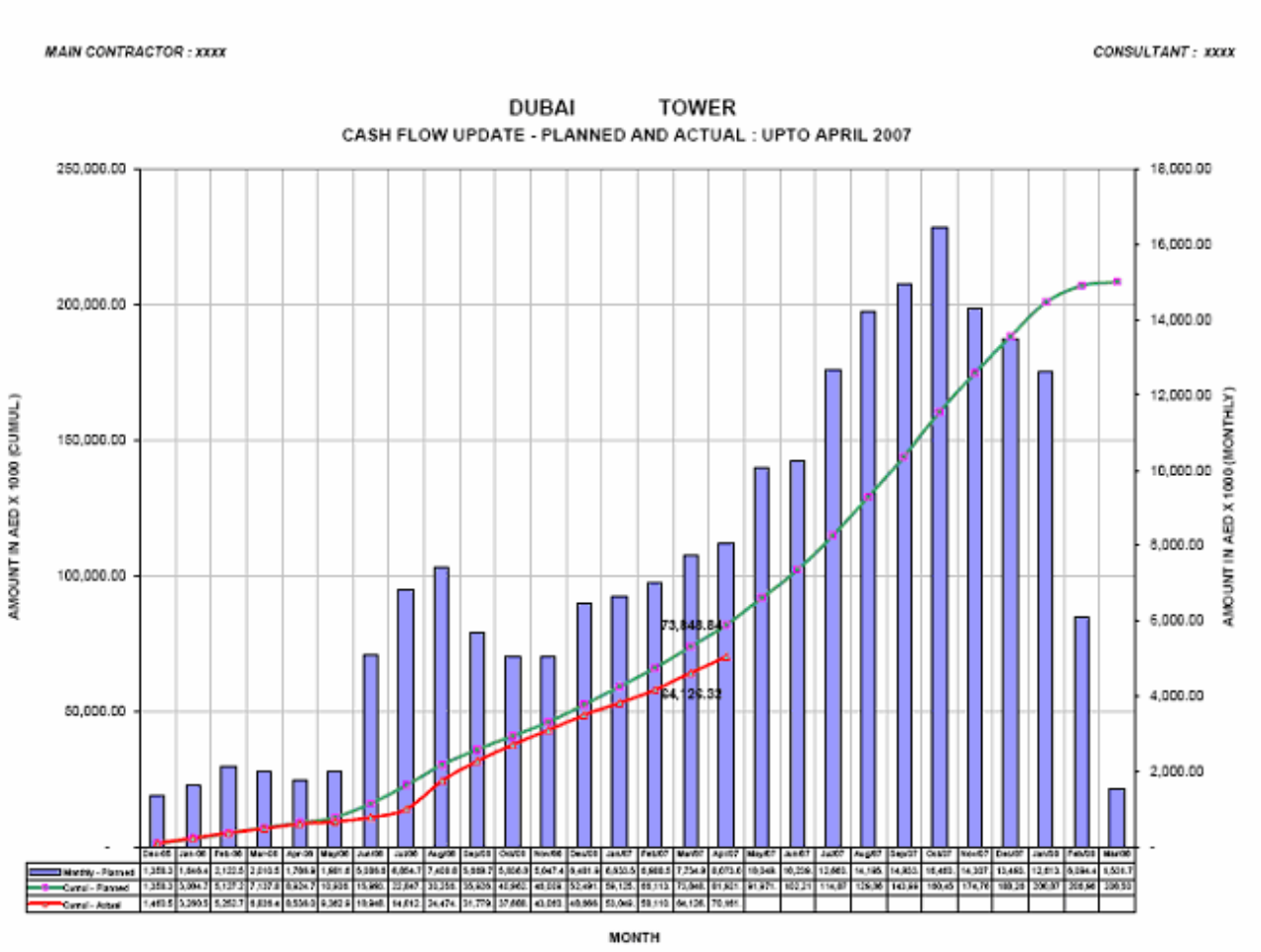
The resource analysis reinforced the need for additional manpower to reduce the impact of initial delay. The monitoring of works by the line of balance helped in achieving the recovery plan. Also, the recruitment and training of local manpower helped in mitigating the delay.

5.2.3 COST MANAGEMENT ANALYSIS & RESULTS

5.2.3.1. Budget.

The recommendation in regards to the budget is to implement a policy to complete the works in away which would minimize the negative effects which have arisen due to various factors already occurred as indicated in

(Figure 11).



(Figure no11). Case Study 1-cash flow

If effective action is not taken to mitigate the delays the conditions of contract clauses related to penalty and liquidated damages would be more harmful than the reduced level of profit or even loss. Also, it should be remembered that every contract is accompanied by an escalation clause so it may be possible to reduce any losses by making effective utilization of this clause in the contract.

RESULT :

The Cost analysis indicated that the cash flow was affected and measures such as acceleration had to be implemented to recover the delays.

5.2.4 NOMINATIONS ANALYSIS & RESULTS

The basis for the problem is the requirement of the nomination by a specified date as per the KPI which is reflected in the baseline master program. This nomination is a critical nomination and since there is delay in this critical nomination it is affecting the successor activities and ultimately the completion of the project itself

The client kept the interior design package works as part of provisional sums for which the client has to nominate a subcontractor to carry out the works.

Since the project is to handed over to a reputed chain of hotel operator which was not finalized, the final design could be freezed only after incorporating the requirements of the hotel operator.

The interior design consultant was also not selected at the time of award of works, hence the interior design concept was not there. Another reason the client could not nominate is the original scope and amount reserved as a provisional sum was found to be falling short to meet the final design as the scope had increased and also the costs had increased due to a boom in the property market.

The cost of materials and manpower had increased significantly as the nomination was due later and the quotations were very high compared to the allocated provisional sum value.

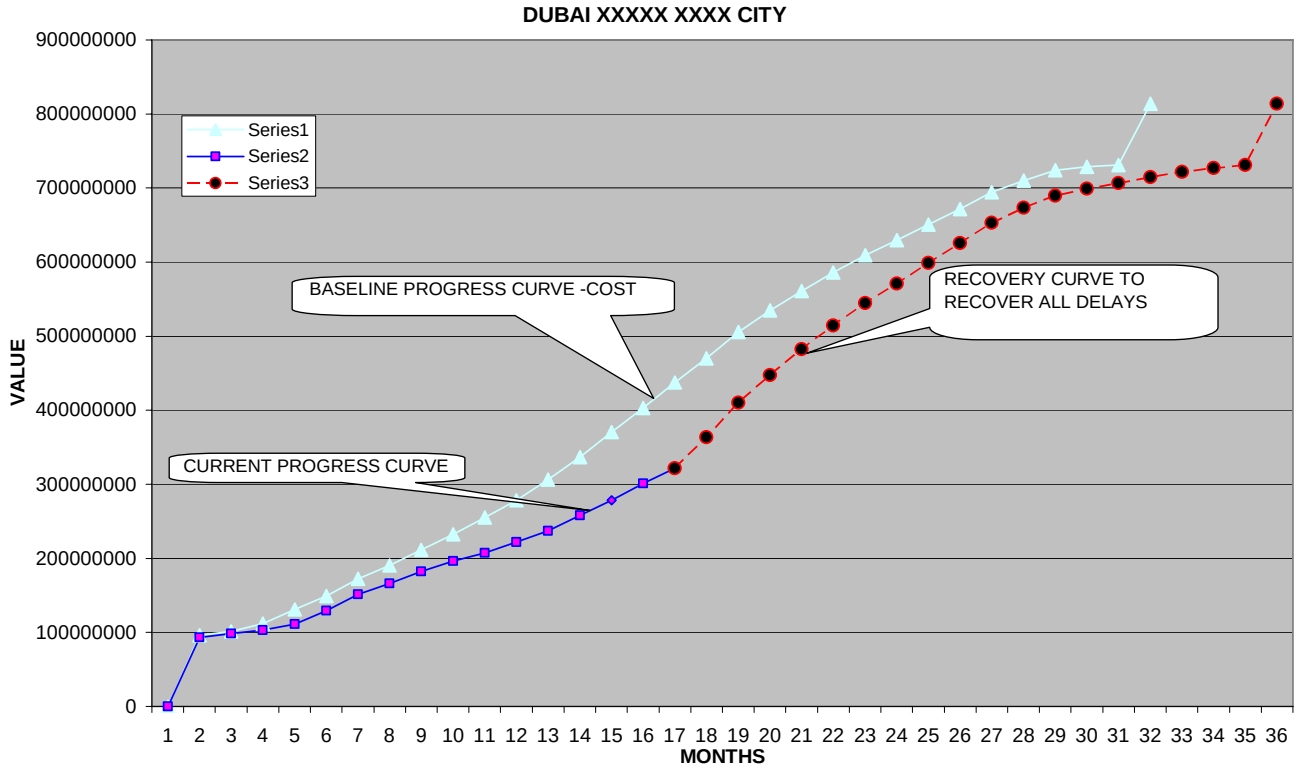
RESULT:

The nominations delay by the client affected the project and this was tackled by acceration and mitigation measures as highlighted in the planning,resource and cost analysis.

5.3 CASE STUDY 2 -ANALYSIS & RESULTS

5.3.1 PLANNING ANALYSIS & RESULTS

There was a delay to the baseline progress curve and the delay was increasing. A proposal to mitigate the delays by ways of partial mitigation and partial acceleration as shown in(Figure 12)



(Figure 12) Case Study 2- Planning

From the above planning analysis, the attempt to reduce the delay by mitigation was shown by the contractor.But the delays in finalizing the design with the concerned parties and nominating the subcontractors after that was a serious cause of concern.

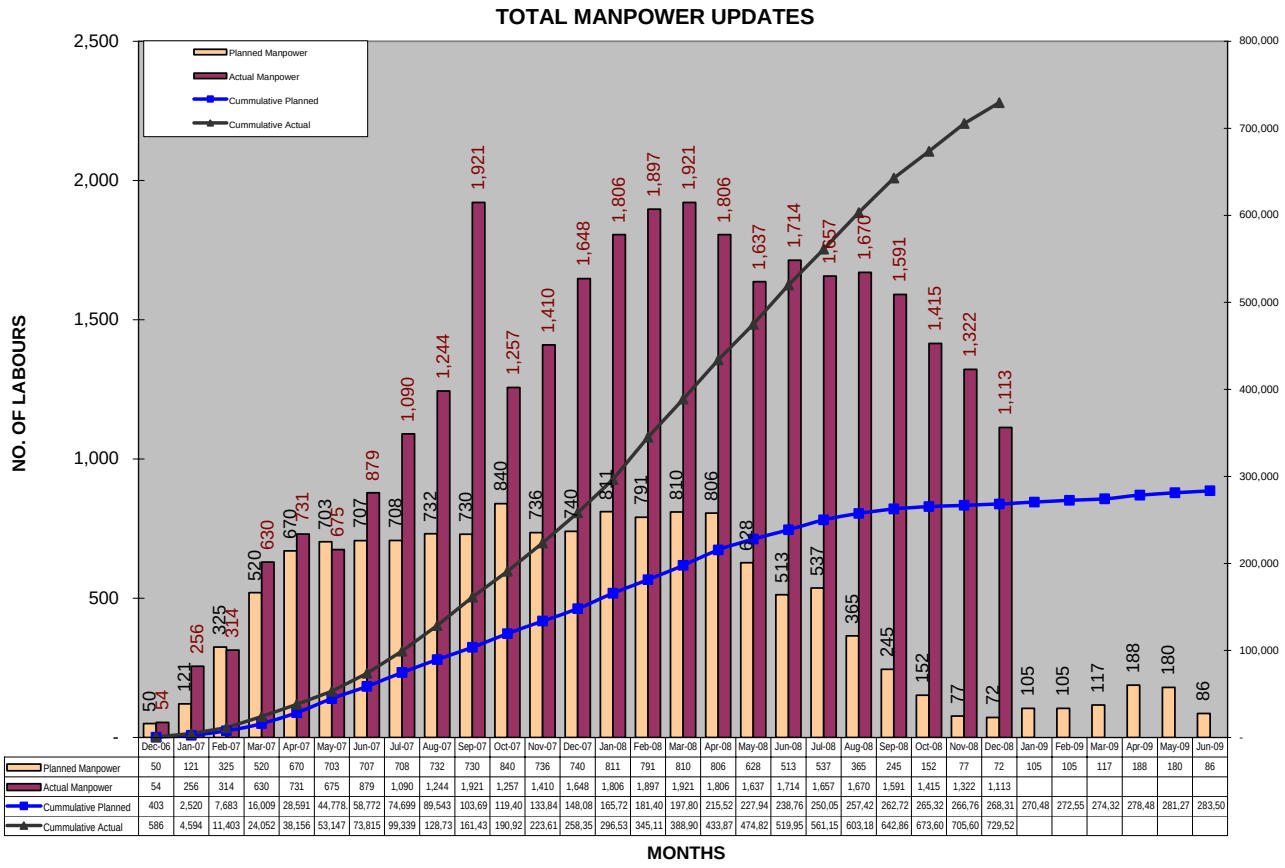
RESULT:

The result of these delays and plans for recovery by mitigation were affected due to non finalization of design and nomination of subcontractors.

5.3.2 RESOURCE MANAGEMENT ANALYSIS & RESULTS

The resources were deployed for works that were finalized and approved. However the works that were constructed were only related to the structure. All the finishes were on hold and could not proceed.

The resources were required for the finishing works but due to absence of any finalized design and details, the resources had to be demobilized from site. See(Figure no13)



	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09
Planned Manpower	50	121	325	520	670	703	707	708	732	730	840	736	740	811	791	810	806	628	513	537	365	245	152	77	72	105	105	117	188	180	86
Actual Manpower	54	256	314	630	731	675	879	1,090	1,244	1,921	1,257	1,410	1,648	1,806	1,897	1,921	1,806	1,637	1,714	1,657	1,670	1,591	1,415	1,322	1,113						
Cummulative Planned	403	2,520	7,683	16,009	28,591	44,778	58,772	74,699	89,543	103,69	119,40	133,84	148,08	165,72	181,40	197,80	215,52	227,94	238,76	250,05	257,42	262,72	265,32	266,76	268,31	270,48	272,55	274,32	278,48	281,27	283,50
Cummulative Actual	586	4,594	11,403	24,052	38,156	53,147	73,815	99,339	128,73	161,43	190,92	223,61	258,35	296,53	345,11	388,90	433,87	474,82	519,95	561,15	603,18	642,86	673,60	705,60	729,52						

(Figure no13) Case Study 2.- Resources

RESULT:

The sequence of works was seriously affected due to the non finalization of designs and subcontractors and hence resources became idle and had to be demobilized.

5.3.3 COST MANAGEMENT ANALYSIS & RESULTS

From the cost management perspective this situation had a serious impact on the cash flow of the project.

The delayed decisions slowed down the works and the non decisions made the works to come to a halt. Also, the client put a hold on the works as he was negotiating with a new stake holder and did not want to commit further funds to the project.

This affected the payments of many subcontractors and a cash flow crisis become apparent.

RESULT:

Due to the decision by the client to put the project on hold and hold the pending payments of all concerned , the cash flow was uncertain as many subcontractors were not sure when they would get their payments.

5.3.4 NOMINATIONS ANALYSIS & RESULTS

The nominations of the subconsultants, subcontractors were all delayed due to the delayed design finalization. The nominated items were also affected due to the delay and hold in payments.

Also,as a new stakeholder was likely to invest in the project,it was unclear what changes would be made to the project and what would be the impact of such changes.

RESULT:

The uncertainty due to lack of decisions and finalizations of nominations have resulted in all the plannned dates to elapse and thus resulting in furthur delays.

5.4 CASE STUDY 3

ANALYSIS & RESULTS

Value analysis is the title given to value techniques applied retrospectively to completed projects to analyze the projects performance and compare the completed versus the planned target.

5.4.1 PLANNING ANALYSIS AND RESULTS

The value for the schedule performance is that the project was completed as per the planned schedule and the handover process was done in accordance with the specifications.

Some additional works and modifications were taken up separately but it was made sure that the customers were not affected by the changes.

The value analysis for the current project performance is listed below

I)CLIENT:

i)The project was completed in time and increased the customers confidence in the project since they had taken premises and had further commitments.

ii)Credibility of the client has been greatly enhanced due to the timely handover of the premises to commence the institutions academic year.

iii)Client also has started generating income upon handing over to the respective customers.

iv)Customers will be confident of future projects by the client.

II)Consultant:

i)The Arabic architectural design has given a distinct look to the project and the project is a perfect blend of traditional design and modern amenities.

ii)The consultant's expert design and engineering staff played a major role in the success of the project.

iii)The consultant took up critical issues with the client in time and ensured the completion of works in line with the program.

III) Contractor :

i)The modifications & changes not having a major time impact were done within the project duration. Major changes were analyzed and time impact done to enable the client to know the time and cost impact and upon his approval of the same the works were executed.

ii)Since the works were of fast track nature, modern /innovative methods were deployed.

iii)Contractor was able to utilize his resources in an effective manner.

IV) Universities & Institutions:

i)Universities were able to commence as per the academic year.

ii)There was no financial loss as the project was handed over in time.

V) Students:

i)Students were able to join the new academic year.

ii)Students did not have to go searching for alternatives as the institutions were ready to commence.

iii)Hostel facilities wherever available were utilized.

VI) DEWA :

i)Power on was achieved in time to allow testing & commissioning

ii)Power on was achieved in time to allow the universities and institutions to commence successfully.

VII)INFRASTRUCTURE :

The infrastructure required for the access to the premises was provided and the overall infrastructure was completed in line with the requirements.

5.4.2 RESOURCES ANALYSIS & RESULTS

The resource analysis indicates that the since there was an initial delay, efforts were made by the client, consultant and the contractor to ensure that mitigating action was implemented.

Also, where it was not possible to mitigate, the client took decisions to allow the acceleration of works to ensure that the delays are recovered.

5.4.3 COST ANALYSIS & RESULTS

The cost analysis for project takes into consideration that the acceleration for some of the works were required such as long lead items and delayed decisions for critical deliveries.

Since the major decisions were taken within the required time frame it did not affect the cash flow drastically and the result due to mitigation and acceleration was indeed the success of the project.

5.4.4 NOMINATIONS ANALYSIS AND RESULTS.

The nominations and other client decisions were mostly inline with the baseline program of works as the client was interested in ensuring that there was no delay to the project. Also,

some delays and changes were actioned by the client on a priority to ensure that the work does not get affected and delayed.

This resulted in the project getting competed on time and ensuring the vision of inaugurating an important facility for the benefit of the people.

5.4.5 VALUE ANALYSIS

For this case study we will do a further analysis of values for various stakeholders of the project.(Table 2,3,4 & 5)

I)CLIENT RELATED VALUE ANALYSIS FOR SUCCESS RATE ACHIEVED(table2)

S.NO	CLIENT RELATED	SUCCESS RATE ACHIEVED
1	The project was completed in time and increased the customers confidence in the project since they had taken premises and had further commitments	AS PLANNED
2	Credibility of the client has been greatly enhanced due to the timely handover of the premises to commence the institutions academic year.	AS PLANNED
3	Client also has started generating income upon handing over to the respective customers.	AS PLANNED
4	Customers will be confident of future projects by the client.	MORE THAN PLANNED

(table2)CLIENT RELATED VALUE ANALYSIS FOR SUCCESS RATE ACHIEVED

II) CONSULTANT RELATED VALUE ANALYSIS FOR SUCCESS RATE ACHIEVED(table3)

S.NO	CONSULTANT RELATED	SUCCESS RATE ACHIEVED
1	The Arabic architectural design has given a distinct look to the project and the project is a perfect blend of traditional design and modern amenities.	AS PLANNED
2	The consultant's expert design and engineering staff played a major role in the success of the project.	AS PLANNED
3	The consultant took up critical issues with the client in time and ensured the completion of works in line with the program.	MORE THAN PLANNED

(table3)CONSULTANT RELATED VALUE ANALYSIS FOR SUCCESS RATE ACHIEVED

III)CONTRACTOR RELATED VALUE ANALYSIS FOR SUCCESS RATE ACHIEVED(table4)

S.NO	CONTRACTOR RELATED	SUCCESS RATE ACHIEVED
1	The modifications & changes not having a major time impact were done within the project duration. Major changes were analysed and time impact done to enable the client to know the time and cost impact and upon his approval of the same the works were executed	MORE THAN PLANNED
2	Since the works were of fast track nature,modern /innovative methods were deployed.	MORE THAN PLANNED
3	Contractor was able to utilize his resources in an effective manner.	AS PLANNED

(table4)CONTRACTOR RELATED VALUE ANALYSIS FOR SUCCESS RATE ACHIEVED

IV) VALUE ANALYSIS FOR SUCCESS RATE ACHIEVED FOR OTHER STAKEHOLDERS(table 5)

S.NO	OTHER STAKEHOLDERS RELATED	SUCCESS RATE ACHIEVED
1	Universities were able to commence as per the academic year	AS PLANNED
2	There was no financial loss as the project was handed over in time	AS PLANNED
3	Students were able to join the new academic year.	AS PLANNED
4	Students did not have to go searching for alternatives as the institutions were ready to commence.	AS PLANNED
5	Hostel facilities wherever available were utilized.	MORE THAN PLANNED
6	Power on was achieved in time to allow testing & commissioning	AS PLANNED
7	Power on was achieved in time to allow the universities and institutions to commence successfully.	AS PLANNED

(table 5)VALUE ANALYSIS FOR SUCCESS RATE ACHIEVED FOR OTHER STAKEHOLDERS

V)LISTING OF VALUES ATTAINED THAT WERE NOT PLANNED ORIGINALLY

I)A landmark project was completed in record time and was operational for various universities and institutions which were not expecting to visualize this impossible achievement.

II)Encouragement to dream higher and provide even better facilities for future developments.

A	CLIENT	
S.NO	VALUE	REASON FOR ACHIEVING VALUE
1	The project was completed in time and increased the customers confidence in the project.	Meticulous Planning and monitoring
2	Credibility of the client has been greatly enhanced due to the timely handover of the premises to commence the institutions academic year.	Ensuring all critical decisions were taken in time.
B	CONSULTANT	
1	The Arabic architectural design has given a distinct look to the project and the project is a perfect blend of traditional design and modern amenities.	The consultants portrayal of clients vision
2	The consultant's expert design and engineering staff played a major role in the success of the project.	Expertise in the field and experience.
C	CONTRACTOR	
1	The modifications & changes not having a major time impact were done within the project duration	Additional resources were deployed to achieve targets
2	Since the works were of fast track nature, modern /innovative methods were deployed	New methods/techniques helped to reduce time.
3	Contractor was able to utilize his resources in an effective manner	Better resource management
D	OTHER STAKEHOLDERS	
1	Universities were able to commence as per the academic year	Timely handover of project
2	Students were able to join the new academic year	Timely start of institutions
3	Power on was achieved in time to allow the universities and institutions to commence successfully	Rigorous follow up with authorities
4	The infrastructure required for the access to the premises was provided and the overall infrastructure was completed in line with the requirements	Proper coordination

REASONS FOR ACHIEVING THE RESULTS(table 6)

From all of the above we can analyze and conclude that all the high ranking values were achieved. The overall result value gained from the project is the successful and timely completion and handover of the project.

CHAPTER 6 :RECOMMENDATIONS AND CONCLUSIONS

6.1 INTRODUCTION

Recommendations for the delays of different project will be different. However some recommendations are similar which are related to the client and contractor. The recommendation for the client is that he should finalize the projects design before commencement of the works and should not make changes to the project unless it is absolutely essential.

The recommendations for the contractor is that the contractor should play a proactive and cooperative role in the projects to ensure its successful completion. Not withstanding the contractual claims if any, the contractor should make all possible efforts to complete the project on time.

The conclusions for the case studies are that the client are primarily responsible for the delays that take place in a project. This delay may be due late finalization for nominated subcontractors or non finalization of designs. The contractor should be also be involved in the process of selection of subcontractors as the ultimate responsibility of completion lies with the contractor.

6.2 CASE STUDY 1

RECOMMENDATIONS FOR CASE STUDY 1

1) The KPI's are the techniques which are applied in the Module 2-Strategy. I have applied this technique to identify the problem of delay in critical areas and provide the corrective actions based on the revised KPI's. The revised KPI'S will include additional parameters of monitoring on a weekly basis and a separate report to be generated to highlight the KPI's.

2) Based on the KPI's a weekly report on "Areas of Concern" is recommended to highlight all or any issue which may not be even part of the reporting system but it can be included.

3) The delay in nominations have led to delay to the project. I have applied the principle of regression analysis to indicate how the project would fare at the current rate of progress and the alternative of how to recover the delays.The regression analysis includes the mitigation efforts which indicates that the delay will be reduced from 10 months to 4 months, thereby achieving a recovery of 6months on the overall completion of the project.

4) A new list of KPI's to be generated based on the current delay and status of works.

5) Any pending design for the project should be completed within a fixed timeframe.

6) The delayed nominations should be done at the earliest.

7) The client should give decision making to a single point of contact rather than routed through the consultants, then the project management consultants and then to the clients.

8) A detailed recovery program of works should be prepared including all activities and it should be monitored and updated on a weekly basis.

9) A detailed manpower histogram should be made for all the works including subcontractors with productivity analysis.

10) The delayed nominated subcontractors should be given accelerated completion dates.

11) All the critical /delayed activities should be accelerated and duration of activities to be reduced by deploying additional resources

12) The option of working in shifts will allow better productivity and enable more workfronts for all subcontractors.

CONCLUSIONS FOR CASE STUDY 1

The conclusions for the problems faced by the aluminum/ glazing company is as follows:

✓ PLANNING CONCLUSIONS :

1) Since, there is a Joint Venture with the client, the aluminum /glazing company is assuming that there will be no penalties/liquidated damages applied and it appears to be resulting in a laid back approach.

2) Without proper planning and program, no project should be taken.

✓ RESOURCE MANAGEMENT CONCLUSIONS :

1) Resources should be planned at the tender stage with firm commitments from available sources.

2) Resources can be taken from different sources/ companies /subcontractors to allow the works to be carried out to mitigate the delays.

3) Specialist training to manpower should be provided as efficient manpower will be able to deliver increased productivity and outputs.

✓ COST MANAGEMENT CONCLUSIONS :

1) The completion of the project with the mitigation and acceleration has resulted in a cost saving as more delays would have meant that the budget would go out of control.

2) The cost for the works should include additional provisions for subcontractors if the product is likely to come from abroad to take care of any inflation or fluctuations in currency.

✓ NOMINATION CONCLUSIONS:

1) Nomination of subcontractors has to be done on time to prevent any delays.
2) Nomination of subcontractors with proven track record should be insisted.

6.3: CASE STUDY 2

RECOMMENDATIONS FOR CASE STUDY 2

1) The client should finalize the designs before commencing the project including finalization of the concept design ,consultants , specialist sub consultants and contractors.

2) The resources deployed to carry out works which were later changed meant a loss of time and money.All details should be finalized before commencement of works.

3) As seen from the updated manpower histogram (Attachment no 11)a lot of manpower was wasted in unproductive work and idle labour. Efforts should be made to ensure that the planned productivity for all resources in achieved.

4) In the event of a project being put on hold it is advisable for the concerned parties to prevent further investments.

5) The client may end up losing more money if he does not finalize with the new stake holder.

CONCLUSIONS FOR CASE STUDY 2

✓ PLANNING CONCLUSIONS :

1) The primary objective of completing the project on time did not happen and there is an uncertainty of completing the project itself hence this project can be termed as a failure from the planning point of view.

2) It can also be concluded the client was unsure of his objective.

3) It can be concluded that the client commenced the hotel project without any market survey or without any basis of supply and demand.

4) Since the project was to be handed over to an operator the client appears to be having little experience in the hotel industry.

5) Due to the delay and project being put on hold,the reputation of the client would be badly affected.

6) The procurement system and contract in Module 5 –Commercial and Procurement has helped me in identifying the problem that the client has not chosen the proper form of contract for this project. The contract should not have been the bid and construct type but it should have been the cost + profit contract project. In this case the client and the designers could have given all the details as per the requirements. It has been recommended that to reduce the delay all the nominated contracts should be allocated to the main contractor who will propose the new required dates and bring three proposals for the client to decide in line with the revised program.

- ✓ RESOURCE MANAGEMENT CONCLUSIONS :

1) The material resources deployed for the project are not fulfilling their objective as the project is not complete.

2) The idle manpower resources could have been deployed in a better manner.

- ✓ COST MANAGEMENT CONCLUSIONS :

1) Clients should have enough funds to complete a project if a financial crisis affects the system.

2) The client should allocate funds in line with the cash flow requirement.

- ✓ NOMINATION CONCLUSIONS:

1) The nominations for the subconsultants was delayed and hence affected the coordination with other services.

2) The nomination of the interior designer was delayed which suggested changes to the interiors of the project thereby ending up in a conflict with the lead consultant.

3) The nomination of subcontractors for various packages were delayed for lack of design and details which affected the works.

6.4 CASE STUDY 3

RECOMMENDATIONS FOR CASE STUDY 3

1) Since the project was completed on time,the main recommendation is that all the stakeholders have to contribute as a team to ensure the success of any project.

2) The contractors should play a positive role in the project and do all possible measures to mitigate any delays that is possible by resequencing of work, deputing resources effectively.

3) The client should appreciate the contribution of the consultant and contractor to achieve the milestone as sincere efforts often go unrecognized.

4) The client should try and freeze the project before commencement to avoid any delays although it is impossible to predict if & when the changes may occur.

CONCLUSIONS:

✓ PLANNING CONCLUSIONS :

1) The project was completed as per the planned schedule and the handover process was done in accordance with the specifications.

2) Some additional works and modifications were taken up separately but it was made sure that the customers were not affected by the changes.

3) The project was completed in time and increased the customers confidence in the project since they had taken premises and had further commitments.

4) Even though the Arabic architectural design was difficult to achieve in a short span of time,it has given a distinct look to the project and the project is a perfect blend of traditional design and modern amenities.

5) The consultant's expert design and and the contractors engineering staff played a major role in the success of the project.

6) The consultant took up critical issues with the client in time and ensured the completion of works in line with the program.

✓ RESOURCE MANAGEMENT CONCLUSIONS :

1) The modifications & changes not having a major time impact were done within the project duration. Major changes were analyzed and time impact done to enable the client to know the time and cost impact and upon his approval of the same the works were executed.

2) Since the works were of fast track nature, modern /innovative methods were deployed.

3) Contractor was able to utilize his resources in an effective manner.

- ✓ COST MANAGEMENT CONCLUSIONS

1) Universities were able to commence as per the academic year thereby generating revenue.

2) There was no financial loss as the project was handed over in time.

3) Students were able to join the new academic year and did not have to go searching for alternatives as the institutions were ready to commence thereby allowing them to save.

4) Hostel facilities wherever available were utilized as outside facilities would have proven expensive and traveling would have been time consuming.

- ✓ NOMINATION CONCLUSIONS:

1) Credibility of the client has been greatly enhanced due to the timely handover of the premises to commence the institutions academic year.

2) Client also has started generating income upon handing over to the respective customers.

3) Customers will be confident of future projects by the client.

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APPENDICES

APPENDIX 1:

Steve Bauld, Kevin McGuinness.(2008) Yours, mine, ours: Offloading all risk risks raising the price*. . Summit. Ottawa: Jan/Feb 2008.* Vol. 11, Iss. 1; pg. 10, 2 pgs

Governments - despite being large customers - generally pay more for what they buy than the private sector. One possible reason may be the growing tendency to allocate all risk to the supplier rather than determining what is yours, theirs and should be shared. This is particularly evident in the area of construction procurement where many risks must be allocated between the parties including design, environmental, weather, planning, labour-relations and labour availability related risks.

Understandably a municipality would want to insulate itself against such risks to the maximum extent possible, particularly where the project involves a type of construction with which the municipality has little experience. Limited relevant experience is common since many construction projects contemplate one-of-a-kind facilities - at least from the municipality's perspective. The goal in allocating risk to the contractor is to secure "price certainty," but arbitrarily allocating risks to the contractor becomes a serious risk to the buyer.

In a construction project, risk may be defined as the possibility of economic gain or loss relating to a particular aspect of the construction process. Every risk has an associate cost that must be borne by one party or another. Every risk assigned to the contractor will increase the price charged to the buyer for the project. Simply stated: Price to the customer = supplier's cost of supply + risk assumed by the supplier + profit.

Moreover, current market conditions within the construction industry may worsen the problem. Price competition is limited in a seller's market, which means that the buyer will likely pay a hedging cost when risk is assigned to the contractor. If the probability of a particular type of risk arising is low, then the cost of having the risk assumed by the contractor is likely to be disproportionate to the benefit obtained.

Many uncertainties arising from construction (such as hidden site conditions and weather related risks) present risks that contractors are in no better position to manage

than is the owner. Some risks are more easily dealt with by the owner than by anyone else, such as design related risks where the contractor is not the designer, as well as risks relating to factors within the owner's control such as delays resulting from site inspection by the owner's consultants.

Ideally, the risks in a construction project will be divided among the stakeholders - owners, design professionals, other professionals and contractors - on the basis of who would best manage the risk in question. The term "manage" means to anticipate, price for, and avoid or mitigate the risk. Government contracts often assign risk with little consideration of best management. For instance, where a municipality reserves the right to vary the volume of supply (in a contract for goods or services), or to terminate the project - a decision that is entirely within the municipality's control - additional risk is created for the supplier. Even though the risk of the municipality buying less than the original order is slim, suppliers naturally increase the price to reflect that risk.

To avoid paying more as a result of unrealistic or uniformed approaches to risk allocation, it is important for municipalities to access and gain a greater understanding of the range of risk allocation alternatives available within the construction market. A variety of alternative project delivery systems have evolved to reduce the owner's risk exposure and when employing one of these standard models, risk will be allocated in a rational manner.

In the traditional government-construct approach design deficiencies and changes pose a high risk to the owner. Under a construction management approach, the construction manager (CM) assumes some of these risks. If the project is completed successfully, the CM is compensated for assuming and managing the risks in question. In a design-build arrangement, more risk is allocated to the contractor since the contractor takes responsibility for design. However, the "price" to the owner is that the owner has less control over the design process and must detail its project specifications to a far greater extent. Problems arise when a contract is written that gives the municipality the best of all worlds.

Some aspects of risk allocation appear relatively uniform, irrespective of which project management system is employed. Growing evidence suggests that risks relating to forces majeure events are best shared between the contractor and owner. In some cases, risk is best insured (e.g., in relation to property damage). A realistic approach entails identifying which party's insurers will provide insurance at the lowest cost.

The assignment of risk for design adequacy varies depending on the type of delivery system. In traditional design-bid-build, the owner warrants the adequacy of the design and can manage that risk through retaining a highly qualified design professional and providing adequate scoping information and fair compensation.

Unrealistic allocation of risk also gives rise to hidden costs, such is reducing both the number and quality of those who will participate in the competitive process: Frequently, the contractors best placed to deliver the construction project on time and within budget (and who naturally seek to avoid taking on high-risk work) will elect not to bid for the contract. These suppliers are also the least likely to perform their work badly. Unrealistic allocation of risk may limit the municipality to second (or lower) tier contractors and may also increase the risk of deficient performance.

Many municipalities tend to over-focus on the price of a contract, undermining efforts to allocate risk responsibly. Where a low bid is received from an inexperienced or smaller contractor, the bidder may lack the financial resources to absorb the risks allocated to it, should they arise. A low bid may mean that the contractor who submitted the bid did not realistically assess the risks associated with the contract. Should serious problems occur, the municipality will receive a claim. While it may be entitled to reject that claim under the terms of the contract, the contractor may then cease to perform or go out of business. Even if costs are successfully passed back to the contractor, any hope of an on-going cooperative relationship will evaporate, resulting in unanticipated cost consequences in terms of reduced quality, late completion, and reduced building functionality as well as probable increased legal costs.

Do not assume that a court will accept an unreasonable allocation of risk. The court may read down what it considers to be unreasonable contract conditions, particularly where the allocation of risk was hidden under a blanket of lengthy and detailed contract provisions. For instance, if on a design-build project the terms of the contract appear to pass to the contractor the responsibility for any errors in the municipality's own performance specifications or design criteria, the court may disregard the strict wording of the contract, unless this unusual allocation of responsibility was made clear to the contractors bidding for the contract.

Municipal owners need both to understand and evaluate their selected project delivery system so as to identify and allocate appropriately each risk relating to a given contract. The system selected should be chosen based upon a careful evaluation of its compatibility with the municipality's needs, priorities, and capability. Risk may often be dealt with effectively by building into a contract incentive plans that contemplate payments tied to the successful management of specific risk consequences or conditions.

The risks related to a contract are efficiently allocated when each of them is assigned in the manner that will lead to the lowest aggregate cost to the parties. A number of common mistakes in construction contracting in relation to risk that tend to lead to higher prices for government work include:

* The assumption that risk under a construction contract may be efficiently allocated in the same manner as under a sale of goods contract. Numerous differences between sales and construction contracts make a typical sales allocation an inappropriate model for construction. In a sales contract, an existing product is sold to a customer and the actual performance capacity of that product is known at the time of delivery. Construction deals with the sale of a future product and eventual performance may only be estimated. Timely delivery of construction products cannot be estimated with the same precision possible with those goods produced on an assembly line basis.

* The use of a tender or RFP process lends itself to a situation where, as part of the contract documentation, risk is allocated by municipal "back office" staff who may well have too little understanding of the price implications of the allocations made. In contrast to the private sector, there is little opportunity in a contract competition to negotiate a more efficient allocation of risk.

* Time is often of the essence in government. Where a municipality insists that the contractor complete within a rigid deadline or pay a liquidated damages penalty, the contractor will factor the anticipated penalty for delay into the price that is bid. The result is that the municipality pays a higher cost for construction, even if the project is completed on time. The extra cost is hidden - unless one compares public sector costs with private.

* Certain types of construction models increase the risk level to both parties. For example, where a long-term commitment (e.g., an extended warranty) is introduced into the construction process, the level of risk is increased, inevitably increasing the price of the contract.

At the end of the day, municipalities (and other governments) may be large customers, but they are only customers. Contracts that look good from the customer's perspective are not necessarily contracts that work in the customer's best interests. Arriving at a fair allocation deal usually proves more economical than a one-sided deal.

Appendix 2

An article by Werner Sabo and James K. Zahn, "When Owners Hire Separate Contractors" (The Construction Specifier, Sept. 2003; Alexandria, Va; 800-689-2900; www. constructionspecifier.com), spells out what architects need to know.

American Institute of Architects (AIA) Document A201 1997, General Conditions of the Contract for Construction, speaks directly to this issue:

* 6.1. Owner's Right to Perform Construction and to Award Separate Contracts.

* 6.1.1. The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and to award separate contracts in connection with other portions of the Project or other construction or operations on the site under Conditions of the Contract identical or substantially similar to these, including those portions related to insurance and waiver of subrogation. If the Contractor claims that delay or additional cost is involved because of such action by the Owner, the Contractor shall make such Claim as provided in Paragraph 4.3.

This affirms the owner's right to hire contractors or use in-house personnel to do some of the work. It also acknowledges the contractor's right to recover costs related to any delays or incurred because of the owner's contractors.

A second paragraph asserts that the GC is covered by the same general contract conditions that apply between the owner and separate contractors:

* 6.1.3. The Owner shall provide for coordination of the activities of the Owner's own forces and of each separate contractor with the Work of the Contractor, who shall cooperate with them. The Contractor shall participate [both] with other separate contractors and the Owner in reviewing their construction schedules when directed to do so. The Contractor shall make any revisions to the construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, separate contractors, and the Owner until subsequently revised.

The first sentence clearly spells out that the owner-not the contractor-is responsible for coordinating the work of the separate tradespeople. The paragraph also makes clear that while it's the general contractor's job to cooperate with all the workers, the GC is not responsible if those workers do not complete their work properly : That's the owner's responsibility.

A/Es need to inform owners of that fact. Many inexperienced owners mistakenly think the relationship between the GC and the separate contractors is the same as the usual contractor-subcontractor relationship. Unless they are told otherwise, these owners also assume the GC oversees all the work of the separate vendors and is responsible for guaranteeing the proper execution of all the work.

That's not the way it's done, contend Sabo and Zahn. Often it's up to the architect to inform the owner that the GC's only obligation is to (1) give separate contractors an opportunity to do their work and (2) to coordinate vendors' schedules. In other words: If a separate contractor fails to complete the job satisfactorily, it's the owner's problem-not the general contractor's.

An easy way to explain the situation is that an owner becomes, in effect, the general contractor when choosing to hire separate contractors, taking on all the GC's obligations to

coordinate the hired contractors. One solution is for the owner to hire a construction manager (CM) to supervise the separate contractors. But hiring a CM can quickly gobble up any savings the owner hoped for in the first place. And if separate contractors fail to perform their duties, any other savings might have to go toward claims and lawsuits.

Of course, A/Es need be cautious when advising owners about using separate contractors, stress Sabo and Zahn, lest it be interpreted that they are recommending the practice. This will not be a problem when the owner is experienced and has handled many projects. But should an A/E recommend to a less experienced owner to use separate contractors, and then no cost savings result, or, worse, arbitration or litigation occur, the owner may hold the A/E responsible and demand that the A/E pay some of the unexpected costs.

As with every aspect of a building project, all the risks and rewards should be thoroughly discussed with the owner, and a written record of the discussion should be filed with project correspondence. Establishing a paper trail is always a good practice.

A/Es have traditionally disliked the use of separate prime contractors. But they are required to do so, for example, under New York State's Wicke's Law, which calls for separate prime contractors for HVAC and structure on public work. Attempts to abolish Wicke's Law on the grounds that it adds complexity and cost to projects have proven unsuccessful."

APPENDIX 3

Halil Shevket Neap*,* Seran Aysal(2004),. Owner's Factor in Value-Based Project Management in Construction.*Journal of Business Ethics.* Dordrecht: Mar 2004. Vol. 50, Iss. 1; pg. 97

"Owner/client is a significant contributing party within the management of a project in construction. In addition to the payment of the bills related to the project, owner/client has duties and responsibilities such as selecting the professionals, making his requirements understood clearly by other parties, making decisions to recommendations and placing orders. Owner/client has to perform these duties and responsibilities at the right times and in correct ways to have the required quality and value for his/her investment. In performing his/her duties and responsibilities owner could introduce positive and negative contributions to the value of the constructed facility. Value-based project management concerns with owner's/client's value system and helps owner/client in performing his/her duties and responsibilities for the optimum positive contributions to the value of the constructed facility in construction. This paper highlights the principles of value-based project management in

construction and investigates the impact of owner contributions to the value of a constructed facility in practice.

A construction organization is an open system organization that accepts its input of human resources, materials, money, machines, all the information including owner's requirements, rules and regulations, and transforms them into a constructed facility (Pilcher, 1992, pp. 8-11). The owner-entrepreneur is seldom familiar with the details of the building industry; he is uncomfortable with the risk in the building cost projections; he wants to manage the expose within the narrowest limits available (McNulty, 1982, p. 32). Owner is a party who contributes significant input to the construction organization.

Owner therefore is not just an investor but also a significant contributing party within the organization. In addition to the payment of all the bills, owner has duties and responsibilities such as making his requirements understood clearly by the other parties, selecting the designers and advisers, making decisions in selection of contract options, selecting the contractors, making decisions to the recommendations and placing orders. Owner has to perform these duties and responsibilities at the right times and in correct ways and together with the best endeavors of the professionals and contractors, owner would have the required quality and value for his investment. The direct commitment of the client is one of the crucial determinants of success (Dodd, 1990, p. 394). Creative and innovative solutions are expected from client analysts, advisers, and consultants, from within and outside the construction industry (Smith and Love, 2001, p. 71). Because of limited human resources, owners have to re-evaluate both the timing and level of their involvement in the capital project delivery process (Anderson and Patil, 2001, p. 77). There are numerous alternative contractual approaches for the owner to choose to bring together interesting parties to form a team for design and construction of a project. In all types of the contractual relationships there are significant disadvantages adversely affecting the achievement of good management. As a result of this owners are suffering from many problems such as increasing costs, not getting the quality and value for their investment and dissatisfaction of the design and the finished product.

This paper investigates the significance of the involvement of the owner in construction management and examines the importance of his/her contributions. It aims to highlight and test in practice, through surveys, the principles of value based project management in construction and investigates the impact of owner's contributions to the value of a constructed facility.

Owner's duties and responsibilities:

Implementation of a construction project is a complicated and complex process as it requires the contribution of different parties, successfully selecting best materials among a

large range, using suitable methods and having capable labor and good supervision. Owner, whether public or private, is the initiating party that owns and finances the project, either from owner's resources or from external financing. The owners of the construction industry are many and varied. They include the public sector bodies such as central and local government and private companies involved in building for domestic, commercial, industrial and retailing purposes (Clough, 1981, p. 3).

First requirement of the owner is to establish his needs and objectives and clearly express them to other parties. This provides a focus for scope definition, guides the design process, and influences the motivation of the project team. The process of setting objectives involves an optimization of quality, cost and schedule. Owner's objectives must be clearly communicated and understood by all parties, and serve as a benchmark for the numerous decisions that are made throughout the duration of the project. The process of identifying owner's needs and objectives require the involvement of a wide range of people within the owner's organization (Oberlender, 1993, pp. 20-21). Owner must clearly develop or agree to a delineation of the responsibilities borne by all members of the project team. Each must understand his/her own responsibilities as well as the extent of responsibilities delegated to the others (Barrie, 1992, p. 171).

Owner's major duties and responsibilities in construction are:

* Identifying his/her requirements and objectives.

* Expressing clearly his/her requirements and objectives to the other interesting parties.

* Determining the overall project budget.

* Selecting designers, advisers and contractors.

* Making decisions to the recommendations.

* Providing coordination for the project.

* Making the final decisions.

* Setting criteria about total budget, payments and project end date.

* Placing orders.

* Paying all the bills as per the requirements of the project.

In construction management, owner therefore is not just an investor but also a significant contributing party from the concept till completing stage of a project.

Appendix 4

According to Casinelli(2005), Project Schedule Delay vs. Strategic Project Planning**.***AACE International Transactions.* Morgantown: 2005. pg. PS191, 7 pgs.Available from: http://proquest.umi.com

"The study regards the problem of schedule delay of construction projects with specific regard to US government projects in Italy. The analysis is undertaken from the owner point of view, as the final purpose of this paper is to identify corrective actions that could be implemented by the owner.

The experience of showed that many projects suffered of schedule delay and that delay mostly occurred during the "initial phase" of the projects, covering a period from five to seven months from contract award. The difficulties to maintain the schedule, since the early stage of project development, create the basis of future problems that will cause further "schedule delay". In fact the contractor is called to prepare "aggressive" recovery schedules, since the early stage, that have an high probability to fail for a combination of factors, as described in the paper.

The study analyzes the factors causing schedule delays and suggests guidelines that, in the opinion of the author, could mitigate the problems of schedule delays and improve the control of schedules for similar US government projects in Europe. Although the study refers to the case of US construction projects in Italy, the author believes that the conclusions may be of general interest for project management.

Schedules fail for a combinations of factors, most of them might addressed by the owner by undertaken an effective strategic project planning before the tender phase, thus during the pre-planning phase.

The guidelines are based on a key concept: a different role of the owner who becomes an agent of project management development:

* by driving the contractor to make its strategic choices at earliest stage of project development and,

* by driving the contractor to the implementation of effective methodologies and techniques of project planning and control.

Schedule delays and costs overrun are matter of concern for the owner as well as for the contractor; the problems refer the area of project delivering methods, with special attention to the international projects and the bidding strategy. Managing projects overseas, in an international environment, requires a different approach to tender and select the contractor; surely it's necessary "breaking the low-bid paradigm" [1] and promote criteria based on the "best value" bid.…The project control of the construction phase, from the owner point of view, starts during the tender | phase. The goal is to lead the contractor to the earliest setting up of the project organization and to the most effective project planning. The solutions proposed (in the form of "guidelines") are based on three set of corrective actions, that can be implemented independently; all of them require a more active role of the owner who becomes the real "engine" for the development of the project management.

Action 1: The contractor should be driven and supported in order to anticipate some critical choices regarding the project organization at the time of bidding preparation and to implement the best practices and techniques of project scope definition and planning.

Action 2: Improve the planning and scheduling activity of the contractor during the execution of the works.

Action 3: Adopt two types of contracts; "reimbursable" for the project management staff of the contractor (indirect cost) and "lump sum", fixed price, for construction works (direct costs).

Actions 1 and 2 must be translated in specific contract's obligations, respectively through "instruction to bidders" and through the integration of the P&S-CS. Action 3 could be limited to the most critical and important projects.

PRACTICAL GUIDELINES

Action 1. Organization and Planning This action has two goals:

* forcing the prospective contractor to the earliest project planning (front end-planning) [5 and 7]

* giving evidence of the clear understandings of "scope of work" and of the contract's requirements.

Practical Guidelines.

* Project key personnel presented by the contractor must include the certified engineers/architects in charge of the submittals preparation; even and especially if these activities shall be undertaken by the subcontractors, as this is a widespread practice.

* Selection of subcontractors: key subcontractors must be selected by the contractor during the bid time and declared in the offer. This is critical because the project startup require the early mobilization of specific subcontractors as well as early submittals.

* The Bid's projects schedule must be "tied" to the baseline project schedule through the "front end schedule". This requires that owner imposes a bid schedule including a detailed front-end schedule covering the "initial phase" of 90-120 days after contract award, that must be used as basis to develop the project baseline schedule. The front-end schedule must contain all critical preliminary activities.

* The owner should impose the use of a WBS (work break down structure) and of a CBS (cost break down structure), in order to get the full integration among the bid's cost estimate, the project budget and the structure of project planning and scheduling.

* The owner should develop a basic WBS (contractual WBS: CWBS) and the contractor should be asked to develop further details (i.e. the further levels of WBS), in order to drive the contactor to give evidence of the understanding of the scope of work.

* Temporary engineering task force , based on site, provided by he owner to facilitate the early submittal process. This will facilitate the "contractor mobilization" in order to get the earliest approval of critical Key documents (quality control plan, submittal register, baseline schedule, safety plan, foundations and shop DWGs etc.) and key submittals (concrete mix design, underground utilities piping etc.).

* The bidder should address all above issues in the Project plan; specific details regarding the content and format of this key document should be included in the "instruction to bidders".

Action 2. Improving Planning and scheduling specifications This action has two goals:

* Facilitating and driving the contractor to undertake an effective project planning (Fig.1) at early stage and the best development of the baseline project schedule; and

* improving the schedule control with emphasis on the process of schedule update.

Practical guidelines.

* Contractual WBS (CWBS) in order to facilitate a common framework among different projects of owner's portfolio and drive contractor to set up an effective structure of multilevel schedule.

* Multilevel schedule: master schedule, summary and detail schedule.

* Schedule control: the process should be improved in regard to the procedures for schedule updating.

Action 3. Different Contract Arrangement

This action has the goal to guarantee that the contractor select skill resources and set up a project management team fitting the project's needs. The analysis presented has pointed out the importance of the Contactor's capability and competence; a different bid strategy, based on the scheme of "Best Value" of the offer rather than based on the paradigm of "Low-Bid", should surely facilitate the delivering on time of the most important

projects. A different and intermediate solution, to be explored, could be based on two different arrangements of Contract for the same project:

* "Reimbursable" for the project staff of the contractor.

* "Lump-sum" for the construction works.

This solution would lead to two main advantages:

* To allow the owner to verify and control, since the bidding stage, the staff contractor intends to "mobilize" to manage the project, guarantying the owner in concerns of the right skills and competences of the selected personnel.

* To guarantee the early set up of project organization, that is so critical to properly start up the project.

The absence of a structured and comprehensive project planning since the early stage (front-end planning) leads the contractor to undervalue both the Scope of works and contracts requirements. Lack of project skills, poor knowledge of project management methodologies and practices are the real limits that avoid better performances.

To facilitate the "project start up", so critical for the success of the project, the owner should force and drive the contractor to make some "critical choices" during the study and preparation of the bid. The owner should integrate his role, becoming an "agent of project management development", playing a more active role targeted to provide methodological support to the contractor. The final goal is to drive the contractor to the early project planning , providing guidance and means for the most effective implementation of project management methodologies."

Appendix 5

- James E Baar. (2002) Project planning: A great communicator. *AACE International Transactions.* Morgantown: 2002. pg. PS11, 5 pgs.

""interactive planning." It is the facilitated process, in a group forum, of an integrated project schedule, which highlights logic through work processes, defines key constraints, defines key milestones, and last but not least, identifies major issues that may affect the project.

The work process is referred to by the acronym "IAP," for interactive planning session. The IAP is a collective effort by the client and key team members to develop a project execution schedule. The word interactive is the key that opens up the communication that allows this concept to be highly effective. See figure 1.

The IAP session's key goals include the following.

* Develop a realistic integrated schedule based on real work process steps and realistic durations. The outcome of IAP provides schedule milestones for the project.
* Facilitate "buy-in" from the project team members. Each team member gets to plan his/her own tasks and comment/interact with the rest of the team, with respect to their needs to achieve their plan. The schedule is not developed independent of the team.
* Define those major issues that have significant impact on the project. These are risk issues and can include a permit, longduration deliveries, release of funding, or personnel resources (for example, can the client provide the reviews required to keep the project deliverables moving?).

At the end of the session, what are the issues? Who holds the action item? What and where are the schedule risks?

Listed below are what the IAP session concept requires of the participants.

* Commitment: giving your best, and doing what you say you are capable of and committed to make happen.
* Trust: must be willing to say what you believe or state your concerns. State your reasons, knowing that the other participants respect and desire your honesty and concern for the project.
* Knowledge: this planning effort requires the participants to understand the project and the discipline work deliverable process, also referred to as work flow. This requires not only knowledge of interdiscipline work process but also intradiscipline work process that in reality sequence work deliverables.
* Project scope: a subset of knowledge, but the focus is understanding what the project entails, along with the technology, size, complexity, etc.
* Listening: paying attention to the "whole" conversation. You are there to participate. Listening and understanding the discussion is critical, since it may apply to or affect you.

Therefore, you might ask, what does the interactive planning concept provide to the participants.

* Team "buy-in": as the saying goes, it will take a team to create/make a project happen. The team that shares what it knows develops the plan together, and therefore, "buy in" to the plan.
* Open communication: everyone who participates in the IAP has an equal opportunity to share his/her expertise, concerns, and knowledge.
* Respect- all participants share, and their information is given the same importance.

RESPONSIBILIES

Responsibilities can and will vary based on the phase of the IAP and the participants.

Generally, the project manager will coordinate and define the goals, and establish the who, what, where, when, why, and how issues.

The disciplines bring their expertise to the IAP. They must be prepared and understand the workflow process.

Materials management personnel offer bid/buy cycles/timing as well as fabrication/ship times of major equipment/materials. If there are subcontracts, similar expectations are expected.

The construction manager brings the construction plans and constructability issues to the IAP. Preplanning is essential.

PRE-IAP DELIVERABLES

To support in the preparation of the personnel who will participate, the following deliverables are typical.

Listing of key client milestones that the client has set. These milestones set the initial schedule goals of the project.

The rough plot plan (general arrangement) includes area designators, if applicable. What is the footprint? This provides an initial picture of project size, complexity, large equipment placement, and schedule sequencing concepts.

The scope definition concerns what the project is all about... capacity? Location? Is it a greenfield project? Retrofit?

PFD/P&ID counts and status: this is critical to understand up front. PFD and P&ID status are knowing what levels are complete or have to be completed and the approval cycles (engineer and client). As process will drive the project, the status (scope) and timing are critical before entering the IAP

The equipment list should include sizing and weights, especially on the large pieces.

The subcontracting plan is a listing of potential subcontracts; scope is an absolute. Knowing how engineering and procurement must support construction helps in the preplanning thinking.

The deliverables must support the goal of the IAP. Remember, an IAP session may be used to plan a study, in the preliminary engineering phase, or during construction. As such, set the deliverables to meet the function. The key is to determine if the deliverables bring out the participant's expertise in the IAP meeting. See figure 2.

IAP SESSION

The IAP session is itself a "mini-project." As such, I cannot emphasize enough that the degree of planning and communication that is put into the IAP follows the old cliche, "good planning followed by good communication" means a great IAP outcome. The IAP session is

made up of three major phases, the pre-interactive phase, the IAP session itself, and post IAP activities.

THE PRE-INTERACTIVE PHASE

The project manager, the project controls manager, and the planner scheduler plan the IAP session.

Define the length of the overall schedule and the divisions (weeks, months, etc.). This sets the outline to print the LAP work schedule. The sequence of the presentations by each discipline are usually organized from the top down. See figure 3.

Define the scope of the IAP. Is this only a study? Is this preliminary engineering? Is this only engineering and procurement? Or is this a full engineering/procurement/construction approach?

Ensure that the deliverables are provided to the IAP participants. This information should be handed out a few days before the session to allow personnel time to review, discuss, and think through the IAP needs.

Each discipline group will receive a specific colored sticky note pad to write out their planning activities. Having a specific color for a discipline allows chart visibility as discipline schedules are developed.

Has the project manager discussed the goals and expectations with the client? This is critical so that client personnel can readily be a part of the session and participate frilly in the IAP. The client also has a particular colored sticky pad for client-related activities that affect the schedule.

THE IAP-GUIDELINES TO SUCCESS

The IAP will only be as good/informative as the issues are discussed. Therefore, one discussion at a time (no sidebars). If everyone is listening to the discussion, the focus is better, and the level of interaction goes up.

Make sure the IAP session fully identifies the client's needs.

* Document review/approval times.
* Outage plans (when and length).
* Tie-in issues (type and length of time).

Keep in mind holiday schedules, especially if critical schedule deliverables and/or activities happen in and around them.

Do not linger on one issue! Remember, there is a time limit to establish the IAP.

You can go back and revisit a discipline or group if information now presented can cause impacts.

* Maintain an action item list and a critical issues list.

POST-IAP ACTIVITIES

Now that the IAP is completed, there are some actions to be taken. The IAP is used by the planner/scheduler to develop the project schedule. The IAP provides the basis for a level II scheduling effort leading to the level III schedule.

Issue the action item list and IAP notes (especially the critical issues list). Determine if a short revisit to the IAP schedule is needed to resolve open issues.

Now that we have an understanding of the concepts for the IAP, let's discuss the approach to how to actually run the IAP. A format for the wall chart is shown in figure 3. The time scale has been set per the client's goals, and the format on the left edge is set to direct the flow of the discussion.

The work sequence, better known as the workflow process, is the key. As the IAP can be applied to any phase of the project, the focus and needs are different for each phase. In all cases keep in mind the work process. Remember, left to right planning is a must.

While this discussion has focused on industrial projects, in essence the IAP session can be applied to any type of industry/project/phase/size. Identify the scope, identify the deliverables that provide definition, and set up the strategy in which the IAP will be sequenced. Then do it!

The interactive planning session as a planning tool is not a one-time occurrence. Projects usually have phases. Therefore, it is recommended that there is an IAP for each phase. This step procedure allows the project team to take the knowledge from the phase they are in and apply this learning in the preceding IAP to redefine the project schedule."