ISTANBUL KULTUR UNIVERSITY
INSTITUTE OF SCIENCES

A PROPOSAL FOR A TIME EXTENSION SPECIAL PROVISION FOR USE WITH STANDARD FORMS OF CONTRACT IN CONSTRUCTION PROJECTS

PhD Thesis by

YİĞİT BEŞLİOĞLU

DEPARTMENT: CIVIL ENGINEERING
PROGRAMME: PROJECT MANAGEMENT

SUPERVISOR: PROF. DR. ZEYNEP SÖZEN

OCTOBER, 2010

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YİĞİT BEŞLİOĞLU 10.2010

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LIST OF ABBREVIATIONS

AACE	: Association for the Advancement of Cost Engineering
ACA	: Association of Consultant Architects
BS	: British Standards
CECA	: Civil Engineering Contractors Association
CPM	: Critical Path Method
DAB	: Dispute Adjudication Board
DDM	: Daily Delay Measure
DOM	: Domestic
ECC	: Engineering and Construction Contract
ECSC	: Engineering and construction short contract
EOT	: Extension of Time
EPC	: Engineer, Procure, Construct
FCEC	: Federation of Civil Engineering Contractors
FIDIC	: International Federation of Consulting Engineers
ICE	: Institution of Civil Engineers
IChemE	: Institution of Chemical Engineers
JCT	: Joint Contracts Tribunal
MF	: Model Form
NATM	: New Austrian Tunnelling Method
NEC	: New Engineering Contract
NHS	: National Health Service
NSC	: Nominated Sub Contract
PFI	: Private Finance Initiative
PSC	: Professional Services Contract
RIBA	: Royal Institute of British Architects
RP	: Recommended Procedure
SCL	: Society of Construction Law
TBM	: Tunnel Boring Machine
TIA	: Time Impact Analysis
TSC	: Term Service Contract
UK	: United Kingdom
US	: United States

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Üniversite	: İstanbul Kültür Üniversitesi
Enstitüsü	: Fen Bilimleri Enstitüsü
Dalı	: İnşaat Mühendisliği Bölümü
Programı	: Proje Yönetimi
Tez Danışmanı	: Prof. Dr. Zeynep Sözen
Tez Türü ve Tarihi	: Doktora - Haziran 2010

KISA ÖZET

STANDARD İNŞAAT SÖZLEŞME ŞARTNAMELERİNDE KULLANILMAK ÜZERE ALTERNATİF BİR SÜRE UZATIMI MADDESİ ÖNERİSİ

YİĞİT BEŞLİOĞLU

Bu çalışma inşaat sektöründe gecikme süreçlerinin daha iyi yönetilebilmesi için bir kılavuz sunmayı amaçlamaktadır. İnşaat projelerinde dikkate değer zaman ve bütçe aşımı yaşanmaktadır ve anlaşmazlıkların önlenmesi, gecikme risklerinin adil paylaşılması ve sözleşme taraflarının iyi ilişkilerini muhafaza ederek geliştirebilmeleri için gecikme süreçlerinin daha iyi yönetilmesi gerekmektedir. Araştırma inşaat sözleşmeleri, gecikmelere ilişkin kavramlar, gecikme analiz metotları ve geçmişte meydana gelmiş anlaşmazlıklara ilişkin kaynakça araştırması ile başlamaktadır. Genel olarak gecikme süreçlerinde, özel olarak ise gecikmelerin analizi sürecinde rastlanan sorunlu hususların tespiti amacıyla gecikmelere maruz kalmış büyük bir altyapı projesinde saha araştırması yapılmıştır. Gerek saha araştırması gerekse kaynakça araştırması neticesinde ortaya çıkan sorunların çözümü amacıyla bu araştırma, ana sözleşmelerin özel koşullar kısmında kullanılabilecek veya sözleşme hazırlayanlar tarafından süre uzatımına ilişkin sözleşme veya şartname maddeleri hazırlanırken yardımcı olarak kullanılabilecek alternatif bir şartname maddesi önermektedir. Şartname maddesinin yanında, bir kontrol listesi modeli ve bir gecikme süreci akış şeması, sözleşme taraflarınca gecikme süreçlerinde meydana gelen sorunların aşılması amacı ile hazırlanmıştır.

Anahtar Kelimeler: İnşaat Gecikmeleri, Süre Uzatımı, Gecikme Analizi, Süre Uzatımı Maddeleri, Gecikme Süreçlerinin Yönetimi.

University	: Istanbul Kültür University
Institute	: Institute of Sciences
Department	: Department of Civil Engineering
Programme	: Project Management
Supervisor	: Prof. Dr. Zeynep Sözen
Degree Awarded and Date	: PhD - June 2010

ABSTRACT

A PROPOSAL FOR A TIME EXTENSION SPECIAL PROVISION FOR USE WITH STANDARD FORMS OF CONTRACT IN CONSTRUCTION PROJECTS

YİĞİT BEŞLİOĞLU

This study aims to provide a guide for a better management of delay processes in construction industry. Considerable time and cost overruns are being exercised in construction projects and a better management of delay processes is necessary in order to avoid disputes, obtain fair allocation of delay risks and to promote good relationship between contracting parties. Research starts with a review of relevant literature about construction contracts, delay related concepts, delay analysis methods and past disputes. A case study has been conducted on a major infrastructure project that has been subject to delays in order to find out problematic issues during delay processes in general and delay analysis process in particular. In order to solve the problems enlightened by case study and literature review, this research proposes an alternative specification clause that can be used with particular conditions of main contracts or that can be used as indicative by contract drafters when preparing extension of time related contract or specification clauses. In addition to specification clause, a checklist model and a delay process flowchart is prepared that can be used by contracting parties to overcome problems encountered during delay processes.

Key Words: Construction Delays, Extension of Time, Delay Analysis, Delay Clauses, Management of Delay Processes

1. INTRODUCTION

1.1 BACKGROUND FOR RESEARCH

Construction industry differs from the other industrial sectors due to the nature of production process. Unlike other industries that produce in large quantities of the same product in closed factories, construction production requires open air, labour intensive production of unique products for every project. This difference reflects itself in the highly risk sensitive nature of the industry. Estimating possible risks before the start of the project and minimising their impact is almost an art of risk management for the sector.

Time and cost overruns are two major risk objects observed in construction projects. These two problems occur, often, simultaneously and are in a cause and result relationship with each other. It is seen that many projects suffer from delays to project completion time, which also causes cost overruns. Delays may result from many reasons, there may be unforeseen ground conditions which are very common in construction projects, there may be extreme weather conditions during the project or there may even be a war in the country that the construction activity takes place in. When one of these events takes place and the project completion is delayed, the burden of delayed period and costs incurred as a result would be borne by the party who carries the risk. To identify the party that will carry the costs of the risk and possibly compensate the other party, the major source available in hand is the contract documents of the project.

Construction contract and its specifications used in the project will typically have risk distribution clauses identifying the party that owns the risks. Risk allocation is done on the basis that potential risks shall be carried by the party who can carry it better than the other party so that its effect on the project shall be minimised.

Though the risk sharing of the parties is defined in construction contracts, delays often result in problematic situations as the damages to be compensated might be costly. Not only the cost to be paid but also the complex nature of the delays paves the way for disputes. Of all the construction disputes, delay claims are possibly the most complex and difficult to solve. Dispute resolution process in delay claims are expensive and time consuming. Another aspect of disputes process is that it can damage the goodwill and relationship between the parties, especially if the project still proceeds, further disputes may occur. Past experiences show that dispute resolution often require expert analysis of delays retrospectively. Experts for both parties do not often share the same views for the responsibility and quantification of delay damages which makes the process much more expensive and difficult for both parties to solve.

1.2 PROBLEM STATEMENT

Standard construction contracts used in construction projects are drafted so that the risks that cause delays when they occur are shared by parties. However, using solely standard conditions of contracts do not reply the need of the industry, especially in problematic cases. Delays to individual project activities usually occur, they may occur consequently or at the same time. When large projects are taken into account, a project would have potentially hundreds of activities taking place, most of them at the same time. The effect of delays in individual activities to the total project completion or even a sectional completion is not easy to quantify. Today, most standard conditions of contract require the contractor to submit a programme schedule to the employer or its representative, often using computer programmes in large projects. These programme schedules are used retrospectively or prospectively to quantify effects of individual delays to the project completion dates and find out the number of days each party is held responsible for. The number of days - or if another time fragment is used that unit of time - is the basic measurement unit to quantify damages resulting from the delay. Continuing developments in computer technology and increasing use of CPM logic in construction projects gave the delay analysts opportunity to develop new analysis methods. Results obtained from technically made delay analysis are combined with the ready risk sharing already done in construction contracts and the responsibility for a delay is achieved.

Though, in order to achieve a fair and reasonable result, delay analysis process has three main requirements. A carefully drafted condition of contract which makes a reasonable risk allocation and has detailed specifications that identifies the possible problems that can occur in relation to delay claims during the project, tidy and objective contract documents that reflect the process of construction project in detail – that requirement is in fact a derivation of first requirement that it can only be obtained if it is expressly stated in the contract – and a delay analysis that is made by an expert who understands the project logic well, who has the necessary experience and who is objective so that the analysis is not manipulated.

The main problem concerning delay dispute resolution process is that the three requirements are rarely found together in practice. Detailed specifications on problems concerning delay analysis are not found in contracts, leaving the solution of the problem to the general clauses in contracts help little when the answer depends on thorny issues of delay related problems such as the ownership of float or the method of delay analysis that the parties shall agree upon. The analysis method that is used for finding out the parties' liabilities in delay disputes is hardly agreed upon in practice. The usual practice in industry is that each party uses the method that will prove his defence or claim and manipulated delay analysis practice is far from being fair and reasonable. Choosing the right method of analysis is strictly essential to reaching fair results. Delay analysis is a technical issue and is also related with the first requirement that was pointed above, a carefully drafted contract. All delay analysis methods take responsibilities of parties as an already available input and analysis will only be meaningful if the main concepts are carefully drafted in the contract documents, otherwise all the result will depend on the subjective decisions of an arbitrator. Summarily, the main problem that this research is based on is; the possible problems relating to delay claims, which take place in construction projects, when the solution is left to general conditions of contract.

1.3 AIMS & OBJECTIVES

This research aims to find out the problems that occur during the analysis of delay claims and make contribution to literature on delay related disputes in construction projects by giving a sample contract specification clause that may be used in contract specifications in order to avoid problems. A specification clause shall be prepared in order to avoid problems taking place in practice as a result of problematic concepts not answered in the contract, and the problematic issues faced in delay analysis. The proposed specification clause is intended as a checklist for contractors and employers, to avoid possible claims or minimise the process of dispute resolution in respect of cost and time for both parties, when used in contracts.

1.4 SCOPE OF RESEARCH

Currently, choice of using standard conditions of contract in a construction project changes according to the type of project. The main factor in choosing the contract type is the project financing. Generally, projects that are financed by the private funds of the owner are contracted using owner prepared contracts. These contracts are often drafted with little credit being given to contractor, having most of the risks transferred to the contractor regardless of contractor's ability to cope with these risks or are not up to date with contemporaneous delay concepts and analysis techniques being used in internationally funded projects. The Turkish standard governmental contract for construction projects that is used for procurement of public works is an example. On the other hand, projects funded by international lenders usually use international standard forms of contract, as the creditors are not keen to fund projects that may cause disputes that may not be resolved in international standards. Some governmental contracts used in other countries are also close to the 'institution based' standard contracts, as a result of the demand of the industry and to overcome the problems resulting from using conventional contracts. The main area of interest of this research is the internationally used, 'standard' contracts therefore; projects that use governmental standard contracts in Turkey are kept out of the scope of the research.

1.5 METHODOLOGY

This thesis is based on a case study of a mega infrastructure project in Istanbul, which uses international conditions of contract. Observation of the delay problems of the project constitutes the main findings of the study. The analysis of these problems has been the basis on which the specification clause in the form of a check list has been developed.

The basic model of the methodology is built upon four steps. The first step is a thorough investigation of existing contract models. Existing contract models are chosen as the models that are chosen by employers in international projects or are known to be internationally 'popular' contracts. Some of the contracts which have been used only in 'local' projects in UK have also been added as they have been subject to delay claims and have been a part of the existing literature in delay claims internationally. The investigation of the existing contract models focuses on the contract clauses relating to delays, relevant events that entitle the contractor to an extension of time and delay damages. Investigation of contract models is completed by a comparison of contracts with respect to their detail of the delay related clauses. Existing literature on contracts and an investigation of some of the contracts by the author are the main sources of this step of the research.

The second step of the research is the investigation of the current applications of existing delay analysis methods. This section studies the processes underlying various analysis methods and their selection criteria through a literature review. This step is concluded by a comparison of delay analysis methods.

The third step focuses on disputes that arose in the construction industry as a result of delay claims. This step aims to study the previous cases of delay claims, type of litigated disputes and court decisions. The approaches of courts to delay claims, main concepts concerning delays and problematic issues are the subject of this part of the research. The third step is also based on a literature review

The next step is the data collection by a case study. A large construction project that is already delayed and is currently experiencing both employer and contractor based delays, has been chosen for data collection. The project is a multi billion infrastructure project that is internationally funded and uses international conditions of contract. The current problems of the project have been studied on site, two of the existing delay analysis methods have been applied on one of the most critical and problematic parts of the project and the results of the research were collected to be used in the next step of the research.

The last step of the research is the development of a proposal of a specification clause that can be used in contract specification documents in order to avoid further problems. The proposal is based on reducing or avoiding problems that occur in delay related disputes, in the light of the experience obtained from the data in the case study. The proposed clause contains the issues that must not be omitted in contracts relating to delay related concepts, analysis models and problematic points.

1.6 DISSERTATION STRUCTURE

The Dissertation consists of six chapters, appendix and references.

Chapter 1 is the introduction. This chapter contains the background to the research, the problem statement which explains the need for research on the subject. The aims and objectives section is about the contribution of the research to the literature. The scope of the study states the limits applied to research and its application field. Methodology is related to the method of study and process of the research. Dissertation structure lists the chapters of the dissertation in order.

Chapter 2 is the methodology. In this chapter, methodology of the research, data collection model and the process of research are detailed.

Chapter 3 is the literature review. This chapter reports all the data obtained through literature review. It contains four main subtitles. These are extension of time clauses in standard forms of contract, delay analysis in construction projects, disputes related to extension of time in construction projects and the summary of literature review. Extension of time clauses in standard forms of contract includes titles on standard forms of contract, delay and extension of time clauses in contracts and relationship between standard forms of contract and extension of time clauses. The title on delay analysis in construction projects includes fundamental concepts (types of delays, concurrent delays, criticality, float ownership and pacing delays), delay analysis models which detail the methods of analysis currently used their selection criteria and a comparison of them. The section on disputes related to extension of time in construction projects has two subtitles; previous cases and resolution of previous cases. The Summary section briefly sums up the literature on delay claims.

Chapter 4 is the case study. The data collected from the case study is explained in this chapter. It contains six subtitles. An overview of the project, current status of the project, major obstacles for delay analysis, delay analysis of project using time impact analysis, delay analysis of project using float mapping method and a comparison of analysis results.

Chapter 5 is proposal for a time extension special provision for use with standard forms of contract in construction projects. This chapter has three subtitles; major concerns in developing a time extension clause, a checklist for a delay provision and suggested clause model.

Chapter 6 is the section where conclusions are drawn and recommendations are formulated.

2. RESEARCH METHODOLOGY

This research aims to propose a guide to the contracting parties in construction sector that will help parties manage delay processes better. Objectives of the research shall be reached by the evaluation of the guide that will comprise two main parts. First part shall include a checklist and process flow guide that will help user to manage the process of delays in projects with minimum problems. The process flow shall be prepared from the viewpoint of the employer; however it can also be used by the contractors with slight modifications. The second part of the guide shall contain a proposal of model specification provision that can be used with main contracts by being incorporated in particular conditions or at least may be helpful to drafters of construction contracts in respect of delay related matters.

The research starts with the literature review. Literature review consists of three main parts; first part is a review of contract models that are popular and widely used among practitioners, especially in international projects. In the second part, a review of literature related to delay analysis in construction projects is conducted and in the third part major disputes arising from delays in construction that have been cited in literature are reviewed.

The first part of literature review is based on reviewing the existing contract models used in international projects or used in UK, US domestically but have been used in projects that have been subject of delay disputes and as a result of this have been part of construction delay related literature in academic field.

In this part of research, delay and extension of time related clauses of contracts have been analyzed and the relationship between standard forms of contract and time extension clauses has been reviewed.

In the second part of literature review, literature related to delay analysis has been observed and explained in two main parts. The first part includes a review of fundamental concepts related to delays in construction and the second part includes delay analysis methods used. A review of fundamental concepts has been found necessary in order to gain a basic understanding of delay processes, besides, review of concepts revealed problematic points that effects delay analysis and management of delay processes. Delay analysis has been a relatively less important concept in the past, however with the development of CPM based models and their growing application in construction projects, computer based delay analysis models as a cause and effect analysis instrument to prove delay claims has been subject of increasing use. As a result, an observation of existing delay analysis models was both necessary and vital for the research. This part of research includes a review of existing delay analysis models, criteria for their selection and a comparison of models.

What kind of disputes arose and how they were resolved by the courts? Third part of the literature review is about the disputes that arose in construction projects in the past and are cited in literature on delays in construction. This part of the research shall be helpful in identifying the approach of the adjudicators to the matters related to delays and the development of law in this respect.

In order to find out the possible problems in analysis process and to collect the necessary data from site, a case study was conducted on a project that has already been subject to delays. Project was a major multi – billion infrastructure project that had delays to project completion date in the past and was still having delays in its activities due to both employer and contractor based delay events. The Project has used computer based planning methods and FIDIC contracts. Currently, there had not been any analysis of delays on the project and dispute settlement processes are continuing. Project was chosen for case study as a result of these aspects of it. During the case study a review of project documents, correspondences and minutes of meetings has been conducted, employer’s staff has been talked about the project process, problematic activities and delays. One of the most problematic parts of the project has been chosen and delay analysis using two of the current methods was done for this part of the project. The analysis process in particular and case study in general has revealed many problematic matters that have to be taken into account when preparing the guide that shall be proposed. Before and after the delays and during the analysis stage, obstacles that prevented a fair analysis of delays and a good management of delay processes with minimum problems have been realized in case study. Due to confidentiality reasons, name of the project, locations and programme schedule activities have been changed and some details about the project that did not conform the confidentiality principle have been omitted in the relevant chapter.

Table 2.1 Research Methodology Framework

1. PROBLEM STATEMENT: MANAGEMENT OF DELAY PROCESSES ANALYSIS OF DELAYS
2. RESEARCH SUBJECT: LITERATURE REVIEW A. CONTRACT MODELS Delay – Extension of time clauses B. DELAY ANALYSIS Fundamental concepts Delay Analysis Methods C. PAST DISPUTES
3. CASE STUDY: PROJECT A Site Study – Data Collection
4. RESEARCH OBJECT: PROPOSAL OF A GUIDE FOR MANAGEMENT OF DELAY PROCESSES

Finally, the proposed guide model consisting two main parts has been evaluated and proposed at the end of the research. Two main parts are the checklist – process flow part and the model specification clause part. Both parts have been developed using the data obtained from the case study and the literature review. The proposal presupposes that the obstacles that have been faced during the case study in the project and other problematic points that have been observed in past disputes could have been prevented by predetermining basic concepts and a good management of delay processes. Specification provision part of the proposal aims to predetermine and thus prevent disputes occurring from vagueness of delay related concepts in the contract form and checklist – process flow part of the guide aims to help parties manage the delay processes with minimum problems.

3. LITERATURE REVIEW

3.1 EXTENSION OF TIME CLAUSES IN STANDARD CONTRACTS

Construction contracts are drafted to document responsibilities and risks of parties during the project. Different contracts have different risk sharing contents and using an unfamiliar contract might result in costly surprises for employers and contractors. Most construction projects require high financial resources and financers of these projects, either as owners of the project or as third parties, would prefer using carefully and professionally drafted, familiar contracts in order to prevent losing money as a result of contractual responsibilities. The trend of using standard contracts is a result of this protective approach of the parties. Standard contracts used in international construction projects are mostly created with collaboration of various parties involved in the sector such as contractors, consultants, employers. The main aim of these contracts are providing fairness between the parties and creating an easier – to – use contract document. Different standard contract models have been used by the construction industry. Many of them have been amended and new versions have been created so as to overcome problems that have been observed during their use. (Bunni 3)

One of the major subjects dealt within standard contract forms is the delays to the project. Clauses relating to delays include definitions of extension of time and how an extension would be awarded, relevant events which would lead to an extension of time for project completion and damages when there is delay in project completion. Level of details in the contract about delay related clauses change due to factors such as the type, edition, area of use etc. Some of the most common and widely used international and domestic contracts and their clauses relating to extension of time, delays and damages are listed below. Different editions of some contract models are listed separately in order to better observe the changing attitude of the drafters of the contract in time.

3.1.1 STANDARD CONTRACT MODELS

Standard contracts may be classified according to the way the contractors are paid, the arrangement of the parties or the type of construction the contract is used for.

Scott lists the main types of contract usually recognised in UK as follows; (Scott 5)
According to types of payment;

i) Lump Sum Contracts

ii) Measurement Contracts

  a) Bill of Quantities
  b) Schedule of rates

iii) Cost Reimbursement Contracts

  a) Cost + Fixed Fee
  b) Cost + Percentage Fee
  c) Target Cost Contracts

According to the ways of arranging parties

  i) Traditional Contract
  ii) Design and Build Contract
  iii) Management Contract
  iv) PFI Contract

Scott's list is a general list used to classify contract types used in UK. A different classification can be done by using the types of construction that the contract forms are used for. Construction contracts can be classified in three major classes according to the construction type; building contracts, civil engineering contracts and plant contracts. Patterson explains the contract choosing procedure for NEC contracts in terms of options; a lump sum contract would pass the whole estimating, pricing and efficiency risk to the contractor (priced contract with activity schedule), a priced contract with a bill of quantities would pass the pricing and efficiency risk to the contractor but retain as client the risk of correctness of a bill of quantities, a cost reimbursable contract would retain the majority of estimating, pricing and efficiency risk and simply pay for the contractor's resources to help achieve the client's requirements, a target contract would share the estimating, pricing and efficiency risk. He offers using a priced contract with bill of quantities when the employer is responsible for the design. Cost reimbursable contract may be appropriate for emergency works, an ill defined scope or research and development work, according to Patterson. (Patterson 159-160)

There are currently, many standard contract forms used by the industry though some of them are widely used and more popular amongst others. One of the most popular standard building contract forms are JCT contracts, they are especially highly popular in UK. They are prepared by the Joint Contracts Tribunal which consists of several representatives from different parties of the industry. Early versions of the JCT contracts were used to be called as RIBA contracts. JCT 63 and JCT 80 were widely used building contracts of their times, recently JCT published its 2005 set of documents as an answer to the changing conditions and needs of the construction industry. (Ndekugri, Rycroft 3-4)

Governmental contracts are one of the most important types in the industry as large amounts of building and civil engineering works are procured by public sector. The Government General Conditions of Contract for Building and Civil Engineering GC/ Works / 1 are the contract model used to procure civil engineering and building works in UK. It was amended as it was mainly a contract for use in war times in UK and was used to give the employer overpowers. After amendments employer has less power than he was used to have. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 255)

British Property Federation has issued the ACA Form of Building Agreement in 1984. The contract was prepared by the Association of Consultant Architects in UK. The main aim of the contract was to use it for commercial building projects. Today, with the growing use of ICE forms, ACA contracts are less preferred. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 259)

Institution of Civil Engineers UK has prepared contracts to be used by the industry since 1945. ICE Conditions of Contract was prepared seven times in years 1945, 1950, 1951, 1955, 1973, 1991 and recently the seventh edition was published in 1999. ICE has also published a new set of contracts under the name New Engineering Contract. NEC was first published in 1993, the second edition was published in 1995 and recently the third edition was published in 2005 under the name NEC 3 contracts. NEC contracts were published in a quite different form than the other conventional forms; the main aim was flexibility in scope, clarity, simplicity and providing a greater stimulus to good project management. (Egglestone, The New Engineering Contract: A Commentary 4) NEC's main principle is the partnering of the risks. Core clauses and optional clauses were prepared so that the contract can be used in a wide range of projects from building to civil engineering or from traditional style party arrangement contracts to design build contracts. Optional clauses were drafted to keep the contract flexible so using any of them may change the distribution of risk between the parties. Different pricing types from lump sum to cost reimbursement type can also be adapted to the contract using options. The NEC family of contracts have different options for the potential user, the engineering and construction contract (ECC), the engineering and construction subcontracts (ESC), the Engineering and construction short contract (ECSC), the professional services contract (PSC) and the term service contract (TSC). Patterson notes that NEC has been used in more than tens of thousands of projects worth billions of pounds since 12 years, but there has only been one case law relating to the contract, so it seems that its revolutionary approach to construction contracts seem to work. The case is the Costain Ltd. v Bechtel Ltd. in 2005. (Patterson, 157)

One of the most popular and widely used set of international contracts is the FIDIC contracts. FIDIC contracts are especially popular in international projects. They are prepared by the International Federation of Consulting Engineers (Fédération Internationale Des Ingénieurs – Conseils). Four editions were prepared in 1957, 1969, 1977, and 1987. In 1999 a new set of contracts were prepared by FIDIC. FIDIC contracts are usually known with the names of the cover of the contract books such as red book, yellow book, orange book etc. The FIDIC Conditions of contract for works of civil engineering construction, fourth edition (the red book), was published in 1987 and amended in 1988 and 1992. FIDIC published its supplement to the Red Book in 1996. The orange book was published by FIDIC as a standard form for design and build contracts in 1995, the second edition was published in 1999. New yellow book replaced the orange book and new silver book was drafted for engineer, procure, construct and turnkey contracts. It also published the green book for use in engineering and building work that comprises relatively small projects. In Red Book 1999 edition there have been some significant changes and new arrangements to the old red book. In 2008 Fidic Gold Book was published which is the conditions of contract for design build and operate projects. Gold Book aims to bring some innovative changes to the control of the risks and the resolution of disputes in the case that they arise. Lane gives the example that, a failure to give notice in terms of clause 20.1 of FIDIC's 1999 Red Book is "tempered by the right of the contractor to apply to the DAB for relief should there be circumstances justifying the late submission" in Gold Book (Lane 185)

Institution of Chemical Engineers UK is one of the other institutions which prepare model contract forms. The last series of international forms of contract by IChemE was published in 2007. The series consists of the IChemE International Red Book (lump sum contracts), the IChemE International Green Book (cost reimbursable contract), the IChemE International Burgundy Book and the IChemE International Yellow Book (subcontracts). Although the forms are mainly prepared for use in the chemical engineering process industries, they have been used in other output – based plant projects. They have been used for railway signalling, combined heat and power plants, post cargo handling plant, and even tunnelling projects in the water and electricity industries based plants. (Bateman 169) It is commented that the omission of the words process plants from the name of the contracts in the latter editions of the forms is a sign showing the willingness of the Institute for the contract forms to be used by a wider community. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 356) IChemE has prepared its first contract in 1968. Known as Red Book for its cover, the contract was prepared for use with lump sum process plant projects. Another IChemE contract is the Burgundy Book which is used for target cost contracts. It is stated that the Burgundy contract was "published in response to industry's demand for a form of target cost contract as a fully stand – alone document, avoiding the need for users to draft amendments to existing forms should they wish to incorporate target cost elements into their contracts" (The

Burgundy Book, Historical Note). The IChemE International contract forms comprise models for lump sum, cost reimbursable and target cost payment types. Mainly, the contracts are drafted to respond to the needs for plant construction projects. The performance based approach of the forms reflects this main aim. When choosing the appropriate contract form, the purchaser has to take his capabilities and requirements into account. If it is required that the contractor shall manage the whole work, using the lump sum International Red Book would be the most appropriate. It is stated that cost reimbursable International Green Book would be the best choice if the client wants to work in close cooperation with the contractor, make changes to the ongoing project or operate the project during construction, the contractor who thinks that the cost is too uncertain would also prefer this contract form equally. In terms of client contractor relationship, using the target cost Burgundy Book may allow the contractor manage the project using more incentive after having decided the necessary details with the client. (Bateman 174)

Another well – known contract model which is used for electrical and mechanical works is the MF / 1 contract. Its full name is 'Model form of General Conditions of Contract for use in connection with Home or Overseas contracts for supply of electrical, electronic or mechanical plant – with erection'. The contract is one of the oldest and popularly used ones, it was first prepared in 1903 and then amended in 1988 and currently a 2000 edition is available for use. (Forward 64)

3.1.2 DELAY / EXTENSION OF TIME CLAUSES

3.1.2.1 JCT MAIN CONTRACT AND SUB - CONTRACT MODELS

In the JCT 80 Contract, time for completion can be extended by clause 25 and clause 33. Clause 25 states the main provisions while clause 33 is about the "war damages". According to clause 25, for a time extension to be awarded, contractor must give notice when it is 'reasonably apparent' to do so then the architect issues a reasonable 'extension of time'. Relevant events are stated in sub clause 25.4. Under sub clause 25.2.1.1 contractor is obliged to give notice of all delays, whether or not on the critical path. Under sub clause 25.3.1 the architect must make his decision in 12 weeks and if he decides to extend, the relevant events need to be written in notice of extension under sub clause 25.3.1. Damages for non-completion are considered under clause 24. Completion certificate is kept necessary for actually completing the project. Written notice to the contractor by the employer is kept necessary to obtain liquidated damages. It is a pre-condition to issue a non-completion certificate before deducting liquidated damages from any sums due to the contractor. In case of extension of time given to the contractor, a ‘repeat certificate’ needs to be issued which renders the previous certificates obsolete. Under 24.4.2, there is no mention of payment of interest, in case of repayment of deductions of liquidated damages to the contractor. Architect is given the power to fix a later completion date which he sees ‘fair and reasonable’ in case of war under clause 33. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 218-225)

JCT Intermediate Form of Building contract – IFC 84 is a simple contract for use with small to medium scale building projects. Extensions of time are considered under clause 2.3. Contractor needs to give notice of delay when a delay becomes apparent. Contractor is not obliged to give details of delay unless it is required by the architect. If there is prevention by the employer, architect may give an extension of time after completion is passed, when the contractor is in culpable delay. Giving notice is not a strict pre-condition in this contract. Sub clause 2.4 states the relevant events for which extensions of time may be awarded to the contractor. These are very similar to those events in JCT 80, though nominated subcontractors and exercise of government’s statutory powers are not included unlike JCT 80. It is stated that these may be covered by Force Majeure clauses. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 236) Sub clause 2.6 keeps the non-completion certificate and certificate of extension of time necessary when there is delay in project completion. Damages are considered under sub clauses 2.7 and 2.8 under which notice prior to the deduction of liquidated damages is kept essential. There is no mention of interest payments in the contract in case of repayments such as in JCT 80 contract. Partial completion is not possible under the contract though using optional clause 2.11 overcomes that problem. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 232-236)

JCT Agreement for Minor Building Works was prepared to be used with contracts up to £50.000 and more, but it was used for quite larger projects by the industry. The contract was prepared quite simply and practically. Relevant events are not stated separately in the contract but rather a general definition stating ‘reasons beyond the control of the contractor’ was used. Clause 2.2 deals with matters concerning extensions of time. It states that delay to project completion must not be a ‘default of the contractor’. Experts find the clause hard to interpret as the meaning is kept wide. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 238) A notice of delay is needed but it is not a strict precondition. The test for awarding an extension of time is reasonableness which will be decided by the architect. Liquidated damages are considered under clause 2.3 in which there is no condition of notice prior to the deduction of damages. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 238)

JCT 81 (Standard Form of Building Contract with Contractor’s Design) was prepared for use with building projects done on a design–build basis. Employer takes the classic role of architect in other JCT contracts. Clause 25 deals with matters concerning extension of time. Contractor must give notice of delay as soon as possible and needs to give particular details of relevant event in this notice. The test for an extension of time is the fairness and reasonableness as in other JCT contracts. Contractor is required to use his ‘endeavours’ to prevent possible delays. Clause 24 was drafted for liquidated damages. Employer has the right to deduct liquidated damages from any sums due to him by the contractor and procedural requirement of notice by the employer prior to deducting liquidated damages is kept essential in JCT 81. There is no mention of interest payments in case of repayment of deductions to the contractor. Relevant events for extensions of time are set out in clause 25.4. They are similar to those in JCT 80 contract, though the effect of changes in statutory requirements on the granting of approvals and permissions under 25.4.7 is not included in JCT 80. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 240-244)

Another contract form is the JCT Fixed Fee Form of Prime Cost Contract. Issues concerning extensions of time and relevant events are very similar in this contract with other JCT contracts. Extension of time is considered in clause 19. Contractor shall give a notice of claim explaining the relevant event.

Under JCT Fixed Fee Form of Prime Cost Contract relevant events are stated under sub clauses 19(a) to 19(l). Clause 18 deals with liquidated damages. Architect's 'written' opinion of delay is necessary. There is no mention of payment of interest in case of repayment of liquidated damages such as in other JCT contracts. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 244-246)

JCT Management Contract 1987 edition was drafted when management contracting was being popular in construction industry in UK. Clauses 2.12, 2.13, 2.14 are concerned with matters about delays and extensions of time. Under 2.12 Management Contractor shall notify Architect / Contract Administrator of delays when it is 'reasonably apparent'. The relevant test when giving extensions of time is stated as fairness and reasonableness. If the architect considers it not necessary to give an extension of time then he must notify the management contractor with a 'written' notice. Clause 2.13 lists relevant events for an extension of time to the contract. Under clause 2.14 Management Contractor shall notify the architect in writing of his proposed decision on extension of time under sub clauses 2.3 and 2.4 of Works Contract Conditions. Architect needs to give written notice of dissent of Management Contractor's decision if he does not agree. Liquidated Damages are considered in clauses 2.9, 2.10, and 2.11. Under clause 2.9 Architect issues a certificate if Management Contractor fails to secure completion on time. Sub clause 2.11 is about the repayments though there is no mention of interest payments. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 247)

JCT Works Contract Conditions is designed for use between the Works Contractor and Management Contractor. It is for use with the JCT Management Contract. The position of a Works Contractor of JCT Works Contract is very similar to the subcontractor of a conventional contract. Management Contractor on the other hand takes the position of the Architect / Contract Administrator. Clauses 2.2 to 2.10 deal with matters concerning delays and extensions of time. Under sub clause 2.2.1 notice of delay by contractor to management contractor in case of any delay to commencement, progress or completion date is obligatory. Management Contractor must be notified of relevant details in any notice under sub clause 2.2.3. Management

Contractor notifies his ‘reasonable’ decision to the architect. Decision time is kept 12 weeks or before the completion date of an extension of time under clause 2.4. Clause 2.8 states that the Works Contractor needs ‘to use his best endeavour to prevent any delay’. Relevant events are listed in clause 2.10 and are very similar to those in other JCT contracts. Damages are considered under clauses 2.11 and 2.12. Sub clause 2.12 details possible damages in case of delay as liquidated damages that the Management Contractor will pay to the employer plus any general damages incurred. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 249-252)

JCT Standard Form of Measured Contracts was prepared to be used for works of regular maintenance or minor improvement. Sub clauses 2.1, 2.2, 2.3 deal with extension of time. Time extension should be ‘reasonable’ time to complete works according to the contract. The test is fairness and reasonableness. There is no liquidated damages provision under the contract which means that the employer should seek for general damages. Sub clause 2.3.2 was drafted to avoid time being at large by limiting completion time for extension. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 254-255)

JCT NSC/C was prepared to replace NSC/4 contract which was drafted for use with JCT 80 contract. Under JCT 80 contract, delay on part of nominated contractor is stated as a relevant event for an extension of time when contractor is in delay because of a nominated subcontractor’s default. Under NSC / C, there is no provision for liquidated damages, which means that general damages can be demanded under case law, this is stated in sub clause 2.9. Section 2 deals with matters concerning commencement and completion. Sub clause 2.1 states that subcontractor shall carry out works in accordance with agreed programme and the contractor shall give sufficient information. Sub clause 2.2 states the procedure for an extension of time, in case of a delay, subcontractor shall give written notice of delay and the contractor shall notify the architect. Contractor requires consent for extension of time from the architect giving details and expected time of delay. Under sub clause 2.3 the relevant test for awarding an extension is stated as fairness and reasonableness. Sub clause 2.6 details the relevant events which entitle the subcontractor to an extension. Sub clause 2.7 expresses that subcontractor may go to arbitration with the contractor if they dissent with architect's decision for an extension. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 264-269)

JCT 2005 is the last edition of JCT forms of building contracts. Under sub clause 2.27.1 contractor shall give written notice as soon as he becomes aware that any section or whole of the works is delayed or likely to be delayed as a consequence of events. Sub clause 2.28 is related to extension of time issues. Under sub clause 2.28.1, if a relevant event takes place and the event does or is likely to do any delay on the completion of the works, then the architect is entitled to fix a new date for completion. The test is fairness and reasonableness. Under sub clause 2.28.2 architect needs to notify the contractor of his decision in 12 weeks, it is commented that whether 12 weeks notification period is a mandatory or directory requirement is a point of discussion. Sub clause 2.28.3 is about the architect's duty to issue any extension of time. The Architect has to make it clear for which event he issues a time extension, the underlying idea here is to prevent global claims. Under 2.28.4 the architect is given the power to reduce extensions only in case of omissions and by the condition that the original completion date is not reduced. Sub clauses 2.28.5 and 2.28.6 defines the time limit for architecture's decision as 12 weeks and summarizes the architects powers and duties regarding to extension of time claims. Relevant events are listed under sub clause 2.29 as; variations, instructions of the architect or contract administrator for resolution of errors, omissions etc. in documents, postponement of work, provisional sums, antiquities, the opening up for inspection or testing of works unless these are due to the fault of contractor, deferment of giving possession of site, suspension by contractor under clause 4.14 of the performance of his obligations under the contract, prevention by the employer, carrying out statutory undertaker of his work, exceptionally adverse weather conditions, loss or damage occasioned by any specified perils, civil commotion or terrorism, strike, lock-out, government intervention under statutory authority and force majeure. Specified perils are defined under sub clause 6.8 and force majeure is left undefined in the contracts. Sub clause 2.31 requires the architect to prepare and submit a certificate of non completion before deducting liquidated damages, which is to be a certificate of fact not of an opinion. Sub clauses 2.32 and 2.37 relate to liquidated damages, subject to submitting a non completion certificate; architect has the right to deduct liquidated damages from payments due to the contractor in case of late completion. (JCT Standard Building Contract Without Quantities, 2005 ed.)

Shortly called DOM1 (BEC / FASS / CASEC Domestic Sub – Contract DOM / 1), this contract is designed for use with JCT main contract such as NSC/C. Damages is considered in clause 12 under heading Sub-Contractor’s liability for damages. Contractor shall give notice of non-completion to the subcontractor who will then be liable for general damages. There is no provision for any liquidated damages. Sub clauses 11.2 to 11.10 deal with matters concerning extensions of time and delays. Relevant events stated under sub clauses 11.10 are very similar to those in NSC/C. Subcontractor shall give written notice of delay when reasonably apparent. The time limit used in DOM1 contract, 16 week under sub clause 11.4, is different from that used in NSC/C which is 12 weeks. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 270-274)

3.1.2.2 GC / WORKS / 1: EDITION 3

One of the contract forms used by public bodies in UK is the GC / Works / 1: Edition 3 – The Governmental General Conditions of Contract for Building and Civil Engineering in its full name. Clause 36 deals with the extension of time, under clause 36(1), when any relevant event takes place contractor has to give written notice of it or the project manager may give an extension of time without written notice if he becomes aware of the delay. It is expressly stated in clause 36(1) that only delays which will prevent completion by the date for completion may be awarded an extension of time, which means that no claim will be available for delays that take place in non – critical paths. Relevant events for an extension of time are listed in sub clause 36(2). Under sub clause 36(4), it is stated that no reduction can be made from extensions unless there is an omission. Contractor must ‘endeavour to prevent delays and to minimise unavoidable delays’ under sub clause 36(6). Sub clause 36(5) states that a contractor may express his dissatisfaction with his claim if it is rejected and ask for a review.

In GC / Works / 1 damages are defined by clause 55 as liquidated damages. Waiver of liquidated damages by Authority may only be on written notice. Under sub clauses

55(3) and 55(4) liquidated damages may be deducted from any sums due to the contractor from the contract or other contracts. There is no mention of interest payments in case of repayments of damages to the contractor. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 256-258)

3.1.2.3 ACA FORM OF BUILDING AGREEMENT

Extensions of time matters are considered in ACA Form of Building Agreement (British Property Federation 1984 edition) under sub clauses 11.5, 11.6 and 11.7. Clause 11.5 lists the relevant events that extensions of time may be awarded for. Relevant events are fewer than other standard contracts; there is no mention of industrial disputes, adverse weather conditions, unforeseen ground conditions and circumstances beyond the contractor's control. Sub clause 11.5(e) covers all acts of prevention by the employer. The test for an extension of time is fairness and reasonableness. It is a precondition that Client's Representative shall be notified when a delay becomes reasonably apparent. Damages are defined under sub clauses 11.3 and 11.4. Issuing a certificate stating that the works are not fit and ready for takeover is a precondition to get liquidated damages. Under sub clause 11.4 payment of interest in case of repayment of liquidated damages is expressly stated. In case of partial delay to any section of Works, liquidated damages shall be scaled down as appropriate. Procedural requirements are stricter than most other contracts under ACA contract. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 260-261)

3.1.2.4 ICE MAIN CONTRACT AND SUB – CONTRACT MODELS

Extensions of time and delays are dealt under clause 44 in ICE Conditions of Contract 5th edition. Under sub clause 44(1) it is stated that the contractor should make claim for an extension of time within 28 days or in a reasonable time. It is not clear whether this is a strict precondition or not. Egglestone comments on clause 44 that the words 'such as fairly…entitle the contractor' makes it vague whether extension should be given anyway or only when there is an extension to completion date. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 277) Relevant events stated in clause 44 are variations under sub clause 51(1), increased quantities under sub clause 51(3), exceptional adverse weather conditions, other special circumstances of any kind and other cause of delay referred to in conditions. Amongst these are clause 32 relating to fossils, excepted risks in clause 20, variation under clause 51. Clause 47 was drafted to deal with liquidated damages. Under sub clause 47(5) payment of interest in case of repayments is kept mandatory. Scaling down of liquidated damages in case of delay in partial completion is regulated under sub clause 47(1) b. It is claimed that the statement in sub clause 47(3) which writes that damages in contract are ‘not penalties but liquidated damages’, would not prevent courts from reaching their own decision when considering damages. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 281, ICE Conditions of Contract, 5th ed.)

The next edition of ICE Conditions of Contract was issued on January 1991. Complex sectional provisions of ICE 5th edition on external of time and liquidated damages clauses were all amended in the contract. Clause 44 deals with matters concerning extensions of time. Relevant events for an extension of time in the contract are similar to those in 5th edition. Under sub clause 44(1) a variation order stated in sub clause 51(1), an increased quantity stated in sub clause 51(4), exceptional adverse weather conditions and other special circumstances are amongst events which will entitle a contractor an extension of time. Contractor may give a notice for an extension in 28 days or the engineer may make an assessment under the contract. Relevant events under 44(1)(iii) are briefly late drawings and instructions under sub clause 7(4), adverse physical conditions or artificial obstructions under sub clause 12(2), instructions causing delay under sub clause 13(3), delay in engineer’s consent to contractor’s methods or because of engineer’s requirements under sub clause 14(8), variations relating to public utilities under sub clause 27(6), facilities for other contractors under sub clause 31(2), suspension of work under sub clause 40(1) and failure to give possession under sub clause 42(3). Except the time limit, which is 14 days, stated in sub clause 44(4) and sub clause 44(5), clause 44 is almost the same with clause 44 of 5th edition book. Commentators highlight the fact that the 14 days limit stated in sub clauses 44(4) and 44(5) are directory only and time would not become at large when 14 days limit is not obeyed.

Clause 47 of ICE 6th ed. deals with liquidated damages. In case of sectional completion, ICE 6th edition lets damages be awarded for each section which may run concurrently. It is expressly provided in the contract that damages provisions are not penalties. Interest payment in case of reimbursement of deductions to contractor is provided. It is stated in the contract that if there is an extension of time awarded after a culpable delay, liquidated damages shall be suspended for that period. There is no requirement for a pre – notice in case of deductions of liquidated damages but it is required that the engineer notifies the contractor in the payment certificate. It is debatable whether a suspension of liquidated damages under sub clause 47 would even apply, when the delaying event is 'non- critical' in the light of the wording of the contract. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 289, ICE Conditions of Contract, 6th ed.)

ICE Conditions of Contract for Minor Works 2nd edition was drafted in 1995 for Works those are shorter than 6 months and do not exceed a total cost of 250000 pounds with 1995 value. Extension of time is considered under sub clause 4.4, a list of relevant events takes place in sub clause, list is typical, and engineer's basis for an extension is a test of 'reasonableness'. An extension of time will not be due for a 'non- critical' delay. As a procedural requirement, contractor needs to issue a written notice of a relevant event. 'Regular review' of Works is to be done by the engineer. Sub clause 4.6 is concerned with damages. Damages are liquidated damages and employer may not deduct them from the payments due, there is no mention of interest repayments and a similar provision to ICE 6th edition relating to damages occurring after completion is passed, was added to the end of sub clause 4.6. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 290-292)

Last edition of ICE Conditions of Contract drafted is the ICE Conditions of Contract 7th edition. Clause 43 states the contractor's obligations with respect to completion of the project under the title 'time for completion'. Sectional completion is foreseen by defining sections in the contract, so that sectional delays and damages may be taken into account. Clause 44, such as in previous ICE forms, is related with extensions of time. Relevant events are listed in clause 44 as; any variation under 51(1), increased quantities under 51(4), exceptional adverse weather conditions, any delay impediment prevention or default by the Employer, other special circumstances of any kind whatsoever which may occur and other relevant clauses referred in the contract. Other relevant events in the contract are; late drawings and instructions cl.7(4), adverse physical conditions or artificial obstructions cl.12(2), instructions causing delay cl.13(3), delay in engineer's consent to contractor's methods or because of engineer's requirements cl.14(8), variations relating to public utilities cl.27(4), facilities for other contractors cl.31(2), suspension of work cl.40(1), failure to give possession cl.42(3), documents mutually explanatory cl.5, expulsion of nominated subcontractor cl.59(4)b. Amongst the relevant events, prevention or default by the employer was new to ICE 7th Ed., special circumstances event was used to cover these kind of delays. It is discussed that it is not clear whether 28 day requirement stated in clause 44(1) is a precondition precedent to entitlement or not. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 345) The requirement in the same clause that, engineer is to make assessment of any extensions of time due with or without the contractor claim, is shown as a proof that it is not a precondition. The assessment requirement in the contract is mainly that the engineer shall make assessments which are 'fair' either prospectively or retrospectively though Egglestone claims that specific references in clauses 44(2)b and 44(5) to the circumstances referred to in sub clause (1) might be taken as indicative of the need for time impact analysis. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 347) Clause 47 is about liquidated damages. Under clause 47(6) excusable delays which occur during a non-excusable delay are considered. The issue was considered in Balfour Beatty case and this clause may be prepared to deal with the problematic position faced in that case. In clause 47(6) engineer is given the power to suspend liquidated damages due during the excusable delay period. The test is not fairness but the 'opinion of the engineer'. It is claimed that the drafting of the clause may cause problems; the critics are on the grounds for suspension stated in the clause. They are drafted so widely that contractors in culpable delay would find so many reasons to suspend liquidated damages and engineer do not have the right to consider whether it is fair or not. Also, by using the phrase 'that part of the works' non-critical activities may also be a reason for suspension while they should not be, besides the meaning of the word part is not defined in the contract. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 350) Balfour Beatty case shows that contractor's entitlement to damages would be on a net basis rather than gross basis and it is claimed that clause 47(6) does not help beyond the case law. (ICE Conditions of Contract, 7th ed.)

ICE Conditions of Contract for Minor Works 3rd edition has been published in 2001. Commencement and completion dates are defined in sub clauses 4.1 and 4.2. Main clause related with extensions of time matters is clause 4.4. Under this sub clause relevant events that would lead to an extension of time award are listed as; instructions under 2.3a, 2.3c or 2.3d, instruction under 2.3b where the test or investigation fails to disclose non-compliance with the contract, encountering an obstruction or condition falling within clause 3.8 and / or an instruction under 2.3e, delay in receipt of instructions, drawings, information by the contractor, failure to give any possession of the land by employer, delay in receipt of materials by contractor which are to be procured by the employer, exceptional adverse weather conditions, prevention by the employer and other special circumstances. It is commented that there is a confusion regarding 'any part of the works' stated in the extension of time clause. Egglestone claims that there is no explanation in the contract for whether 'any part of the works' refer to those parts detailed in the appendix or given a wider meaning as if it is given a wider meaning problems regarding damages and delay claims in non critical activities may occur. Clause 4.6 is related to liquidated damages for late completion and there is no provision for the employer to deduct liquidated damages from the contractor. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 352, ICE Conditions of Contract for Minor Works, 3rd ed.)

FCEC Form of Subcontract (The Blue Form) was drafted in 1984 for use with ICE 5th edition, then it was amended to be used with ICE 6th edition in September 1991. There is no provision for liquidated damages in case of delays, in FCEC form of subcontract. Sub clauses 3(3) and 3(4) relate to damages and require the employer to seek general damages. Events that lead to extensions of time award mainly include the extensions relating to breaches of subcontract by the main contractor and those events that extension would be awarded under the main contract. The test for an extension of time is a test of fairness and reasonableness. There is an express provision for the subcontractor to give notice of relevant event in 14 days for getting an extension. Sub clauses 6(2) to 6(5) relate to extensions of time. Sub clause 6(3) takes partial extension into account and under sub clause 6(5), contractor shall notify sub – contractor of any extensions of time obtained under the main contract. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 306-307)

3.1.2.5 CECA FORM OF SUBCONTRACT

In CECA Form of subcontract drafted in 2008, clause 6.1 deals with commencement and completion. Clauses 6.2 to 6.5 deal with extensions of time matters. Relevant events are stated in these clauses as any circumstances or occurrence entitling the contractor to an extension of time for completion of main works under the main contract, any variation orders, any breach of subcontract by the subcontractor. The test is fairness and reasonableness as in many other forms. Giving written notice by the subcontractor is a precondition under the contract for an award of a time extension. It is expressly stated that the extension of time given to a subcontractor due to an extension given to main contractor shall not exceed the main extension given to the contractor. The contractor is responsible to inform the subcontractor of any extensions given by the employer in writing. Clauses 3.3 and 3.4 are related to damages, liquidated damages are not mentioned in the contract form which is common in many subcontracts however liquidated damages relating to the main contract are mentioned in the form so that they can be included in general damages due to the subcontract. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 354-355)

3.1.2.6 THE NEW ENGINEERING CONTRACT MODELS

The 2nd edition of NEC contracts is drafted in 1995 under the name NEC2 – The Engineering and Construction Contract. The New Engineering Contract was aimed to be used for both in design – build or simple build projects. NEC is revolutionary in its approach to construction contracts, using optional clauses in quite wider areas in respect to traditional contracts. Patterson defines the fundamental strengths of the NEC contracts as clarity, flexibility and being stimulus to good management, in its drafting. (Patterson 157). NEC is modular in structure. The contract includes core clauses which include all the key project management processes and optional clauses that are chosen by the parties – often by the client – according to the unique characteristics of the project. Optional clauses are listed as; One ‘main option’ (A, B, C, D, E, F) relating to payment, one dispute resolution option (W1 or W2), any number of its chosen secondary options (numbered X), jurisdiction – specific secondary options (numbered Y), additional conditions of contract (option Z). (Patterson 158)

In NEC employer may carry the risk of both cost and time in neutral events. Liquidated damages clauses are prepared as optional clauses in NEC. Optional Clause L relates to sectional completion. In Option R delay damages are considered, under Option R1.2 it is expressly provided that interest shall be paid in repayments. Contractor’s entitlement to bonus is protected against any delay. If option R is not added then the contractor will be responsible for general damages. If Option R is added but no rate is mentioned for liquidated damages, then this may exclude general damages liability but will probably be treated as a nil clause. In optional clauses, a proportioning down of damages in case of sectional completion is not available; ICE6th ed. may be used to prevent any problems occurring from sectional completion. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 302) There is no mention of deductions of damages from any sums due. The following clauses are related with extensions of time in a NEC contract; sub clause11.2 (12) – completion date, sub clause 30(2) – date of completion, sub clause 60.1 – compensation events, sub clause 61.1 – notifying compensation events, sub clause 62.1 – quotations for compensation events, sub clause 63.1 – assessing compensation events, sub clause 64.1 – the Project manager’s assessments, sub clause 65.1 – implementing compensation events. Sub clauses 60.1 to 60.6 state compensation events, sub clause 60.1, 60.2, 60.3 state events that apply to all main options, 60.4, 60.5, and 60.6 apply to NEC contracts with a bill of quantities. Optional clauses T, J, U list secondary optional compensation events. Project manager is required to notify contractor of compensation events when these events are foreseeable and contractor is required to report compensation events in 2 weeks. A revised work programme is also required from the contractor. Optional sub clauses list, delay by the employer in making advanced payment under sub clause J1.2, change in law occurring after contract date under sub clause T1.1, any delay, additional or changed work caused by the application of the CDM regulations which could not have been foreseen as compensation events. Three main omissions from the relevant events are listed as; failure by the Project manager to act in accordance with the contract, late supply of information to contractor and failure by employer to give access and use of site to contractor. It is commented that these may be covered by other clauses such as 60.1(2), 60.1. (3), 60.1. (18). (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 304) Under sub clause 65.2, if there is concurrent culpable and non – culpable delay, a contractor shall still be paid for non – culpable delay. Sub clause 63.3 identifies that floats are owned by contractor, extensions of time are assessed with regard to the work programme and not with regard to the time for completion. (The New Engineering Contract – engineering and construction contract, 2nd Ed.)

NEC3 is the last edition of NEC contracts. NEC never uses the term extension of time unlike conventional contracts. Rather, a change in completion time is preferred to be used. NEC3 looks relevant events as compensation events which could result in extension of time or extra cost awards to the contractor. Compensation events are the only events that allow the contractor even the possibility of an increase in the prices or a delay to the contractually required completion date. There is no difference between events which result in extra costs or extra time but it is a matter of calculation of extra costs and delays, whichever results from the compensation event. Clause 62.2, a core clause in the contract, identifies this issue. Under clause 63.3 delays is defined. In clause 63.6 risk allowances are defined, a commentary suggests that as reference is made to planned completion rather than date of completion, contractor would own any terminal float in the accepted programme. As said before, relevant events are classified as compensation events in NEC3 contracts and are listed in nineteen heads in clause 60.1. These events are; instructions changing the works information, late access given by the employer, things not provided, suspensions, works by the employer and others, late replies to communications, fossils antiquities etc., changed decisions, withholding acceptances, searches for defects, inspections, physical conditions, weather, employer’s risks, early take-over, late provision of testing facilities, correction of assumptions, breach by the employer, prevention events. Employers preferred items to delete from the above list in order of preference are listed as, weather, physical conditions when contractor is responsible for design and prevention. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 341) NEC3 does not include a damages clause in its core text; it is chosen to be included in optional clauses. In optional clause X7 a liquidated damages clause is prepared, without which, contractor will be responsible for general damages. Patterson stresses that amendments made to ECC contract in June 2006 made simply adding 'additional compensation events' in the contract data unavailable and using the additional conditions of contract (option z) to modify the list of events in clause 60.1 instead. (Patterson 164)

3.1.2.7 MF/1 CONTRACT MODELS

MF/1 General Conditions of Contract for the Supply and Erection of Electrical and Mechanical Plant (1988 edition) was prepared to be used in process and plant contracts. It is published by a joint committee of the Institutions of Electrical and Mechanical Engineers. Its provisions about delays and damages are unusual and it is commented that in projects using MF/1 there had been problems with delays and damages. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 309) Sub clause 34.1 defines what a delay in completion means for the contract. In sub clause 34.1 it is stated that when no time is fixed for completion of the Works then liquidated damages will be paid if completion is not achieved in a reasonable time. However, liquidated damages normally apply only when there is a fixed completion time and if no completion time is fixed general damages would apply as the time would be at large. Clause 34.2 defines what a prolonged delay is, under this sub-clause after fixing the final completion date no relief to a contractor would be given for neutral events after fixing the final completion date. Sub clause 33.1 is about the extensions of time for completion. Under this sub clause relevant events are defined as variations under clause 27, acts or omissions of the purchaser or engineer, industrial disputes, circumstances beyond the reasonable control of the contractor and force majeure under sub clause 46.1. Adverse weather conditions were not expressly included though wording of events 'beyond reasonable control' might fill this gap. It is expressly stated that sub clause 33.1 applies to delays occurring after completion. Sub clause 33.2 is about the delays by subcontractors. It is stated in 33.2 that if relevant event applies directly to a subcontractor then the contractor would be still entitled to an extension of time. Though when the subcontractor is culpable there would not be an automatic extension as contractor is responsible form the sub contractors. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 309-318)

The latest edition of MF/1 contracts is the MF / 1 (REV 4) 2000 edition. Clause 13.1 defines the date of passing the test of completion as the date for completion. Under clause 29.1 sectional completions is provided. Extension of time in case of delays is dealt with under clause 33.1. Relevant events under the clause are variations, acts or omissions of the purchaser or the engineer, industrial disputes, circumstances beyond the reasonable control of the contractor. Force majeure is dealt with under clause 46.1 and extensions of time are awarded in case of force majeure. In clause 33.1 it is expressly stated that it applies in case of delays that take place during culpable delay and this applies both for delays caused by the purchaser and by neutral events. A notice of claim is held as a condition precedent under clause 33.1. Damages are stated in clause 34.1 and it is stated that liquidated damages will become due in the case of delays however the wording of the clause suggests that if no time be fixed for completion liquidated damages will be due if works are not completed in reasonable time. Normally, if no time is fixed time will be at large and general damages shall apply. Prolonged delay is stated in clause 34.2 of the contract. MF/1 has been criticised for its wording on some points. It is stated that words ‘any industrial dispute’ in relevant events may cover both disputes without and within the contractor’s management structure and the clause is generous to the contractor in this respect. ‘Circumstances beyond the reasonable control of the contractor’ is also found wide in meaning as it may not be apparent whether unexpected site conditions that appeared before tender may be seen as circumstances or not. Another criticism is that the wording of clause 34.1 creates uncertainty about awarding liquidated damages by using the words ‘as cannot in consequence be put to the intended use’. It is stated that putting another condition beyond failure to complete works such as being put to the intended use gives contractor an unnecessary advantage while he does not have a take over certificate and shall normally pay liquidated damages. In relation to the matters concerning mitigation of consequences of delay written in clause 33.3 of the contract, MF / 1 is found to have some unclear issues related to procedural requirements. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 360-371)

3.1.2.8 IChemE CONTRACT MODELS

Institution of Chemical Engineers UK has drafted Red Book 1995 edition under the name The IChemE Red Book – Conditions of Contract for Process Plant - 1995 Ed. (Lump Sum Contract with Contractor's Design). Times and stages of completion are defined under clause 13. Clause 14 states the issues about delays, force majeure and relevant events. Under sub clause 14.2 relevant events are defined as any circumstances beyond the control of either party (force majeure), sub clause 6.3 conditions (unforeseen site conditions), variations, suspensions, any breach of contract by the purchaser and failures of nominated subcontractors. Sub clause 14.4 states that failures of nominated subcontractors and breaches by the purchaser must be valued on a cost plus profit basis. Under sub clause 14.2 disputes may go to an expert whose ruling would be binding under clause 45. Damages for delay are written under clause 15. According to this clause there is difference between stages and sections in sub clause 15.1 and other things in sub clause 13.1. Stages and sections attract liquidated damages while other things do not. There is no express provision for deduction or proportioning down of liquidated damages. Under clause 44 certain classes of loss are excluded from recovery in case of general damages. (The IChemE Red Book – Conditions of Contract for Process Plant, 3rd Ed.)

In the 4th edition of the IChemE Red book, drafted in 2001, process and / or plant is omitted from the title, which is commented as showing the eagerness of the writers of the contract to give it a wider use in lump sum projects especially in the civil engineering construction industry. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 356) Sub clause 13.1 relates to completion issues, readiness of take over tests is stated as the necessary milestone for the completion. Sectional completion is also possible under the contract, section 32.1 states completion of construction of the plant as a sectional completion. Sub clause 14.1 deals with extensions of time matters, relevant events under the contract are listed as, unforeseen physical conditions under clause 6.3, variation ordered by the project manager excluding those given due to the contractor's own default, breach of the contract by the purchaser, failure of nominated subcontractors, force majeure, and suspension. Under 14.1 contractor shall, in case of occurrence of a relevant event, claim from the project manager of an extension of time and shall state what he thinks fair and reasonable, while the project manager shall assess the extension time. This is different from the other forms where the contractor only informs the project manager of delay event and the project manager awards what he sees fit. In case of force majeure events award of extension of time is possible for both parties. Claims for extensions of time is are valuated under the rules for variations and clause 14.4 expressly requires the delay claims to be valuated on a cost plus profit basis while force majeure delays would cause parties to bear their own cost risks under clause 14.5. Sub clause 14.2 defines force majeure. Damages awarded in case of delays are defined as liquidated damages under sub clauses 15.1 and 15.2, there is no provision for deduction of liquidated damages or any sectional proportioning of them. Clause 15.2 "restricts the contractor's entitlement to any further extension of time to delays caused by variations and unforeseen physical conditions". (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 360, The IChemE Red Book – Conditions of Contract for Process Plant, 4th Ed.)

The Burgundy Book is the Target Cost model of contract prepared by IChemE in 2003. Times of completion and approved programme are stated under clause 13. Under sub clause 13.1 the completion is defined as works being ready for take over procedures of the plant. Sub clause 13.3 requires the contractor to submit a 'reasonable' programme. Under sub clause 13.5 project manager has the right to ask the contractor for a revised programme or accelerate if contractor falls behind the programme. Delays and relevant events are written under clause 14 of the contract. Under sub clause 14.1 employer and contractor may both give notice if either party is delayed by a force majeure event. Clause 47 makes expert as a binding authority if a variation is not agreed by the parties. Relevant events are defined as 'any physical conditions not foreseen by an experienced contractor possessed of all information that Contractor had' (sub clause 6.1), variation orders, suspension orders, breach of contract by the purchaser and a failure of any nominated subcontractor. Sub clause 14.2 defines force majeure events as government action or trade embargo, war, hostilities, acts of terrorism etc., riot or civil commotion, epidemic, earthquake, flood, fire or other natural physical disaster, exceptionally severe weather conditions or consequences thereof, denial of the use for any railway, port, airport, shipping service or other means of public transport, industrial disputes, other than solely confined to the Contractor and / or his subcontractors or their employees including employees of any affiliate of the contractor or subcontractor. In case of a force majeure event taking place, each party bears its own costs, except contractor's site costs. These site costs are added as actual costs and target costs are calculated including these costs (Sub clause 14.4). In case of continuation of force majeure effects for 120 days each party may terminate the contract under sub clause 14.5. Clause 15 is related to damages for delay. Sub clause 15.1 defines damages as liquidated damages. Partial liquidated damages are payable but there is no direct mention of deduction under clause 15.2. Schedule 11 is about times of completion and states the completion of construction for liquidated damages. Under Schedule 12 if liquidated damages are stated as nil or zero, no general damages may be claimed either. According to the guide notice section of the contract sectional take over may be referred in Schedule 11 and 12. (The Burgundy Book, 1st Ed.)

3.1.2.9 FIDIC CONTRACT MODELS

Extension of time related matters are mainly discussed in clauses 43, 44, 46 and 47 in FIDIC Red Book 4th edition. Relevant events are written in sub clauses 6.3, 6.4, 12.2, 27.1, 36.5, 40.2, 42.2, 41.1, 69.4. Sub clause 43 defines the time for completion. Under sub clause 44.1, in the event of amount or nature of extra or additional work, any cause of delay under relevant events, exceptionally adverse climatic conditions, prevention, delay by the employer and other special circumstances except for contractor's breach, an extension of time shall be awarded. Sub clause 44.2 makes 28 day notification period a pre-condition. Extensions for extra work would be considered on a net basis which means that omissions, variations and reductions should be considered. Other causes of delay under the contract include sub clause 6.4 late supply of information, sub clause 12.2 adverse physical conditions, sub clause 27.1 fossils and articles of value, sub clause 36.5 test not provided for, sub clause 40.2 suspensions of work, sub clause 42.2 failure to give possession, sub clause 69.4 employer's default on payment. Test of entitlement for an extension of time is stated as 'fairness'. Lane notes that in clause 44, there is no method or guidance as to how to calculate the fair entitlement or compensate the contractor when there is delay due to the employer's fault. (Lane 187) Clause 47 is about the liquidated damages. Under sub clause 47.1 partial completion and liquidated damages for partial completion is defined. Deduction of damages is possible under the clause, it is expressly stated that it is not a penalty clause. In sub clause 47.2, it is written that liquidated damages will be reduced in proportion accordingly, if not stated for sectional delay. Sub clause 47.3 is about optional bonuses for early completion. There are no provisions on payments of interest in repayments. Work programme requirement is in sub clause 14. There is no requirement to a particular form, presentation or content of work programme. The contract does not mention of network analysis or critical paths. There is not any sanction for not submitting or any late submission of the programme. In FIDIC Red Book 1987 Ed. contract form, time being at large is prevented by sub clause 44.1(d) by stating 'any delay, impediment or prevention by the employer' which is a catch all phrase. Engineer's failure in following procedural requirements may result in loss of right of liquidated damages for employer, especially for those resulting from due consultation requirements. Another important point about the contract is that work programme is not part of contract documents, engineer consents but he does not approve the programme which means that he assumes no responsibility. FIDIC 1987 Red Book is found to have the gap of not making it clear whether bonus payments will be done when employer prevents by acts of prevention early completion. It is noted that non culpable delays will result in extensions of time only for those on critical path under FIDIC Red Book. This will result float in the other activities being owned by employer. (Bunni 346, FIDIC Conditions of Contract for Works of Civil Engineering Construction, 4th Ed.)

In FIDIC Yellow Book, under Sub clause 8.2, time for completion is defined as including tests for completion. Sub clause 8.3 is about the work programme, it is more descriptive than 1987 ed. Relevant events are listed as variations, exceptionally adverse climatic conditions, unforeseeable shortages in the availability of personnel or goods caused by epidemic or governmental actions, any delay, impediment or prevention caused by or attributable to the employer, employer's personnel or the employer's other contractor's on the site, errors in the employer's requirements, right of access to the site, setting out, unforeseeable physical conditions and fossils, suspension by employer, delays caused by authorities (Sub clauses 8.4a, 8.4b, 8.4c, 8.4d, 8.4e, 8.5, 8.9, 1.9, 2.1, 4.7, 4.12, 4.24). Clause 8.7 is related to the damages, there is no mention of deduction or interest payment on repayments in this clause.

(Conditions of Contract for Plant and Design Build for Electrical and Mechanical Plant, and, for Building and Engineering Works, Designed by Contractor, 1st Ed.)

FIDIC Red Book has been renewed in 1999. Relevant sub clauses in Red Book 1999 are as follows; delayed drawings or instructions (1.9), right of access to the site (2.1), setting out (4.7), unforeseeable physical conditions (4.12), fossils (4.24), testing (7.4), delay caused by authorities (8.5), consequences of suspension (8.9), interference with test on completion (10.3), variations and adjustments (13), adjustments for changes in legislation (13.7), contractor's entitlement to suspend work (16.1), consequences of employer's risks (17.4), consequences of force majeure (19.4). Sub clause 8.1 defines commencement of works, it is more clear and more precisely drafted than the old red book which simply said 'the contractor shall commence the Works as soon as is reasonably possible after the receipt by him of notice to this effect from the engineer.' (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 373) Sub clause 8.2 defines time for completion, sub clause 8.4 deals with extension of time matters. Lane comments that in Clause 8.4 of the 1999 Red Book, there is no guidance on how the extent stated in wording 'if and to the extent that completion for the purpose of sub clause 10.1 is or will be delayed' is to be measured. He states that these issues are often the source of disputes and are complex. (Lane 187) Clause 8.5 defines the delays caused by authorities and who carries its risks, force majeure is defined in 19.1. It is underlined that weather conditions must be adverse in order to be identified under 8.4c. Clause 20 is drafted to describe procedural steps for entitlement to an extension of time; it makes notice of claim a pre – condition for an extension of time award. Under sub clause 20.1, engineer is entitled to take account of failure of contractor in his determination for an extension. Liquidated damages are dealt with in clause 8.7 and proportioning of the damages is dealt with under clause 10.2. (Conditions of Contract for Construction, For Building and Engineering Works designed by the Employer, 1st Ed.)

In FIDIC Conditions of Contract for EPC / Turnkey projects 1st edition 1999, extension of time and delay related sub clauses can be listed as; right of access to the site (sub clause 2.1), fossils (sub clause 4.24), testing (sub clause 7.4), commencement of works (sub clause 8.1), time for completion (sub clause 8.2), work programme (sub clause 8.3), extension of time for completion (sub clause 8.4), variation (sub clause 8.4a), relevant events (sub clause 8.4b), any delay caused by or attributable to employer, employer's personnel (sub clause 8.4c), delays caused by authorities (sub clause 8.5), consequences of suspension (sub clause 8.9), interference with tests on completion (sub clause 10.3), adjustments for changes in legislation (sub clause 13.7), contractor's entitlement to suspend work (sub clause 16.1), consequences of employer's risks (sub clause 17.4), Force majeure (sub clause 19.4). Sub clauses 1.9, 4.7, 4.12 are not included in Silver Book. Unlike Red book, conditions of contract for lump sum, EPC / Turnkey projects do not provide proportioning down of the damages unless contrary is agreed by parties. (Conditions of Contract for EPC/Turnkey Projects, 1st Ed.)

Shortly called the Gold Book, FIDIC has published its Conditions of Contract for Design – Build – Operate type projects in 2008. Relevant events for an extension of time are set in the contract as errors in the employer requirements (sub clause 1.10), right of access to the site (sub clause 2.1), setting out (sub clause 4.7), unforeseeable physical conditions (sub clause 4.12), fossils (sub clause 4.24), testing (sub clause 7.4). Clauses related to extension of time are commencement date in sub clause 8.1, time for completion in sub clause 8.2, programme in sub clause 8.3 and damages in sub clause 8.5. Delay damages relating to design build period are defined in sub clause 9.6 and delays and interruptions during the operation service are in sub clause 10.6. Sub clause 9.1 is related to commencement of design and build process, sub clause 9.2 is related to times for completion of design and build and sub clause 9.3 is about the extensions of time for design and build. Relevant events under sub clause 9.3 are variation (9.3a), relevant events (9.3b), exceptionally adverse climatic conditions (9.3c), unforeseeable shortages in the availability of personnel or goods caused by epidemic or governmental actions (9.3d), any delay, impediment or prevention caused by or attributable to the employer, the employer's personnel or the employer's other contractor's on the site (9.3e). Delays caused by authorities are considered as relevant events under sub clause 9.4, suspension is also another reason for extension of time claims by the contractor under sub clause 9.8. Sub clauses 10.2 and 10.6 are related to delays during operational period. Sub clause 10.2 defines the commencement of operation services. Sub clause 10.6 is about the delays and interruptions during the operation service. Sub clause 10.6(a) states that there will be no extension of period of operation service as a result of any delay caused by the contractor. Under sub clause 10.6(b) there will be no extension for delays caused by the employer. Relevant events are listed as delayed tests on completion of design build under sub clause 11.2, adjustments for changes in legislation under sub clause 13.6, adjustments for changes in technology under sub clause 13.7, contractor's entitlement to suspend work under sub clause 16.1, consequences of employer's risks of damage under sub clause 17.6, consequences of an exceptional event under sub clause 18.4. Sub clause 11.5 is related to the completion of works and sections. (Conditions of Contract for Design, Build and Operate Projects, 1st Ed.)

FIDIC Conditions of Contract for Design Build and Turnkey 1995 contract is now replaced by yellow book. Sub clause 4.11 of FIDIC Conditions of Contract for Design Build and Turnkey 1995 relates to unforeseeable sub surface conditions. Sub clause 4.14 is on work programme and requires a work programme to be submitted. Relevant events in the contract are variation (sub clause 8.3), force majeure (sub clause 19.1), relevant events under sub clause 8.3, physical conditions on circumstances on site which are exceptionally adverse and were not (by the base date) foreseeable by an experienced contractor (sub clause 8.3), any delay, impediment or prevention by the employer (sub clause 8.3), delays caused by authorities (sub clause 8.4) fossils (sub clause 4.24), suspension (sub clause 8.8), contractor's entitlement for suspend work (sub clause 16.1), employer's risks (sub clause 17.3), consequences of employer's risks (sub clause 17.4). In sub clause 8.6 which is related to liquidated damages, possibility to make deductions is presumed. (Conditions of Contract for Design – Build and Turnkey, 1st Ed.)

In FIDIC Conditions of Contract for Electrical and Mechanical Works 3rd edition 1987, sub clause 12.1 keeps a work programme submission mandatory although it is not a detailed one. The requirement for completion is defined in sub clause 25.1 as passing all the tests. Clause 26.1 is about extension of time for completion. Relevant events for an extension of time are listed as extra or additional work ordered in writing under clause 31 (sub clause 26.1a), exceptional adverse weather conditions (sub clause 26.1b), physical obstructions or conditions which could not reasonably have been foreseen by the Contractor (sub clause 26.1c), Employer's or Engineer's instructions otherwise than by reason of Contractor's default (sub clause 26.1d), the failure of Employer to fulfil any of his obligations under the contract (sub clause 26.1e), delay by any other contractor engaged by the employer (sub clause 26.1f), any suspension of the Works under clause 23 except when due to the Contractor's default (sub clause 26.1g), any industrial dispute (sub clause 26.1h), the Employer's risks and force majeure (sub clause 26.1j). Under sub clause 26.2 delays by subcontractors is taken as a relevant event. Sub clause 27.1 states that in case of delays liquidated damages should be awarded, preventing general damages for delays. Sub clause 37.2 defines employer's risks. (Conditions of Contract for Electrical and Mechanical Works Including Erection on Site, 3rd Ed.)

FIDIC's subcontract model FIDIC Conditions of Subcontract for Works of Civil Engineering Construction 1st edition was drafted in 1994. In this contract; sub clause 2.3 requires the sub – contractor to submit a work programme. Sub clause 7.1 defines the commencement of works and time for completion. Under sub clause 7.2 relevant events for en extension of time claim are defined. These are listed as follows; circumstances which entitle the main contractor to receive extension, instruction pursuant to sub clause 8.2, breach for which the main contractor is responsible. Sub clause 7.3 is about the contractor's obligation to notify. There is no mention of liquidated damages so general damages will apply unless optional clause 74 is added. Contractor is responsible to notify for all extensions to the sub –contractor under sub clause 7.3. (FIDIC Conditions of Subcontract for Works of Civil Engineering Construction, 1st Ed.)

Another FIDIC contract is the FIDIC Short Form of Contract 1st edition 1999. Sub clause 6.1 of FIDIC Short Form of Contract defines the employer's responsibilities. Clause 7 is about the time for completion. Sub clause 7.1 defines the execution of works, 7.2 requires a work programme to be submitted. Sub clause 7.3 is about the extensions of time, it is written that an extension of time should be awarded if the contractor is delayed by any event under sub clause 6.1, though an early warning is the precondition. Liquidated damages are awarded under sub clause 7.4 and force majeure is defined under sub clause 13.2. (FIDIC Short Form of Contract, 1st Ed.)

3.1.3 COMPARISON OF CONTRACT MODELS IN RELATION TO SCOPE OF DELAY CLAUSES

Different types of contracts have different approaches towards time extension matters. Though it is the duty of the contractor to complete on time, contractor would have the right for an extension of time if he is prevented from completing on time by the employer or by some third party intervention. Extension of time clauses in a contract can be classified under three headings, those which are related to extension of time, those which are related to damages and those which are related to relevant events. Clauses in which the time for completion, work programme, sectional completion and delay are defined may be classified under the heading clauses related to extension of time. Under these clauses often the fundamental concepts relating completion and extensions of time are defined, the procedural requirements for an extension of time for completion is listed and the related test for employer or employer's representative is written.

The second class of clauses is those which are related to damages. In law, in case of late completion a contractor would be responsible to pay damages to the employer. If these damages are written in the contract, they are called the liquidated damages. When there is no contractual provision regarding liquidated damages then the contractor would be liable to pay general damages to the employer. If the contract contains a liquidated damages clause then the employer cannot seek for general damages.

Another type of clause in the contract is about the relevant events. Relevant events are those which give an entitlement to an extension of time to contractor when they occur. Contracts often list the relevant events to identify and share the risks between the contractor and the employer.

Table 3.1 Contract – Extension of Time Clause Matrix

NAME OF CONTRACT	CLAUSES RELATED TO EXTENSIONS OF TIME	DAMAGES	RELEVANT EVENTS
JCT 80 STANDARD FORM OF BUILDING CONTRACT	cl.25, cl.33	cl.24	cl.25.4
JCT INTERMEDIATE FORM OF BUILDING CONTRACT – IFC 84	cl.2.3	cl.2.7, cl.2.8	cl.2.4
JCT AGREEMENT FOR MINOR BUILDING WORKS	cl.2.2	cl.2.3	
STANDARD FORM OF BUILDING CONTRACT WITH CONTRACTOR'S DESIGN (JCT 81)	cl.25	cl.24	cl.25.4
JCT FIXED FEE FORM OF PRIME COST CONTRACT	cl.19	cl.18	cl.19
JCT MANAGEMENT CONTRACT 1987 Ed.	cl. 2.12, cl.2.14	cl.2.9, cl.2.10, cl.2.11	cl.2.13
JCT WORKS CONTRACT CONDITIONS 1987	cl.2.2,cl.2.3,cl.2.4, cl.2.5,cl.2.6, cl.2.7,cl.2.8,cl.2.9	cl.2.11, cl.2.12	cl.2.10
JCT STANDARD FORM OF MEASURED TERM CONTRACTS	cl.2.1, cl.2.2, cl.2.3		
GC / WORKS / 1: EDITION 3	cl.36	cl.55	cl.36(2)
ACA FORM OF BUILDING AGREEMENT BRITISH PROPERTY FEDERATION 1984ed.	cl.11.6, cl.11.7	cl.11.3, cl.11.4	cl.11.5
JCT NOMINATED SUB-CONTRACT NSC/C (1991)	cl.2.2, cl.2.3	cl.2.9	cl.2.6
JCT 2005 STANDARD BUILDING CONTRACT	cl.2.27, cl. 2.28	cl.2.32, cl.2.37	cl.2.29
BEC / FASS / CASEC DOMESTIC SUB-CONTRACT DOM/1	cl.11.2,cl.11.3,cl.11.4,cl.11.5,cl.11.6, cl.11.7,cl.11.8, cl.11.9	cl.12	cl.11.10
ICE CONDITIONS OF CONTRACT – 5th ed.	cl.44	cl.47	cl.44

ICE CONDITIONS OF CONTRACT – 6TH ED.	cl.44	cl.47	cl.44
ICE CONDITIONS OF CONTRACT 7TH ED., 1999	cl.44	cl.47	cl.44
ICE CONDITIONS OF CONTRACT FOR MINOR WORKS (2nd ed. – 1995)	cl.4.4	cl.4.6	cl.4.4
ICE CONDITIONS OF CONTRACT FOR MINOR WORKS (3rd ed. – 2001)	cl.4.4	cl.4.6	cl.4.4
CECA FORM OF SUBCONTRACT 2008	cl.6.2, cl.6.3,cl.6.4,cl.6.5	cl.3.3,cl.3.4	cl.6.2,cl.6.3
NEC 2 – ENGINEERING AND CONSTRUCTION CONTRACT	cl.11.2(12), cl.30(2), cl.61(1), cl.62(1),cl.63(1),cl. 64(1),cl.65(1)	Option R	cl.60(1), cl.60(2), cl.60(3), cl.60(4), cl.60(5),cl.60(6) Optional clauses T,J,U
NEC 3 – ENGINEERING AND CONSTRUCTION CONTRACT	cl.62.2, cl.63.3,	Option X7	cl.60.1
FCEC FORM OF SUBCONTRACT (THE BLUE FORM)	cl. 6(2), cl.6(3), cl.6(4),cl.6(5)	cl.6(2)	cl.3(3), cl.3(4)
MF/1	cl.33.1,cl.33.2,cl.3 4.1	cl.34.1	cl.33.1
MF / 1 (REV 4) 2000 EDITION	cl.33.1,cl.33.2,cl.3 4.1	cl.34.1	cl.33.1
The IChemE Red Book - 1995 ed.	cl.13,cl.14	cl.15	cl.14.2
The IChemE Red Book – 4th ed. 2001	cl.13,cl.14	cl.15	cl.14.2

IChemE Target Cost Contracts – The Burgundy Book	cl.13,cl.14	cl.15	cl.14.2
FIDIC CONDITIONS OF CONTRACT FOR WORKS OF CIVIL ENGINEERING CONSTRUCTION (4TH. ED 1987) RED BOOK	cl.43, cl.44, cl.46	cl.47	cl.6.3, cl.6.4, cl.12.2, cl.27.1, cl.36.5, cl.40.2, cl. 42.2, cl.41.1, cl.69.4.
FIDIC CONDITIONS OF CONTRACT FOR PLANT AND DESIGN BUILD (FOR ELECTRICAL AND MECHANICAL PLANT AND FOR BUILDING AND ENGINEERING WORKS DESIGNED BY THE CONTRACTOR)	cl. 8.2, cl.8.3	cl.8.7	cl.1.9, cl.2.1,cl. 4.7, cl.4.12, cl.4.24, cl.8.4,cl. 8.5,cl. 8.9
FIDIC CONDITIONS OF CONTRACT FOR CONSTRUCTION (1st ED. 1999) RED BOOK	cl.8.1,cl.8.2,cl.8.4, cl.8.5	cl.8.7	cl.1.9, cl.2.1,cl.4.7,cl.4.12, cl.4.24,cl.7.4, cl.8.5,cl.8.9,cl.10.3, cl.13.7,cl.16.1,cl.17.4,cl.19.4
FIDIC CONDITIONS OF CONTRACT FOR EPC/TURNKEY PROJECTS (1st ED. 1999)	cl.8.1,cl.8.2,cl.8.4, cl.8.5	cl.8.7	cl.2.1,cl.4.24,cl.7.4, cl.8.5,cl.8.9,cl.10.3, cl.13,cl.13.7, cl.16.1,cl.17.4, cl.19.4
FIDIC CONDITIONS OF CONTRACT FOR DESIGN, BUILD AND OPERATE PROJECTS (1ST ED. 2008)	cl.8.1,cl.8.2,cl.8.3, cl.9.1,cl.9.2,cl.9.3,	cl.8.5,cl.9.6,cl. 10.6	cl.1.10,cl.2.1,cl.4.7, cl.4.12,cl.4.24,cl.7.4, cl.9.3,cl.9.4,cl.9.8, cl.10.6,cl.11.2,cl.13.6, cl.13.7,cl.16.1,cl.17.6, cl.18.4

FIDIC CONDITIONS OF CONTRACT FOR DESIGN BUILD AND TURNKEY (1ST ED. 1995) ORANGE BOOK	cl.8.3	cl.8.6	cl.8.3, cl.19.1, cl.8.4,cl.4.24, cl.8.8,cl.17.3,cl.17.4
FIDIC CONDITIONS OF CONTRACT FOR ELECTRICAL AND MECHANICAL WORKS (3RD ED. 1987)	cl.26.1	cl.27.1	cl.26,cl.31
FIDIC CONDITIONS OF SUBCONTRACT FOR WORKS OF CIVIL ENGINEERING CONSTRUCTION (1ST ED. 1994)	cl.7.1, cl.7.3	Optional cl.74	cl.7.2
FIDIC SHORT FORM OF CONTRACT (1ST ED. 1999)	cl.7.1, cl.7.3	cl.7.4	cl.7.3

A contract – extension of time clauses matrix model is given in the table. The table consists of names of contract models which are discussed in chapter 2.1.2 and their extension of time, damages and relevant events related clauses.

One of the matters included in extension of time related clauses is the definition of 'time for completion'. Almost all of the standard forms of construction contracts fix time for completion. Time is either fixed using pre – defined construction period or using a fixed construction finish date. Commencement date is also defined in the standard forms in order to prevent confusion occurring. Egglestone notes that using 'date for completion' is more preferred in building forms while specifying the 'time for completion' is preferred in civil engineering forms (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 21). JCT forms specify the obligation of the contractor as to 'complete on or before the completion date', ICE forms use completing the construction 'within the time prescribed'. This difference may also reflect itself in extensions of time clauses; in JCT forms architect is given the power to 'fix a new completion date'; in ICE forms on the other hand engineer is given the power to grant 'period of time'. FIDIC Red Book calculates the time for completion from the commencement date, which is specified as the date of receipt of the notice to commence the works. (Bunni 543)

One of the other issues related to extensions of time is the sectional completion. Though time for completion is almost always defined in the contracts, sectional completions may not be defined in all of them. When sectional completion is defined in the contract employer may start using completed part of the works before full completion of the works is achieved while it is advantageous for the contractor that he can be relieved from some of his contractual obligations by having finished the section of the works. It is important that the contractual documents make it clear what is meant by sections, phases, sectional completion and how the liquidated damages provisions apply to sectional completion. When sectional completion is predefined in the contract, liquidated damages are proportionately scaled down with sectional completion according to the contracts. JCT, ICE, FIDIC contracts all have sectional completion clauses. JCT contracts have a sectional completion supplement issued in 1975 to be used with contracts, in order to have effect this supplement has also be used with the main contract document. FIDIC contracts express that 'completion in extension of time clauses is a completion of the works or any section or any part of any section making sectional completion possible'.

Most contracts have time requirements related to extensions of time clauses, contractors often have to inform the employer's representative of any delay in a predetermined time interval or the employer's representative has to give his decision in a predetermined time. Standard contracts have various time requirements though whether these are a condition precedent or not are a matter of discussion. An example is the review of extensions after completion; both JCT and ICE contracts have time limits for review after practical completion though in Temloc v. Erill it was decided that failure by the architecture to observe in predetermined time limit did not invalidate liquidated damages due. In FIDIC Red Book the Engineer has the discretion to allow or not to allow the contractor to be awarded the extension of time even if the notice requirement under sub clause 44.2 is not strictly followed by the contractor. On the other hand it is stated that when the engineer fails to follow the procedural requirements of sub clause 44.1, then the employer may lose his rights of liquidated damages. Bunni states the fact that the courts take the view that the engineer has the power to allow the contractor extension of time when the procedural requirements are not fulfilled, separate and additional to the procedure of the contract itself (Bunni 346). As a result, under FIDIC Red Book, giving of notice under sub clause 44.2 prior to an extension of time award is not a strict precondition. It is stressed that to avoid such uncertainties arising from the sub clauses 44.1 and 44.2 FIDIC Red Book, preventive amendments are done by the employers such as when the procedural requirements are not followed by the contractor, contractor will lose his claims to any extensions of time (Bunni 349). FIDIC Gold Book requires that a notice given in terms of clause 20 must state that it is given under clause 20.1. A failure to give notice would result in the contractor losing his right to claim extension of time though if it is considered by the contractor that there are circumstances justifying his late submission, he may submit details to DAB and if he is found to have the right to an extension of time by DAB then he will be awarded an extension.

An important part of delay related clauses is written on relevant events that entitle the contractor to an extension of time. Specifying these events expressly in the contract is a part of risk allocation between the contractor and the employer. These events are usually similar in the standard contracts though level of details in the contracts change, some models have defined these events and their sharing between the parties in a more detailed manner while some others have only general definitions about risk sharing in case of relevant events taking place. Some commonly used relevant events in the contracts may be listed as unforeseen physical conditions, adverse weather, damage to the works, sub – contractors default, strikes, force majeure, statutory undertakers' works, possession of site and access to the site, late issue of drawings and instructions, variations and extra works, non – compliance with instructions, availability of resources and other special circumstances.

Force majeure clauses are one of the common and important features of different construction contracts. In common law jurisdictions there is no concept of Force Majeure so UK origin contracts such as JCT, ICE do not have express clauses defining force majeure. MF / 1 is an exception as it has a force majeure clause and is a UK origin contract. In contracts from common law jurisdictions, events that may be defined as force majeure are usually listed one by one and are defined as relevant events entitling the contractor to an extension of time.

FIDIC Conditions of Contract defines a force majeure event as an:

> exceptional event or circumstance which is beyond a Party's control, which such party could not reasonably have provided against before entering into the contract, which having arisen, such Party could not reasonably have avoided or overcome, and which is not substantially attributable to the other Party. (cl.19)

Fourth edition of the Red Book had the special risks concept to cover force majeure events though 1999 forms of FIDIC contracts preferred defining a Force Majeure clause under clause 19. Bunni is of the opinion, in his book on FIDIC contracts, that FIDIC's approach to use Force Majeure clause in the 1999 forms shows the desire to take a closer position to the civil law principles rather than the common law principles or an attempt to clarify force majeure concept for engineering use. He further comments on the Force Majeure clause of the FIDIC forms as unnecessary and wide as the meaning of exceptional event is open to discussion. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 265, Bunni 535)

Adverse weather conditions are another relevant event that is usually cited in the standard contracts. Unless it is expressly defined as a relevant event, weather conditions are risks which are to be borne by contractors, however if a standard contract defines adverse weather conditions as a relevant event, risk would be shared by parties as the contractor would be entitled to an extension. In the recent years, there is a trend in the contracts that all risks that generate from weather conditions are given to the contractors. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 267) If there is a clause that defines adverse weather conditions as a relevant event for time extension in the contract, the weather must be really adverse in order to be entitled for an extension of time and it is the employer's representative who will decide that question. In NEC contracts, risks from adverse weather conditions are partly shared by the employer. NEC tries to overcome problems that using 'exceptionally adverse weather' concept of the other contracts might create by using certain, well – defined weather measurements under clause 60.1.13. Recorded specific weather measurement is compared with the weather data and a compensation event occurs if the weather condition is 'to occur on average less frequently than once in ten years'. (Patterson 162) JCT 63 uses ‘exceptionally inclement weather’ to define the risk while in JCT 2005, ‘exceptionally adverse weather conditions’ is used in the wording of the clause, ICE prefers the word ‘exceptional adverse weather conditions’. JCT contracts refer to ‘delay to the progress of the works’ when considering entitlement to an extension when weather conditions are adverse, that means not only must there be weather conditions exceptionally worse than the average weather conditions of the area but also there must be delay to the progress of the works. Contracts such as MF/1 and IChemE Red book do not have adverse weather conditions as a relevant event however it is stated that in those cases using the wording ‘beyond contractor’s control’ may be helpful to overcome the problem. FIDIC uses the term ‘exceptionally adverse climatic conditions’ to cover the weather risk. The 1999 Red Book entitles the contractor to an extension of time for ‘exceptionally adverse climatic conditions’ under sub clause 8.4, which is the same under sub clause 44.1 of the Red Book 4^{th} edition. Commentators on the subject share the view that stating what constitutes ‘exceptionally adverse weather’ is one of the main areas related to disputes regarding extensions of time. (Lane 188)

Another main heading of relevant events is the strikes, riot etc. Some contracts prefer detailing strikes and other events as relevant events while others may prefer even not using it. When these kinds of events are not expressly included in the contract then force majeure or ‘other special circumstances’ headings are used in order to overcome problems. Strikes may be as a result of bad relationship between contractor and his own employees or it may cover subcontractors or other suppliers. Awarding extensions of time when there is a strike is subject to a test of ‘fairness and reasonableness’ in JCT contracts. In ICE contracts, there is no mention of strikes and the matter is resolved under ‘other special circumstances’ clause. FIDIC takes strikes under ‘force majeure’ clause into account. It is expressly provided in FIDIC forms that strikes must be ‘by persons other than the Contractor’s personnel and other employees of the contractor and the subcontractors.’ In IChemE contracts, there is no mention of strikes and it is expressly provided that “mere shortage of labour, materials or utilities shall not constitute Force Majeure unless caused by circumstances which are themselves Force Majeure.” (Sub clause 14.2)

Damage to the works constitutes one of the headings that take place under relevant events. Reasons for damage to works can be various; they can result from the contractor's negligence, circumstances out of contractor's control, employer's negligence or faulty design. Contractor's own negligence will not obviously entitle him to an extension of time but in the case that damages result from the negligence of the employer contractor shall be awarded extension of time. When the damage is due to another factor beyond the control of the contractor, then, contractor may be awarded extension of time according to the wording of the contract. ICE contracts do not have specific clauses regarding extensions of time in case of damage to the works. Past cases are not indicative about the position of ICE contracts on the matter as arbitrator and engineer decisions have not been consistent on the matter. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 271) In JCT contracts damage to the works are defined under 'specified peril' and are taken as relevant events. Specified peril is listed as; "fire, lightning, explosion, storm, tempest, flood, bursting or overflowing of water tanks, apparatus or pipes, earthquake, aircraft and other aerial devices or articles dropped there from, riot and civil commotion, but excluding excepted risks." FIDIC chooses to include 'damage to works' events under force majeure clause.

Delays caused by sub – contractors are normally contractor's risk and contractor will not be given a time extension as a result of sub – contractors default. In some cases, if the contractor is required to obtain approval of the employer's representative and approval is unreasonably delayed and that delay causes a delay in project completion time, then an extension of time may be given to the contractor. The problematic issue relating to sub – contractors is when nominated sub – contractors are used in the project. It is noted that most of the contracts are trying to avoid disputes arising from nominated sub – contractor caused delay by giving all the responsibility to the main contractor however it is difficult to give all responsibility to main contractors as in case of nomination some of the risks would be shared by the employers. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 272) ICE contracts allow extensions only "for delays arising from determination of the nominated sub – contractors' employment". JCT contracts on the other hand make "delay on the part of nominated subcontractors a relevant event". In early forms of JCT contracts subcontractors default was taken to be included as an event 'beyond contractor's control' and extension of time was awarded to the contractor however later versions included subcontractor default 'within' contractor's control to avoid unfair results. In FIDIC contracts, contractors are responsible for the acts and default of any subcontractor unless he is a nominated subcontractor.

Gas, water, electricity and telephone installations are common in construction projects and are included in the contracts under the heading 'statutory undertakers' works'. In case of statutory undertakers work, contractors will almost always get an extension of time if there is delay to project completion, but the main area of dispute arises from recovery of costs and the result would be different according to the nature of delay. If the delay is supposed as a neutral delay then award of an extension of time will be according to the wording of the contract, on the other hand if the 'statutory undertakers work' is seen as an act of prevention, then, an extension shall be awarded to the contractor. Almost all the standard contracts have statutory works as a relevant event, when they have not included there are provisions covering the both prevention and neutral situations which give an award of time extension. Besides statutory undertakers' works, some contracts also have delays caused by the restrictions implied on use of labour, supply of materials, power and energy using statutory powers, as a relevant event entitling the contractor to an extension of time. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 275)

Catch all phrases are often used by contract drafters in order to avoid problems of extensions of time due to gaps in the wording of the contract. 'Other special circumstances', 'all causes beyond the contractor's control', 'any other circumstances of any kind whatsoever' are some of these phrases. It is noted that courts have given limited meaning to catch all phrases when there is breach of the contract by the employer. ICE contracts use 'other special circumstances' to cover any delay which is unforeseen and beyond the control of the contractor. In FIDIC Red Book 4th ed. uses in sub clause 44(1) e 'other special circumstances', which may be considered as a catch all provision. It is stated that sub clause 44(1) e has caused problems in interpretation and caused disputes among parties. (Bunni 347) The scope of the words special circumstance is not clear enough and results may be unpredictable. Bunni notes that following events have not been included expressly in

FIDIC Red Book and are tried to be covered under the heading 'other special circumstances'; discrepancies in or divergence between contract documents – as in JCT 80, errors in drawings, technical specifications, items of reference for setting out of the works provided by the employer – as in 1999 yellow book, changes in law / legislation – as in Red Book 1999, delays caused by other contractors employed by the employer, or nominated subcontractors / suppliers – as in JCT 80, delays caused by public bodies / authorities – as in 1999 Red Book (Bunni 347). However, it should not be forgotten that considering these events as under 'other special circumstances' is in the discretion of the employer's representative who is to give his decisions 'fairly'.

Late possession of the site is one of the major problems frequently occurring in civil engineering works and using it as a relevant event in contracts is becoming more popular. Giving late possession of site by the employer is cited as a relevant event in most of the contracts especially in recent editions. JCT 2005 provides late possession of site as a relevant event for time extension in the form of 'deferred or late possession' while in JCT 80 there is no mention of late possession as a relevant event. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 277) ICE contracts also include late possession as a relevant event. Under FIDIC, late possession of site is considered as two different categories according to the seriousness of the breach. It is expressly stated that employer must give possession of the site where the works will take place to the contractor within the predetermined period or if not predetermined within reasonable time period to the contractor, if the possession of the site is not given by the employer then this will lead to a termination of the contract by the contractor as that will be a substantial breach of the contract. On the other hand if the contractor is not given the possession of 'any foundation, structure, plant, or means of access' within the timescale stated in the specification, this is considered as a less serious breach where the contractor will be entitled to an extension of time for the delay in work programme and possibly compensation. (Bunni, 540)

Another relevant event is the late issue of drawings and instructions. The subject has been subject of many disputes, when there are not any express provisions contractors often argue for implied terms in the contract which require the employer to provide him drawings and instructions on time, while employers would possibly argue for implied terms which give them the right to give drawings and instructions so that it does not pass the limit of prevention. Courts often take the issue from the perspective of ‘reasonable time to supply’ necessary information in the absence of express provisions. ICE forms use the phrase ‘any failure or inability of the engineer to issue at a time reasonable in all circumstances’; JCT forms use the wording; ‘the contractor not having received in due time’. ICE forms’ preference of ‘reasonable’ in the wording is found as a more contractor sided approach as the contractor argue that he was not given the drawings or instructions at ‘reasonable’ time. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 280) FIDIC also uses the words ‘within a reasonable time’ to state the time requirement for submission of documents.

Variations and extra works done in the project is another reason for extensions of time. Variations are a part of construction projects as foreseeing every event that will occur and planning in this respect is almost impossible. When there is a variation to the project, the contractor will clearly be entitled to an extension of time and the employer will lose his right to liquidated damages for the project delay period. Extra works, on the other hand, is not the same with extra quantities and some contract documents may give the risk of extra quantities to the contractor, in which case, he will not be entitled to extension of time. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 281) FIDIC Red Book 4th ed. discusses variations in clause 51. Red Book 4th ed. describes a variation as any change from the specified sequence or timing stated in a programme submitted by the contractor under clause 14 and instructed by the engineer under clause 51. Under clause 51 a contractor is prevented from doing any variations to the project without the instruction of the engineer which shall be written or if given orally, shall be given in written form as soon as possible. A major problem that frequently occurs is the form of the ‘written instruction’, whether a drawing that has the changes done on it constitutes a written instruction or not is a point of discussion. In 5th and 6th editions of the ICE Forms of Contract for Works of Civil Engineering Construction, the engineer is empowered to order a change in the contractor’s specified ‘method’ of construction in addition to its timing. (Bunni 300) In NEC, variation is set out as the first event as a compensation event in sub clause 60.1.1. It is described as ‘works information being changed'. Patterson notes that variation is a major risk for a client, especially when the requirements of the client are not clearly set out in the work information at the time of award of the contract. (Patterson, 161)

Almost all the construction projects have underground works and risk of encountering unforeseen conditions is quite high. Unforeseen conditions or as generally used in construction contracts, unforeseen ground conditions, is an event that would possibly lead to an extension of time of the project completion. In the absence of express contractual provisions the risk in adverse ground conditions is the contractor's. Some conditions of contract, such as ICE, do not have any reference for ground or site. ICE conditions of contract clause 12 states "physical conditions (and artificial obstructions) encountered during the carrying out of the works" (ICE Conditions of Contract, cl.12). Egglestone underlines the practice in the construction industry that some employers now amend clause 12 and substitute 'ground conditions on site' for 'physical conditions' (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 284). FIDIC Red Book 4th ed. uses clause 12 to respond the risk from unforeseen ground conditions. Under clause 12, if it was 'reasonable' for the contractor not to foresee the ground conditions, such as that an experienced contractor cannot foresee, then the risk of the ground conditions rests with the employer. Bunni states that the main reason for this risk allocation is the fact that contractor would have forced to include this high risk in his tender if he had to carry it so that the contract would become a 'gamble' for the contractor, further on, it is the employer who chooses the precise site location and has more opportunity to carry out necessary investigations. He also notes that the word 'reasonable' used to describe the obstruction or conditions in FIDIC Red Book third edition was not included in the fourth edition while the phrase "could not have been reasonably foreseen by an experienced contractor" was kept the same. He underlines that many authoritative commentators criticized the word 'reasonable' to have 'indefinite' meaning. (Bunni, 310-315)

Unforeseen ground conditions have been covered under sub clause 4.12 in the 1999 Red Book. Sub clause 4.12 deals with unforeseeable physical conditions and their effect on the contract and the contractor's obligations under the contract. The contractor would be entitled to a time extension when there is an unforeseen ground condition on site subject to sub clause 20.1. Under sub clause 1.1.6.8, unforeseeable is defined as ‘not reasonably foreseeable by an experienced contractor by the date for submission of the tender’. 1999 Red Book also takes into account the fact that for the contractor it is cannot make a comprehensive site investigation in the tender stage and keeps the requirement of investigation ‘to the extent which is practicable’. Though what is practicable may be a point of further disputes. In NEC contracts the default risk allocation is set in sub clause 60.1.12. In order that physical conditions be ‘compensation events’ in NEC contracts they have to be within the site, not weather events (as in FIDIC contracts) and “such that an experienced contractor would have judged at the contract date to have such a small chance of occurring that it would have been unreasonable for him to have allowed them. (Patterson 163)

The third type of clauses found in standard conditions of contracts related to delays is the damages clauses. In case of delays encountered in the project, contractor would have to pay liquidated damages if he is found liable for the delay and damages clauses direct this issue. Liquidated damages may be defined as the genuine pre – estimate of all the losses which will be borne by the employer as a result of late completion of the works, calculated at the time of making the contract. The advantage of having a liquidated damages provision is that the damages that will be paid by the contractor is limited and known and the employer who receives late completion does not have to prove his losses due to such delay such as in general damages. (Bunni 370)

In JCT contracts there are two important general conditions prior to the deduction or payment of liquidated damages; first is that the architect must have issued a non – completion certificate, second is that the employer must have given a notice to the contractor for payment of liquidated damages. NEC has a rather different approach to delay damages clauses than the traditional contract models. In NEC, only provisions related to delay damages are in optional clause X7 which can either be included in the contract or not. In clause X7, delay damages start from the completion date or take over date whichever is the earlier though under clause 35 when the employer starts using any part of the works; contractor would be entitled to a take over certificate for that parts of the work automatically. In order to apply partial completion and damages for delay in partial completion in the contract, optional clause X5 should also be adopted besides optional clause X7. One of the main problems in relation to liquidated damages is the amount of extension that should be given to the contractor when he is already in delay due to his own fault. The matter has been observed in the case of Balfour Beatty v. Chestermount Pty. Ltd. (1993), and it was decided that extensions should be on a net basis rather than gross basis (Gibson 95). In ICE Conditions of Contract the matter is answered in sub clause 47.6 by suspending damages for the period of delay. However, the drafting of the clause has been criticized by the commentators. Using the test of opinion of engineer rather than using 'fairness' and the determined grounds of suspension are found too wide. It is stated that contractors in culpable delay and paying liquidated damages will "readily find a range of matters outside their control to offer as excuses for continuing delay". (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 350) Use of 'that part of the works' in the wording of the clause may also lead to award of suspension of damages for non – critical delays on the project. FIDIC Red Book is a re – measurement contract and it permits partial taking over unlike EPC / Turnkey contracts so Red Book has partial completion and proportioning down of damages clauses while FIDIC EPC / Turnkey does not. (Bunni 88)

3.2 DELAY ANALYSIS IN CONSTRUCTION PROJECTS

3.2.1 FUNDAMENTAL CONCEPTS

A project delay can be defined as an extension in the predetermined project completion time. Various definitions may be found in the literature for defining delay, defining the term is important as it might have important legal consequences. Literally delay means "to make someone or something behind in schedule or usual rate of progress or movement" (Webster's Third New International Dictionary 595-596). It implies a holding back in completion**.** The Society of Construction Law describes a delay to completion in its Delay and Disruption Protocol as "in common usage, […] either delay to the date when the contractor planned to complete its works, or a delay to the contract completion date" (55), a delay to progress is defined in the same Protocol as "a delay which will merely cause delay to the Contractor's progress without causing a contract completion date not to be met. It is either an employer delay or a contractor delay to the progress" (55). Braimah states that delay has no precise technical meaning in construction contracts though he tries to identify it in its common meaning in the industry as "any occurrences or events that extend the duration or delay the start or finish of any of the activities of a project" (43). In order to define a delay, a predetermined project completion time must have been defined before project starts.

In most of the construction projects, unless a small scale short project, project completion time is specified in the contract, project completion time may either be specified as a project completion date or predetermined as project duration from the start of the project in terms of days, workdays, weeks, months etc. Building contracts often prefer to set fixed dates while civil engineering contracts prefer fixing project duration so that project completion may be calculated from project commencement. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 2nd Ed. 21) In order to avoid confusions regarding project completion time, contracts must define project start and project completion concepts precisely.

Sometimes, usually on small scale projects, a project completion time is not predetermined between the parties and it is assumed that the project will finish in a reasonable time. When a delay occurs in this kind of projects, the time is said to be at large, that means the contractor shall finish the project in a reasonable time. From the employer's sight, prevention of time being at large is important as reasonable time is not a clear, determined duration for the completion of the works. Reasonable time would be determined on the facts of each project. Egglestone in his book Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. lists the circumstances of time being at large as;

- where an act of prevention by the employer creates delay and that delay is not covered by an extension of time provision,
- where there is no stated time or date for completion,
- where there is lack of clarity in the provisions for extending time,
- where the provisions for extension of time have not been properly administered, have been misapplied, or have not been utilised,
- where there has been waiver of the original time requirements,

– where there has been interference by the employer in the certifying process. (33)

Another fundamental concept related to delay claims in construction is prevention. Principle of prevention in relation to project delay may be defined as, when one party prevents the other from fulfilling his obligations, he cannot claim damages or extension of time because of that obligation being not fulfilled. Principle of prevention may stop an employer from getting liquidated damages when the contractor is already in delay. Historically, the effective use of prevention principle is less important today then it was in the past, as standard construction contracts mostly define acts and share the risks for what could be defined under an act of prevention in the past. An act of prevention is defined historically as “virtually any event not expressly contemplated by the contract and not within the contractor’s sphere of responsibility” (Wallace 624).

When the project is in delay due to the fault of the contractor, employer would ask for damages from the contractor to cover his losses. When the amount of damages that would be paid by the contractor to the employer in case of delay is predetermined and expressed in the contract, these damages are called the liquidated damages. Employer will not be awarded general damages when liquidated damages are already available for him in the contract though when it is not written in the contract, employer may seek for general damages. General damages are problematic for each party, employer might have difficulties in proving the damages that he had to borne as a result of project delay while the contractor may have to compensate large amounts of losses that he could not predict which may even result in bankruptcy. When there are predetermined liquidated damages in the contract, even if his losses exceed the predetermined rate, employer may not seek for additional general damages (Bunni 372-375).

3.2.1.1 TYPES OF DELAYS

Delays have been classified in different models in literature. These classifications have been derived from the origins, consequences, compensability and their timing. A classification using the origins or in other words causation would list delays as owner caused delays, contractor caused delays and third party caused delays. The classification is obvious, a delay may be as a result of owner / employer’s own acts, a result of contractor’s acts or due to an act of third party for which neither contractor nor employer did anything. Scott summarizes delays according to responsibility in Table 3.2, the examples and remedies in Scott’s table should be read in light of the contractual schemes that may have different risk allocation models.

Table 3.2 Delay Types According to Responsibility (Scott 1)

Delay type	Examples	Remedy
Employer Responsible (E)	Variations, Failure to Provide Site / Information	Extension of time with recovery of overhead costs
Contractor Responsible (C)	Insufficient Labour / Plant, Remedial Works	No compensation in either time or cost
Neither Party Responsible (N)	Strikes, riot, Exceptional adverse weather, force majeure	Extension of time to defray deduction of liquidated damages, but no costs.

Delays may also be classified according to their consequences as critical delays and non – critical delays. A critical delay is one which would result in an overall delay in project completion time. A non – critical delay on the other hand is one which occurs on a non – critical path on a CPM schedule and does not effect the overall completion time of the project. In case of a non – critical delay, a time extension would not be awarded but the contractor would probably recover his additional costs incurred due to that delay (SCL Delay and Disruption Protocol, 54).

Compensability is another classification concept used in the literature by past researchers to classify delays. Excusable and non – excusable delays are two main headings used under this classification. Under the heading excusable delays, a sub classification is also made as excusable compensable and excusable non compensable delays. Excusable delays are those delays which do not occur as a result of the contractor's actions or inactions. Excusable delays, when founded, entitle the contractor to a time extension, if the completion date is affected.

Excusable delays may again be divided into two sub – groups as; delays those are compensable and delays those are non – compensable. Excusable compensable delays are those which are caused by the owner's direct actions or omissions. In this case, the contractor is entitled to a time extension and compensation for extra costs associated with the delay which include direct costs and overheads. Excusable non-compensable delays are neither the fault of the contractor nor the owner. They are due to acts or omissions of a third party; force majeure is a good example. The contractor, in this case, would be entitled to an extension of time since there are no grounds for damages, but would not be given any delay damage compensations, cost risk will be borne by him. (Braimah 45, Keane, Caletka 93)

Non-excusable delays are caused by the contractor's or the subcontractor's, usually except nominated sub – contractor's, direct actions or omissions. In case of non-excusable delays, the contractor is not given any time extension or delay damages. On the other hand, the employer will be entitled to liquidated or general damages. Braimah underlines the fact that "there is generally no such entitlement for delay caused by events over which the contractor exercises some control, e.g., productivity of its labour or equipment" (Braimah 44).

Another classification concept is derived from the timing / duration of the delays, when two or more delays occur concurrently or they have concurrent delay effects they are called the concurrent delays. Concurrent delays are subdivided into two groups as time concurrent delays and delays that have concurrent effects.

Non – concurrent delays on the other hand are also subdivided in literature as serial delays and independent delays. Arditi and Robinson define serial delays as "sequences of successive non – overlapping delays on a certain network path" while an independent delay occurs "in isolation or does not result from a previous delay and which effects can be readily calculated" (Arditi, Robinson 22).

Table 3.3 Classification of Delays

<table>
<tr><td colspan="3">CLASSIFICATION OF DELAYS</td></tr>
<tr><td rowspan="3">CAUSATION BASED</td><td colspan="2">OWNER CAUSED DELAYS (E)</td></tr>
<tr><td colspan="2">CONTRACTOR CAUSED DELAYS (C)</td></tr>
<tr><td colspan="2">THIRD PARTY CAUSED DELAYS (N)</td></tr>
<tr><td rowspan="2">CONSEQUENCE BASED</td><td colspan="2">CRITICAL DELAY</td></tr>
<tr><td colspan="2">NON – CRITICAL DELAY</td></tr>
<tr><td rowspan="3">COMPENSABILITY BASED</td><td rowspan="2">EXCUSABLE DELAY</td><td>EXCUSABLE COMPENSABLE DELAY</td></tr>
<tr><td>EXCUSABLE NON COMPENSABLE DELAY</td></tr>
<tr><td>NON – EXCUSABLE DELAY</td><td></td></tr>
<tr><td rowspan="4">TIMING BASED</td><td rowspan="2">CONCURRENT DELAYS</td><td>TIME CONCURRENT DELAYS</td></tr>
<tr><td>CONCURRENT EFFECT DELAYS</td></tr>
<tr><td rowspan="2">NON – CONCURRENT DELAYS</td><td>SERIAL DELAYS</td></tr>
<tr><td>INDEPENDANT DELAYS</td></tr>
</table>

3.2.1.2 CONCURRENT DELAYS

All the past researchers and literature on project delay and related issues stress the fact that, of all the discussions related to delays, concurrent delays are the most problematic ones as they require most detailed legal and technical analysis. It is claimed that there is no universally accepted definition of ‘concurrent delay’ though an acceptable one may be “a period of project over – run which is caused by two or more effective causes of delay which are of equal causative potency” (Caletka & Keane 203). Another simple definition is that concurrent delays refer to delay situations “when two or more delays, regardless of the type, occur at the same time or overlap to some degree – either of which occurring alone would have affected the project completion date" (Gibson 133). Hoshino defines concurrency occurring as "where another activity independent of the subject delay is also delaying the ultimate completion of the chain of activities" (Hoshino 1). Nguyen states the other names used to express concurrent delays in the literature as; simultaneous delays, commingled delays, intertwined delays (Nguyen 26).

When different types of definitions in literature are taken into account, it would be seen that two different types of concurrent delays may be defined. Concurrent delays that occur at the same time period, happening at the same time, so that they are literally concurrent, and concurrent delays that do not occur at the same time periods but have the same delay effect on the project, so that their effects are concurrent on the project. It is obvious that for the second type of concurrency to take place, the delays should happen on parallel as – built critical paths.

Literal concurrency is almost a very little possibility if not unachievable; an absolute concurrency cannot happen as time is infinitely divisible (AACE RP 29R-03 80). AACE underlines the fact that regarding concurrency from the viewpoint of contemporaneous occurrence would not be the 'adequate basis' to resolve disputes. This kind of approach is called the gross concurrency. It gives the example of two delay events occurring at the same day but one in the morning and one in the evening and stresses that whether or not these delays are literally concurrent is a result of planning time units used for the project (AACE RP 29R-03 80). SCL states in its Delay and Disruption Protocol that the term "concurrent delay is often used to describe the situation where two or more delay events arise at different times, but the effects of them are felt (in whole or in part) at the same time. To avoid confusion, this is more correctly termed the concurrent effect of sequential delay events" (SCL Delay and Disruption Protocol 53). The main difference between the types of concurrencies comes from the different conception of float ownership. Under the literal concurrency theory, float of an activity belongs to that activity while functional concurrency theory reads float concept as belonging to the network and as not 'inherited' in the activity itself. When the total floats on a network are consumed, delays would become concurrent with other delays on parallel critical paths**.** An important difference between the two methods of concurrency is; when literal theory is used there would be many isolated compensable delays, net time and damage effects of delays would be calculated after the time and damage effects of each delay is calculated however when functional approach is used, net damage effect of delays would not be calculated, as offsetting would be done before damages are calculated. It should be kept in mind that in an analysis where literal theory is used, damages from delays may be quite different for contractor and for the employer as liquidated damage rates would differ from contractor's damages in case of excusable compensable delays (AACE RP 29R-03 80-81).

Researchers have stated some main approaches of the courts to concurrency cases in literature. Egglestone lists these approaches as The Devlin approach, the dominant cause approach, the burden of proof approach, the tortuous solution, the apportionment, the but – for test, the first in line approach and the first past the post approach (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 290-291) Gibson notes three main approaches as the Devlin approach, The Dominant cause and the burden of proof approach. He also cites the 'Malmaison' test as a modern approach for the 'thorny' issue of concurrency (Gibson 133-134). Keane and Caletka also list three of the main approaches as the first in line, the dominant cause and the apportionment approach (Keane, Caletka 204)

The first approach comes from the name of Judge Mr. Devlin's judgement in shipping case of Heskell v. Continental Express Ltd. (1950). Keating expresses that The Devlin approach suggests "if a breach of contract is one of two causes of a loss, both causes co – operating and both of approximately equal efficacies, the breach is sufficient to carry judgement for the loss." (qtd. in Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 291) Egglestone notes the fact that legal commentators makes the point that Devlin approach does not operate satisfactorily in construction cases where there are counterclaims and where the competing causes are not of equal efficiency. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 290)

Table 3.4 Methods of Courts to Identify Concurrency

CONCURRENCY	
AUTHOR	METHODS OF COURTS TO IDENTIFY CONCURRENCY
EGGLESTONE	DEVLIN APPROACH
	DOMINANT CAUSE APPROACH
	BURDEN OF PROOF APPROACH
	TORTOUS SOLUTION APPROACH
	APPORTIONMENT APPROACH
	BUT FOR TEST
	FIRST IN LINE APPROACH
	FIRST PAST THE POST APPROACH
MARRIN	FIRST CAUSE APPROACH
	DOMINANT CAUSE APPROACH
	AMERICAN APPROACH
	MALMAISON APPROACH
GIBSON	DEVLIN APPROACH
	DOMINANT CAUSE APPROACH
	BURDEN OF PROOF APPROACH
	MALMAISON
KEANE & CALETKA	FIRST IN LINE APPROACH
	DOMINANT CAUSE APPROACH
	APPORTIONMENT APPROACH

When there are two concurrent delays in a project but one is the dominant and effective cause of the delay, the party who bears the risk for that delay is the responsible party for the delay. Whether a cause is dominant or not is a question of fact that would be answered by the courts using common sense. This approach is called the dominant cause approach. Though it was taken as supportive in a construction case for direct loss and expenses claim case where a JCT 1980 contract was used, dominant cause approach is not very appropriate for construction cases while it suits well with insurance cases (H. Fairweather and Co. Ltd. v London

Borough of Wandsworth, 1987). It is stated that dominant cause approach may still be used as an argument in construction cases depending on the circumstances of a case. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 292) Some authors, on the other hand, as Winter completely reject the use of dominant cause approach for construction cases. (Winter 14-20)

In the 'burden of proof' approach, when there are two concurrent delays and the claimant is in breach of contract then, the burden of proof is on the claimant to show that the other party is responsible for the delay (Gibson 134). In the tortuous solution, "the claimant recovers if the cause on which he relies caused or materially contributed to the delay."(Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 291) It is also noted that though apportionment approach could not find support from the courts in relation to extension of time claims in construction contracts, recent cases show a shift to using this approach in global claims. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 291-293)

In recent cases of London Underground Ltd. v. Citylink Communications Ltd. (2007) and City Inn Ltd. v. Shepherd Construction Ltd. (2007) apportionment approach was approved by judges. In the apportionment approach delay losses are apportioned between culpable and non – culpable causes of delay, predicting that these usually coexist and it would be fair to use it in global claims. In the case of City Inn Ltd. v. Shepherd Construction Ltd. (2007) it was found a suitable approach by judge to be used with JCT type forms. It is claimed that except JCT forms the rule may be hardly used as other contract forms might have "precisely defined rules that differ" from that of JCT forms. (Egglestone, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 297) Judge decision in City Inn has been heavily criticized for not taking precedent into account and it is stated that using 'Malmaison test' would have been more appropriate for the awarding of damages and extensions of time in that case. (Winter 14-16)

The first in line approach takes the first event that happened prior to the concurrent event as responsible from the delay. It is claimed that a drawback of this approach is that the results do not reflect the impact of culpable delay (Keane, Caletka 205).

Braimah notes that this approach is mainly based on the idea of but for test (Braimah 50). ‘But for test’ is a legal test for finding out the factual causation of an event in which events are listed in chronological order and are read in consequence such that event A would not have happened but for event B. This goes on until ‘de minimis’ rule applies which does not take events which are so little effective on the happening of another event so that it is not taken into account in explaining the causation of the other event. This legal approach has been applied in some extension of time cases however Marrin states that this approach has not attracted so much support in following cases and is not used any more (Marrin 10-11).

The American approach takes the view that when there are concurrent delays on a project “neither party will recover financial recompense unless and to the extent that they can segregate delay associated with each competing cause and prove the delay upon which it relies. (Marrin 9)

Another well – known approach of the courts to extension of time claims when there are concurrent delay events is called the ‘Malmaison test’. The name comes from the case of Henry Boot Construction (UK) Ltd. v. Malmaison Hotel (Manchester) Ltd. (1999). The rule suggests that when there are not any other words to the contrary in the contract, the contractor would be entitled to an extension of time in case of concurrent excusable and non – excusable delay events. ‘Malmaison test’ has been approved by authorities as appropriate especially when there are ‘simultaneous’ causes of delays. (Winter 16) A survey result conducted by Scott and Harris in 2004 also reveals the fact that UK claims professionals favour the Malmaison approach to be used by the courts. The same survey also reveals that unlike the general rule, most professionals believe that contractors should be paid compensation in case of concurrent delays. (qtd. in Bramiah 54)

Concurrency is one of the matters taken into account in the SCL Protocol. The protocol states in Guideline Section 1.4 that though there are differing views and approaches to the issue of concurrency, its view on the subject is that the contractor’s entitlement to a time extension shall not be reduced in case of a concurrent delay event occurring. SCL states that separate analysis should be made in order to decide whether compensation should be paid to the contractor. It suggests analysing employer risk event first. The SCL protocol suggests making of delay events as soon as they occur rather than the classical approach of the courts which prefer 'after the event' analysis and dominant event approach. SCL especially underlines that its approach is based on the prevention principle of the English Law according to which an "employer cannot take advantage of the non – fulfilment of a condition, the performance of which the employer has hindered" (SCL Delay and Disruption Protocol 15-18).

Three scenarios are used to explain the approach of SCL to the issue of concurrency by Keane and Caletka; in the first scenario employer risk event and contractor risk event occurs at the same time period and have concurrent delay effect. In this scenario both parties would argue for damages and contractor would also argue for extension of time award. It is stated that SCL Protocol suggests extension of time award to contractor, no prolongation costs, "but payment of costs arising directly as a result of the employer's delay event" (Keane, Caletka 207-209).

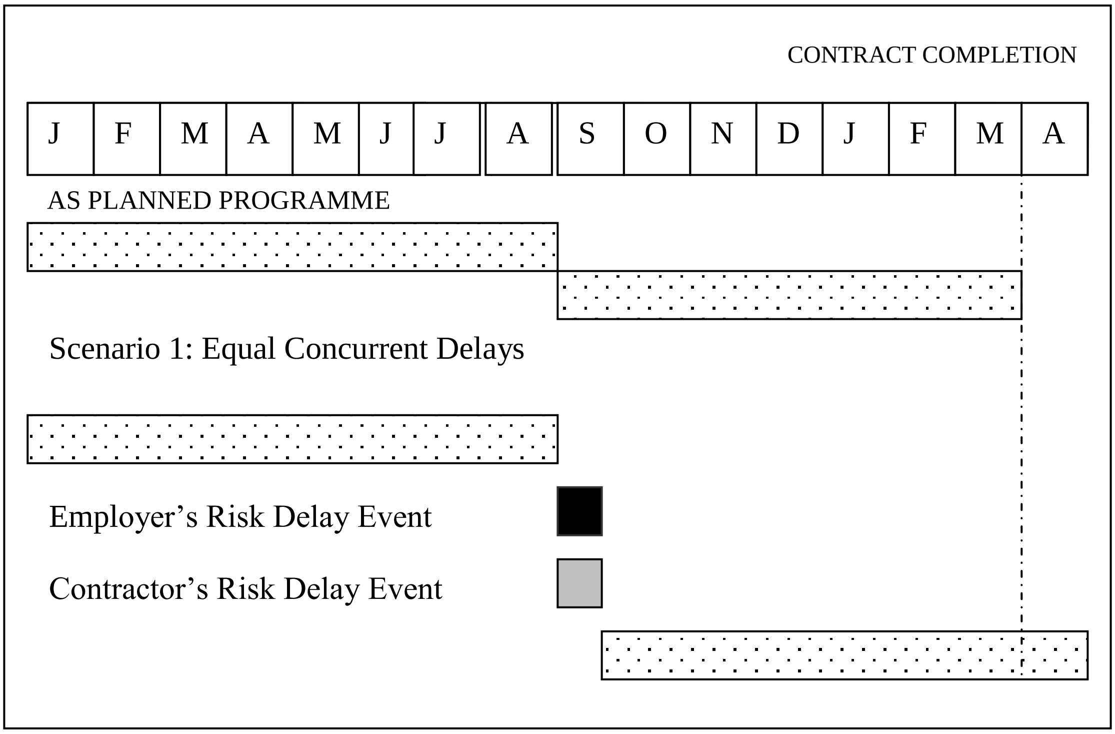


Figure 3.1 SCL Concurrency Scenarios – Scenario 1 (Keane, Caletka 208)

In the second scenario there is a two month employer delay event occurring concurrently with one month contractor delay event. Both delays are on critical paths as in first scenario. In this scenario contractor would argue for a two months extension of project completion date and two month prolongation costs while the employer would argue that the contractor is entitled to one month extension of time and one month prolongation costs. The SCL Protocol in this case suggests a two month extension of time and prolongation costs for one month awarded to the contractor. Costs arising directly as a result of employers delay also are due to be paid to the contractor.

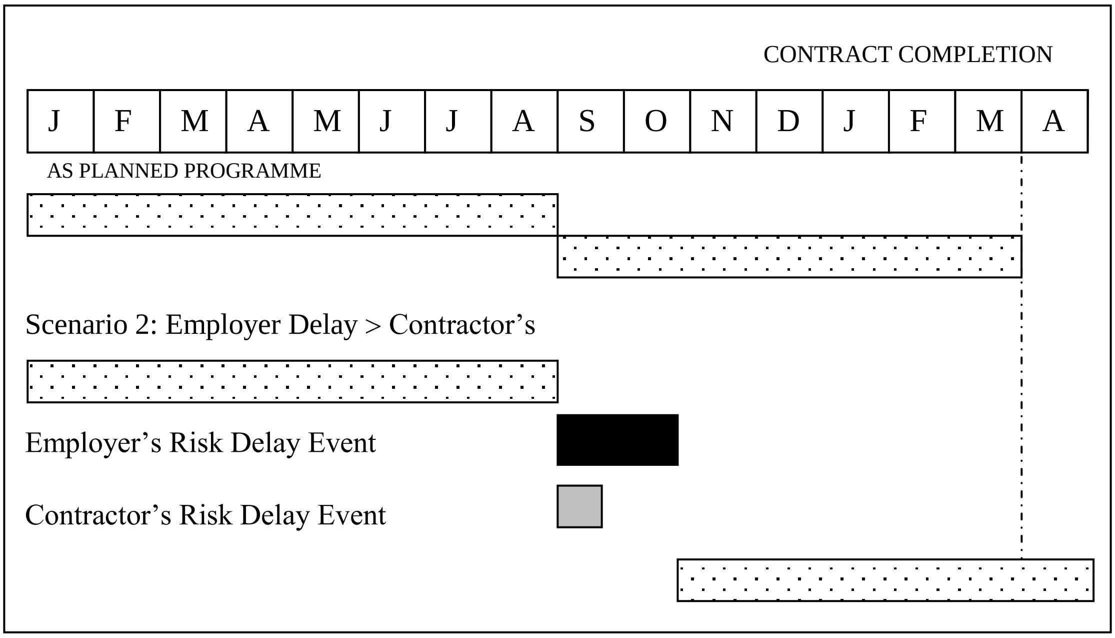


Figure 3.2 SCL Concurrency Scenarios – Scenario 2 (Keane, Caletka 208)

The third scenario consists of a one month employer delay and a one month contractor delay occurring concurrently in the same time period ands a further one month contractor delay. The contractor might claim a one month extension of time and one month of prolongation costs, whereas the employer might argue that there is neither entitlement to an extension of time nor any prolongation costs. The SCL Protocol advises one month extension of time entitlement, no prolongation costs, but payment of costs arising directly as a result of the employer's delay event.

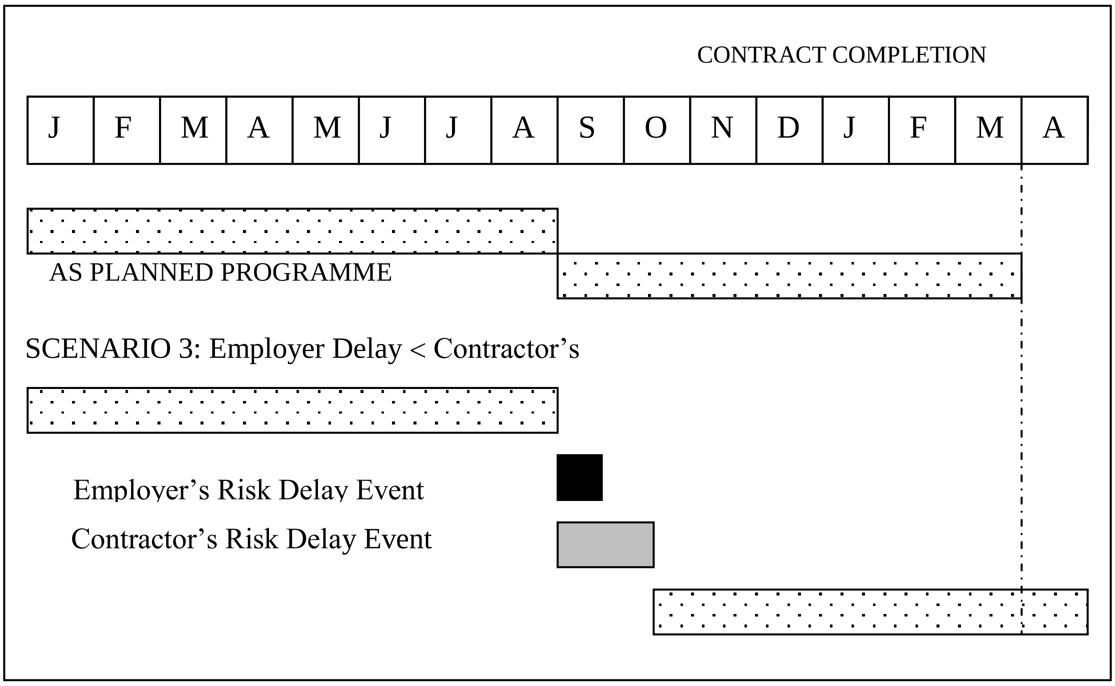


Figure 3.3 SCL Concurrency Scenarios – Scenario 3 (Keane, Caletka 209)

SCL protocols approach to time and cost matters in concurrent delays have been criticized in respect that it separates these issues without stating exactly the principles in identifying costs to be awarded. Adams refers to Marrin and states that JCT, ICE and FIDIC forms all would lead to similar results about award of costs and time in concurrent delays; that is, "the award of any EOT must carry with it an award of prolongation costs, irrespective of concurrent delay" (Adams 5).

3.2.1.3 CRITICALITY

Delays may either occur on a critical path or a non – critical path. A delay that occurs on a critical path is called a 'critical delay' and would delay project completion time. A non – critical delay on the other hand would not delay the project completion time and would not be awarded any time extensions though non – critical delays consume floats on their paths. The concept of criticality derives from CPM usage. In the network logic a path may be critical if it is the longest path and / or it has zero or least float value on the network. AACE notes that using advanced scheduling techniques makes some differences in identifying the critical path. It is noted that most practitioners agree that the longest path on the network is the critical path. A negative float value would show that the path is behind the schedule and completion date for the project is already delayed. It is noted in AACE that there are two schools for interpreting the criticality of paths with negative float values. First, the zero total value school assumes that all negative total float paths are critical while the second school of thought assumes that lowest total float path below zero is the critical path. The difference is that zero float value school defines the critical path as anything less than total float of one unit. If it is assumed that the critical path is the path with least float value than the zero float thinking is more acceptable while the longest path definition accepts the least float value understanding more. AACE notes that the two approaches are not logically inconsistent and which of the definitions is correct depends on the principles. CPM principles point towards the lowest total float value school however the contractual approach to the project completion date would point towards a zero float value approach as all negative value paths impact project completion date (AACE RP 29R-03 87).

Another concept related to criticality is 'near – criticality'. Near criticality is rather a technical analysis concept than a fundamental one, it is important for analyzing delays using CPM calculations. In order to prevent analyzing all activities and all delays in a project the concept of near criticality is produced. Near critical activities are the activities that are on the brink of becoming critical activities, they have float values that are near to the critical float value. Near critical activity delays are "the most likely suspects of concurrency, and therefore must be analysed for partial concurrency to the extent that the net effect of that delay may exceed such relative float" (AACE RP 29R-03 88). Near critical activities may differ according to the structure of each project. Some factors regarding the determination of near critical activities are listed by AACE as follows:

- Duration of discrete delay events
- Duration of analysis interval
- Historical rate of float consumption
- Amount of time or work remaining on the project. (88-89)

Duration of discrete delay events is a criterion in quantifying the near critical activities. The calculation of the near critical activity float values may either be done using the maximum duration of all the delay activities or using the average value of all the delay activities occurring on the project. The maximum or the average measure is added to the value of the float value of the critical path to obtain the near – critical float value. Any schedule activity or path carrying a float value between that value and the value of the critical path float is taken as near critical activity or path. On the matter of detail of the analysis, AACE RP stresses the fact that "while ensuring a finer granularity of delay events gives rise to added work in modelling and documenting those delay events, the trade – off is less number of activities to analyse for concurrency" (AACE RP 29R-03 88).

Duration of analysis interval means the duration used to analyse for each window or duration used from start to finish of each segment of the analysis. A method used by for quantifying the near critical activities is adding the duration of analysis interval to the float value of critical path. The logic underlying the method is that the potential change in the critical path due to the progress of the works during the analysis interval shall be equal to the duration of that interval (AACE RP 29R-03 89).

An important point to note about the analysis interval criterion is that, when this method is used the float consuming pace of the activity chains shall be taken into account with respect to the analysis interval. This means that if an activity on schedule is seemed to consume floats fast, that is, more than the analysis interval duration, this shows that it is on a trend to become critical in near future and though it may not be on the near critical criteria at the time the analysis takes place, it might be taken as a near critical activity (AACE RP 29R-03 89).

A last consideration of near criticality is the amount of time or work remaining on the project. If a project is coming to the end, activities may be performed out of sequence to meet an aggressive project deadline; AACE suggests, after 90 – 95 percent completion on a project, to take all activities in the near critical criteria 'regardless of float' (AACE RP 29R-03 89).

Except from its technical meaning in programming terms, some studies take criticality in construction delays in its practical meaning; Lyden categorizes criticality of activities as 100% critical, fairly critical, non – critical but possible cumulative effect and zero critical (Lyden 6). He lists the criteria for his classification as;

- Size and complexity of the activity
- Site restrictions
- Timing
- Location of the site
- Contractor’s site and organization
- Type of Project
- Availability of resources
- Legal Constraints. (6)

3.2.1.4 FLOAT OWNERSHIP

Float ownership is one of the most controversial and most discussed issues in literature. Caletka defines a float as “the time difference between a sequence of activities and the critical path. Where float is present an activity may be started later than its early start date, yet not prolong the project” (Keane, Caletka 191). Gibson defines float as function of the programme network whose amount and position within a programme is dependent upon the manner in which the network has been constructed. A non – critical activity has float that can be consumed until the activity becomes critical. If the delay continues, then the activity’s float will become negative, and there will be a critical delay to the completion of the project (Gibson 121-122).

There are different types of floats and each defines different concepts. As an activity in a project has at least one predecessor activity and one successor activity in the project schedule, each of which has an earliest start and latest start dates with earliest end and latest end dates, there are four types of float.

Total float defines the amount of time that an activity can be delayed without affecting the total project completion time. The British Standard BS 4335; 1987 defines total float as; the time by which an activity may be delayed or extended without affecting the project duration (qtd. in Gibson 121). It is calculated as follows: Total Float = latest end event time – earliest start event time – duration.

Free float defines the amount of time that an activity in project schedule can be delayed without delaying the successor activity. It is calculated as follows:
Free Float = earliest end event time – earliest start event time – duration.

Late free float signifies the time equal to latest end event time less latest start event time less duration and is of no practical significance. It is calculated as:
Late free float = latest end event time – latest start event time – duration.

Independent float is the amount of time by which an activity can be delayed or extended without affecting the preceding or succeeding activities. It is calculated as follows:
Independent float = earliest end event time – latest start event time – duration.

Bunni states that 'independent float' when the delay that occurs in an activity is shorter than the independent float duration, then that delay would not delay project completion though it is possible that it would cause disruption in the project (Bunni 362).

Float is useful for the purpose of optimisation of resources for the contractors or to absorb non – critical delays due to contractor's fault, from the viewpoint of the contractor. In most standard forms of contract, it is unclear whether it is the employer or contractor who owns the programme float. It is stated that most contracts lack provisions regarding ownership of float, except those used for public works in US (Lowe et al. 7). Winter states that the float is created by the contractor in his own programme to overcome delays and problems, not to "accommodate the employer's" so belongs to the contractor. He states that starting from the time of 'Malmaison' case there has been a trend to take only the delays on critical paths into account by the English courts (Winter 17).

SCL Protocol keeps the view that when a contract contains language stating that contractor will be entitled to a time extension when the employer delay delays the project completion then the project owns the float, however when the contract is drafted so that the contractor is entitled to time extension when there is employer delay, then the contractor owns the float (SCL Delay and Disruption Protocol 14).

Lowe underlines the fact that such as the SCL Protocol, US practice is also supportive of the idea that in the absence of any contractual provisions, project owns the float (Lowe 9). Adams reports a recent industry survey reveals that 80% of the construction professionals are of the opinion that float belongs to the contractor. He criticizes SCL Protocol for its approach that, if there is not any contractual provision float belongs to the project, and finds it 'dubious and untenable'(Adams 4).

3.2.1.5 PACING DELAYS

Pacing delay is defined as "a delay resulting from a conscious and contemporaneous decision to pace progress of an activity against another activity experiencing delay due to an independent cause" (Hoshino 1). The concept of pacing delay is closely related with the concept of concurrent delay. Concurrent delay is in consideration when another independent delay or delays effect the completion time of the project other than the subject delay which already delays the project completion. Pacing delay, on the other hand, occurs when that independent delay other than the subject delay is a result of conscious decision of the employer or the contractor to pace the progress of the works. In literature, the subject delay is called the parent delay. The main difference, then, between a pacing delay and concurrent delay is the consciousness and voluntary action in the causation of the delay. Pacing delays are not a result of involuntary problems. Pacing delays can be performed by using different techniques. Works can be slowed down by making less production in unit time, works can be wholly suspended by stopping work on site, resources can be reduced to minimum etc. AACE RP defines the aim of pacing delay as

> by pacing the work, the performing party is exercising its option to reallocate its resources in a more cost effective manner in response to the changes in the schedule caused by the parent delay and thereby mitigating or avoiding the cost associated with the resource demands if one were to 'hurry up and wait'. (84)

In programming terms, pacing delay can be identified as the consumption of the float that is created by the 'parent delay'. When the 'parent delay' occurs that causes the creation of total float on other activities which can be consumed. By pacing the works, the party that does the pacing delay, takes the advantage of this relative total float to use its resources in a more cost effective manner. It is stressed that pacing is believed to save money or effort to the implementing party without penalty (Hoshino 1).

Practically, pacing delay can be divided into two different groups; direct pacing and indirect pacing. When the parent delay occurs in an activity that is predecessor to the activity that is paced, this is called direct pacing, paced activity is on the same path with the delayed activity and consumes float created on the same path. The reduction in crew size or slowing of the works by less production is typical examples of direct pacing. This kind of pacing is not very problematic and sometimes is not even considered as pacing because there is not concurrent delay. Delay that is usually discussed under the heading 'pacing delay' in literature is often the second type of delay which is 'indirect' pacing. In this kind of delay, the activity that is being paced or in other words that is being delayed voluntarily, is not directly dependent in a predecessor / successor relationship, on the same path, with the activity that the 'parent delay' occurs. Pacing delay in indirect pacing, shares the same time frame with the parent delay, as a function of schedule timing, and is concurrent with it (Hoshino 1). AACE RP uses the example of **"**landscaping subcontractor who demobilizes its crew and returns at a later time because critical path work in the building has been delayed" to describe indirect pacing (AACE RP 29R-03 84). For the activity that is being paced, relative total float is created by the parent delay and it is being consumed. The practice would be done typically by reduction of resources or stopping the whole works.

In practice pacing delay is used by the party who does it as a defence to concurrent delay claims by the other party. When there is a concurrent delay event, the party who is responsible for the 'parent delay' would want to escape from the burden of costs by claiming that there is concurrent delay. This typical claim is opposed by the other party with the counter claim of pacing delay. This practice reveals the character of pacing delays that they are not distinct delay events but an alternative interpretation of a concurrent delay event position in the project. As long as there are not any concurrent delays, there would not be an issue of pacing delay. From the viewpoint of the contractor, pacing works is generally an accepted right and contractor is not liable for damages occurring, especially in case law jurisdictions.

J.Wickwire et al. reflects this approach as "where the government causes delays to the critical path, it is permissible for the contractor to relax its performance of its work to the extent that it does not impact project completion" (qtd. in Prateapusanond 100). Common law jurisdictions prefer, on the issue of float ownership, first come first served basis, thus the shared ownership of float by parties and their view of the concept of pacing is in accordance with that view (Lowe 9). The issue of compensability is in the heart of debates concerning pacing delay; an accepted pacing delay would change the quality of parent delay in respect of compensability. The following table summarizes different scenarios.

Table 3.5 Net Effective Matrix – Pacing Delay – Contractor Perspective
(AACE RP 29R-03 85)

DELAY EVENT	CONCURRENT WITH	NET EFFECT
Owner Delay	Another Owner Delay or Nothing	Compensable to Contractor, Non excusable to Owner
Contractor Delay	Another Contractor Delay or Nothing	Non excusable to Contractor, Compensable to Owner
Force Majeure Delay	Another Force Majeure Delay or Nothing	Excusable but not compensable to either party
Owner Delay	Contractor Pacing	Compensable to Contractor, Non excusable to Owner
Owner Delay	Force Majeure Delay	Excusable but not compensable to either party
Contractor Delay	Force Majeure Delay	Excusable but not compensable to either party

Employer has also the right to pace, so pacing must not be viewed only from the viewpoint of the contractor. If employer does a valid pacing of the works that would make an excusable contractor delay a non excusable one. Pacing delay is often used when there is compensable delay at issue and when there is not guidance in contract or it is not clear whether the other delay is pacing or not, experts have created some basic guidelines to clear the position of existing delays, AACE Recommended Practice for Forensic Schedule Analysis lists them in descending order of importance as; existence of parent delay, showing contemporaneous ability to resume normal pace and evidence of contemporaneous intent (AACE RP 29R-03 86).

1. Existence of the parent delay: Pacing delay is created as a reaction to parent delay which already exists, so it cannot occur by itself. The parent delay must be equally or more critical than the pacing delay, that requires of a comparison of total float values of delayed activities in the programme schedule. It is stressed that in large projects delayed activities may become quite complex and defining pacing may become difficult but the basic requirement is that parent delay must precede the pacing delay. Using near critical activities in determining pacing delays may be helpful.

2. Showing of contemporaneous ability to resume normal pace: It is obligatory that the contractor shows that he had the ability and resources necessary to complete the paced activity on time, had there not been any pacing. This requirement is strictly close to the idea that the delay in the activity is a result of voluntary decision of the contractor and not any other problematic issues out of control. Contractor has to show that he used his initiative to slow down or suspend works and he had the ability to resume progress at normal rate.

3. Evidence of contemporaneous intent: This requirement aims to prevent the using of pacing as a defence retrospectively for a delay what was in fact a concurrent delay. Contemporaneous intent must be presented in order to show the voluntary intent of pacing at the time delay occurred. After the fact analysis is not very helpful in this respect especially in the form of testimony. Best proof of contemporaneous intent is the written documents showing pacing though in practice this is not very commonly used so it is stressed that this requirement is not as important as the preceding ones. (AACE RP 29R-03 86) It is stressed that when pacing "is argued with hindsight, it should be treated with both caution and scepticism, especially when the assertion is unsupported by contemporaneous records" (Keane, Caletka 213).

Keane, Caletka lists the following factors to be demonstrated for the acceptance of a delay as a pacing delay by the relevant party;

- Knowledge of the more critical excusable delay,
- Evidence of an express decision to pace its works,
- Notification to the employer / contractor that its works would be paced so as not to cause further delay and / or disruption to the works,

– The ability to reinstate normal outputs if the pre-existing delay was mitigated or avoided. (212)

3.2.2 DELAY ANALYSIS

3.2.2.1 DELAY ANALYSIS METHODS

To recover damages resulting from delays that the other party is liable for, the party which seeks damages must prove three basic elements; proof of liability of other party, proof of causation and proof of damage. Delay analysis is mainly done for the purpose of proving causation between liability and damage. (Tieder 2, Farrow 4) It is done with an aim to find out the causes and effects of various delays throughout the project process. It can be done on the basis of a cause analysis or effect analysis prospectively or retrospectively. There are various methods for analyzing delays in a project. Although different names may be used for different methods, the method used for delay analysis purposes should be a standard one for the courts to take it into account. (Tieder 18) Farrow divides the delay analysis methods in two major groups; theoretical based methods and actual based methods. He includes the global and net impact methods, the as planned but for, the as planned impacted and the as built but for methods under theoretical based methods while as planned v. as built, window / snap shot, and the impact update methods are included under actual based methods. (Farrow 6) Barry names delay analysis methods under five headings; impacted as planned method, time impact analysis method, collapsed as built or but – for analysis, snapshot / windows / time slice analysis, as planned v. as built method (Barry 1).

In literature many different classifications and methods can be found under different names. In this research, methods will be summed up in five main headings similar to the classification of SCL Delay and Disruption Protocol with additional method of float mapping.

As built vs. as planned method is the simplest method of all techniques. Method is mainly built on comparing the as planned schedule prepared before the project start with the as built schedule. It is an observational and retrospective analysis method. The analysis does not involve any addition or subtraction to or from the schedules.

Lowe et al. state that in US as planned v. as built method is seen as more accurate than the impacted as planned or collapsed as built methods. (Lowe et al. 15) AACE Recommended Practice for Forensic Schedule Analysis names the method as observational / static / gross analysis method and lists its strengths as;

- Easy to understand,
- Based on as built critical path,
- Technically simple to perform,
- Can be performed with very rudimentary schedules,
- Can be performed with very little as built data,
- Closely related to actual events. (36-37)

Its weaknesses are also listed as;

- Not suitable for projects of extended duration,
- Not applicable to projects built in a manner significantly different than planned,
- Not suitable for complicated projects with multiple planned critical paths,
- Less accurate as the analysis advances through the project,
- Relatively time consuming when implemented correctly. (37)

During the application of the method the start and finish dates of activities are compared on the schedules. When conducting the analysis, choosing the late planned dates rather than the early ones is suggested as delay to an activity cannot be realized before the late planned dates are passed. “If the baseline schedule has both early and late dates the analysis should be performed using late dates unless reviews of the late dates reveal that the logic associated with the late dates is significantly different than the logic of the early dates” (AACE RP 29R-03 34). If the schedule has significant logic differences from the logic associated with the early dates, then it should be corrected.

AACE Recommended Practice for Forensic Schedule Analysis lists the basic steps for method as follows:

1. Identify the baseline schedule. This schedule can be a CPM model or a graphic – time scaled diagram. Original planned logic should be evident from the programme schedule. Sequence of activities and their timing should be available. If the project proceeds using new baseline schedules then both the previous and latter baselines should be taken into account

2. Comparison is done tracing the planned logic, possibly on the critical and near critical paths, at least until the first delay is observed.

3. Delayed starts, extended durations, delayed finishes are identified for each activity. A table is prepared in which each activity's planned and actual durations and the cause of any changes, if any, is shown. The aim is to identify the most significant delays that occurred, possible mitigations and accelerations.

4. Observation of out of sequence logic can be helpful in identifying mitigations and shorter than planned activity durations can be helpful in identifying acceleration. A table consisting of any logic changes in programme schedule, with the causes of those changes is prepared.

5. Simultaneous delays are identified.

6. Logic changes to original programme as the project advances should be taken into account and carefully identified, as the results would become less accurate without taking these changes into account.

7. Causes of extended and shortened durations are identified.

8. Time extensions awarded should be considered as they will change the overall delay to the project. (AACE RP 29R-03 33)

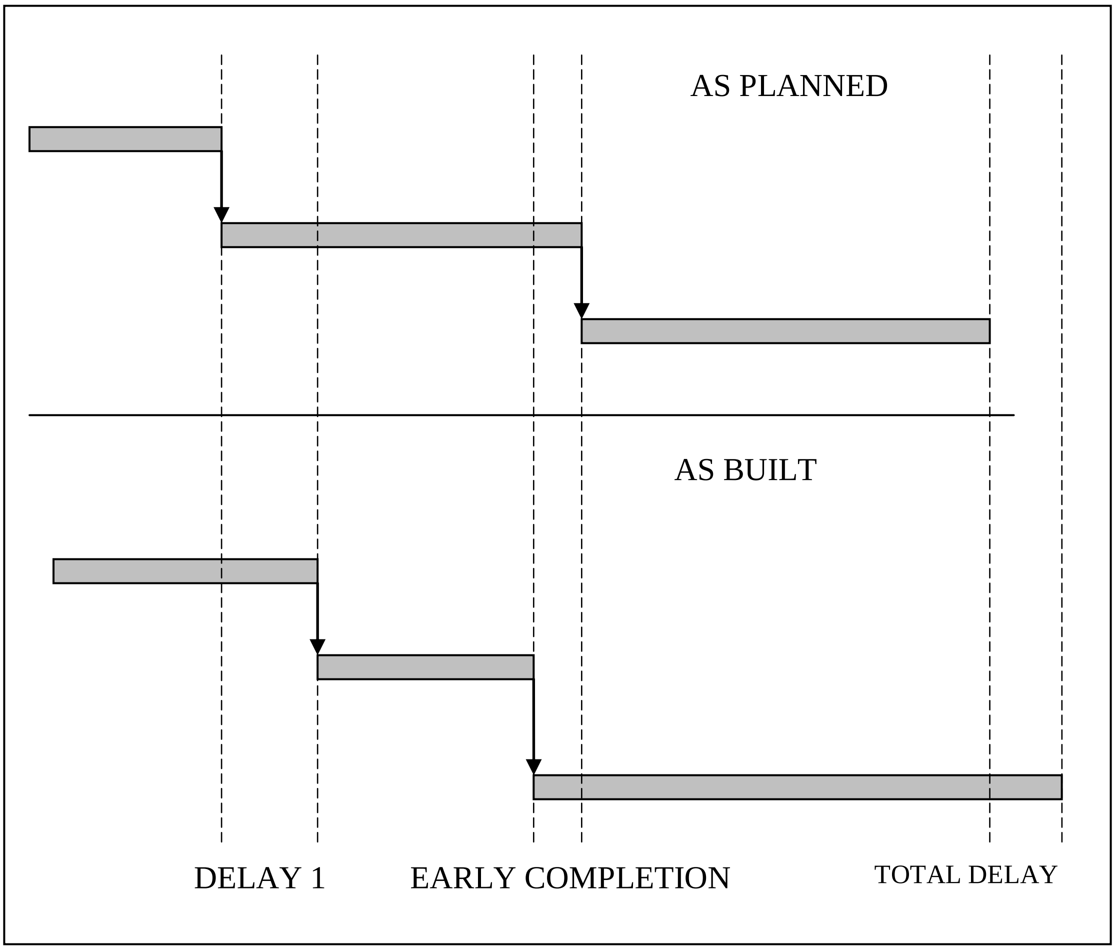


Figure 3.4 A simple model for as planned v. as built method

As planned vs. as built model is often seen as the simplest form of all delay analysis models since it does not require complex procedures though it can be used for large scale projects if it is done on a daily basis. This method is called daily delay measure. DDM is based on identifying activities that are on critical and near critical paths. DDM compares late start and finish dates with as built start and finish dates. It can be done on a daily, weekly or any other periodic basis. This practice, however, is labour intensive and requires detailed comparison of as planned vs. as built schedules. As built and as planned programme schedules are taken such that each has daily activity details (AACE RP 29R-03 34).

Another version of as planned vs. as built method is applying the method in different periods so that delays can be more precisely identified. The method is called by AACE Recommended Practice for Forensic Schedule Analysis as observational / static / periodic analysis method. Using more periods would give the analyst opportunity to identify delays more easily. It is stated that rather than being more accurate, using periods only give efficacy to the analysis. (AACE RP 29R-03 37)

Impacted – as – planned technique is named by AACE Recommended Practice for Forensic Schedule Analysis as modelled / additive / single base analysis method. It is also known as the entitlement method or the programme of possible entitlement method. (Farrow 8) The method is a modelled one because it creates a simulation of a scenario, it is additive because the simulation is created by adding new delay activities to original baseline and is single based because it is applied on a single baseline though it may be used on multiple baselines as well.

The application methodology of the analysis is as follows; the baseline programme that will be used for the analysis is prepared. If there is not an available baseline programme or programme logic has changed during the project, an amended baseline can be used though the amended baseline should be agreed by the parties to avoid further disputes on the programme. The second step is adding delays to the original programme as activities. Delays are identified using the project documents and original programmes then they are taken as delay events and are added to the baseline programme. Delay events can either be added separately as employer delay events and contractor delay events or they can be added together. Delay events are added to the baseline programme using logical predecessor and successor links. Delay events can be added one by one thus giving the opportunity to seek impacts of each delay event on the project or they can be added altogether showing the total impact on the project. Inserting delay events one by one is called stepped insertion, inserting delay events together is called global insertion (Keane, Caletka 127-130).

Concurrency may be found by comparing the results of employer delay events total effect on the project completion with contractor delay effects total effect. After using impacted as planned method the completion date obtained may be different than that obtained actually. Caletka states that the difference may be as a result of several factors such as deviations from the as planned sequence, deviations from the as planned durations, additional delays not considered in the impacted as planned model or a possible mitigation on the critical path (Keane, Caletka 131). Advantages of the impacted as planned technique are listed in AACE Recommended Practice for Forensic Schedule Analysis as;

- It is easy to understand,
- It does not require an as built schedule,
- It can be implemented relatively easily and quickly compared to other methods. (63)

Farrow also finds the method strong in respect that it does not require as built schedule; a schedule of delay events with an as planned programme is enough to conduct an analysis. On the other hand, he states that the original programme may not be correct and there might have been logic changes throughout the project progress which are not reflected in the analysis results. He also claims that as the analysis lack the as built data, some delays that have not actually delayed the works may be taken as delaying the works, hence, does not reflect the real project progress logic (Farrow 9). AACE Recommended Practice for Forensic Schedule Analysis lists the disadvantages of the impacted as planned method as;

- It does not rely on an as built schedule it is hypothetical and produces theoretical results unlike observational analysis models,
- It cannot identify true concurrent delays. (63)

In US, the impacted as planned method has been rejected by the courts and commentators as an accurate retrospective delay analysis method. It is found too theoretical and as a legally unacceptable method of proof. “In the light of the almost unanimous rejection of this method by US courts and commentators, it is unlikely that, in the absence of extraordinary circumstances, any American adjudicator would accept it as appropriate” (Lowe et al. 17)

Barry states that decision makers on delay claims are primarily interested in whether delay to project completion was actually incurred as a result of delay event used in analysis. He finds impacted as planned disadvantageous in this respect, he adds that impacted as planned should only be used when the contract expressly requires so (Barry 3).

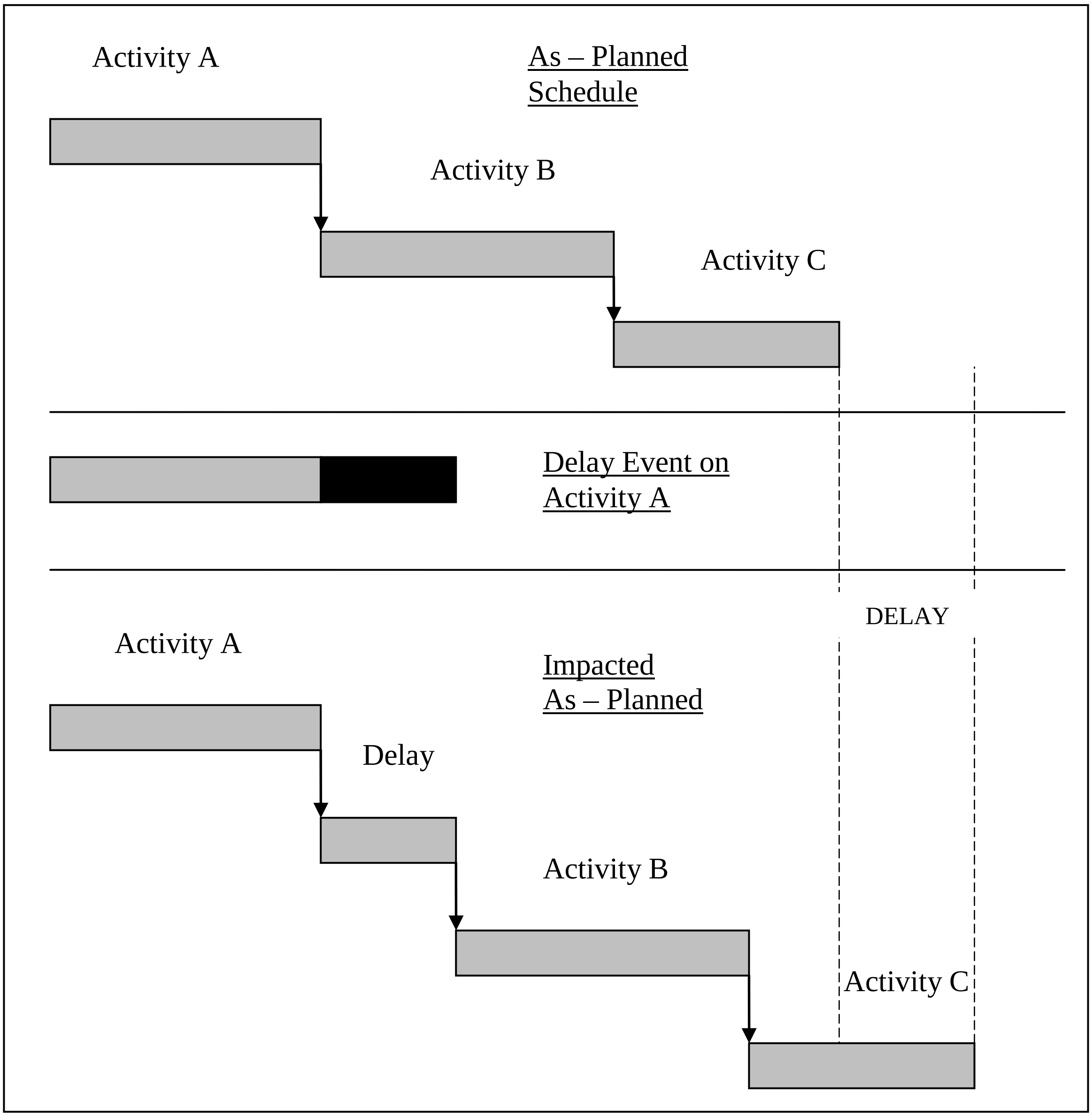


Figure 3.5 A Simple Model for Impacted As Planned Method

There are various names for the analysis method which in this research is called 'Time impact analysis'. Time impact analysis is sometimes used as the common name of all delay analysis methods. The name 'Windows analysis' is also used but the main difference is that, windows analysis is done on a periodic basis in which the periods are often chosen as update intervals such as a month, while in the so – called time impact analysis 'snapshots' are used which identify the delay event time

(Gibson 180, Ottesen 5). Time impact analysis is similar to impacted as planned method but uses multiple basis unlike the impacted as planned analysis method. The method is referred by AACE Recommended Practice for Forensic Schedule Analysis as modelled / additive / multiple base analysis model. Time impact analysis is also known as the preferred method of Society of Construction Law. Time impact analysis is a modelled method as it uses a hypothetical simulative model for analysis. It is additive because it is based on adding delays as activities to multiple baseline programmes and it is, unlike impacted as planned method, a multiple base analysis method because it uses multiple impacted baselines for analysis. It is a contemporaneous analysis method. Contemporaneous analysis is defined by Wickwire as "starting the analysis with the beginning of the project and then stopping at various reference points monthly or quarterly during the life of the project to determine the location of the critical path, along with any delays or positive time gains to the project (by evaluating positive or negative float generated on the critical path during the period in question), until the completion of the project is reached" (qtd. in Ottesen 8-9).

Time impact analysis can either be used for a retrospective or prospective analysis. In retrospective analysis, delay events durations are found from the documents such as letters, notices between parties, moments of meetings and updated programmes. These durations are added and linked to baseline schedule using logic predecessor and successors. At this point the model takes the form of a hypothetical simulation and experience of the analyst is an important necessity for the success of the analysis. When used prospectively, the duration of a delay event would be guessed using past experience and the best result can only be taken if an agreed duration between the parties is used for analysis. SCL protocol proposes using TIA retrospectively with a hindsight approach to delays. That means that when assessing delays that occurred throughout the project, it recommends considering delay from the viewpoint of whether the contractor 'should have been given extension of time' at the time delay occurred (SCL Delay and Disruption Protocol 49). Lowe states that this approach will not be consistent with the American approach of retrospective use of TIA and in US; events that have happened after the delay event occurred will also be taken into account when considering the grant of extension of time to the contractor. (Lowe et al. 21-22)

AACE Recommended Procedure lists the strengths and weaknesses of the time impact analysis as follows:

- It is easy to understand,
- It does not require an as built schedule. (68)

Keane, Caletka adds that time impact analysis relies on contemporaneous intentions meaning that it takes the logic changes during the project and the critical path changes into account. On the other hand its weaknesses are;

- It does not rely on an as built schedule so it is a hypothetical model.
- It is labour intensive, technically complex and requires frequently prepared progress schedules. (139)

Procedure of time impact analysis is stated as follows:

- Delay events and their duration are identified using project documents.
- A table comprising the predecessors, successors, durations and commencement dates of delay events are prepared.
- Delay events are classified as employer delay events, contractor delay events and third party delay events according to the risk sharing assessed in the contract documents.
- The contemporaneous project programme, which reflects the progress of the project just prior to the delay event, is taken as baseline to the analysis. This process is also called a putting a snapshot to the project.
- Baseline programme's data date and completion date is noted.
- Delay events are inserted into the baseline programme as separate activities using logic predecessors, successors and durations. Insertion can be made using individual delays or a fragnet is created comprising relative activities and inserted to the programme.
- Fragnets, delay events are inserted into programme chronologically and new completion dates are noted on the table. Employer and contractor risk events

are inserted separately and collectively in order to find approximate concurrent delay events.

- A table of results is created and any anomalous results are reviewed. (Keane, Caletka 131-140)

TIA is, as stated above, preferred method of SCL Delay and Disruption Protocol. Protocol prefers using Time Impact Analysis for a prospective analysis during the project, in compliance with its approach that delays shall be considered whenever they occur, while the project proceeds (SCL Delay and Disruption Protocol 44).

An important matter in delay analysis is the identification of concurrency. Concurrent delays may, as explained above, be identified in time impact analysis by inserting employer delay events, contractor delay events and third party delay events separately and then entering these events collectively and comparing project completion dates for each addition. It is stated by commentators that the concurrency found in this way only reflects the approximate concurrency as a predictive model cannot identify true concurrency by itself (Keane, Caletka 139). AACE Recommended Practice for Forensic Schedule Analysis reflects this as one of major weaknesses of Time impact analysis method while Keane, Caletka finds it a strength of the method that it can identify approximate concurrency relatively easily in comparison with other methods (Keane, Caletka 139, AACE RP 29R-03 68). It is noted that time impact analysis can both give very accurate results, if done correctly, or very wrong results, if done incorrectly, due to the hypothetical nature of the method. If the best results are to be taken from the analysis then it is best practice for parties to agree upon using the method prior to analysis. Besides agreeing upon some variables such as duration of events in fragnet, successor and predecessors of delay events, baselines to be used, remaining durations of progressing activities might be extremely useful for the success of the analysis (Keane, Caletka 140).

Anomalies during the analysis stage may occur and identification of these anomalies is important in obtaining an accurate result. One of the reasons may be the changes of logic, changes in working periods or activity constraints reflected in progressing schedules of the project. Keane, Caletka recommends making optional analysis reflecting what the results would be if these changes were covered in prior programme schedules, in these cases (Keane, Caletka 134).

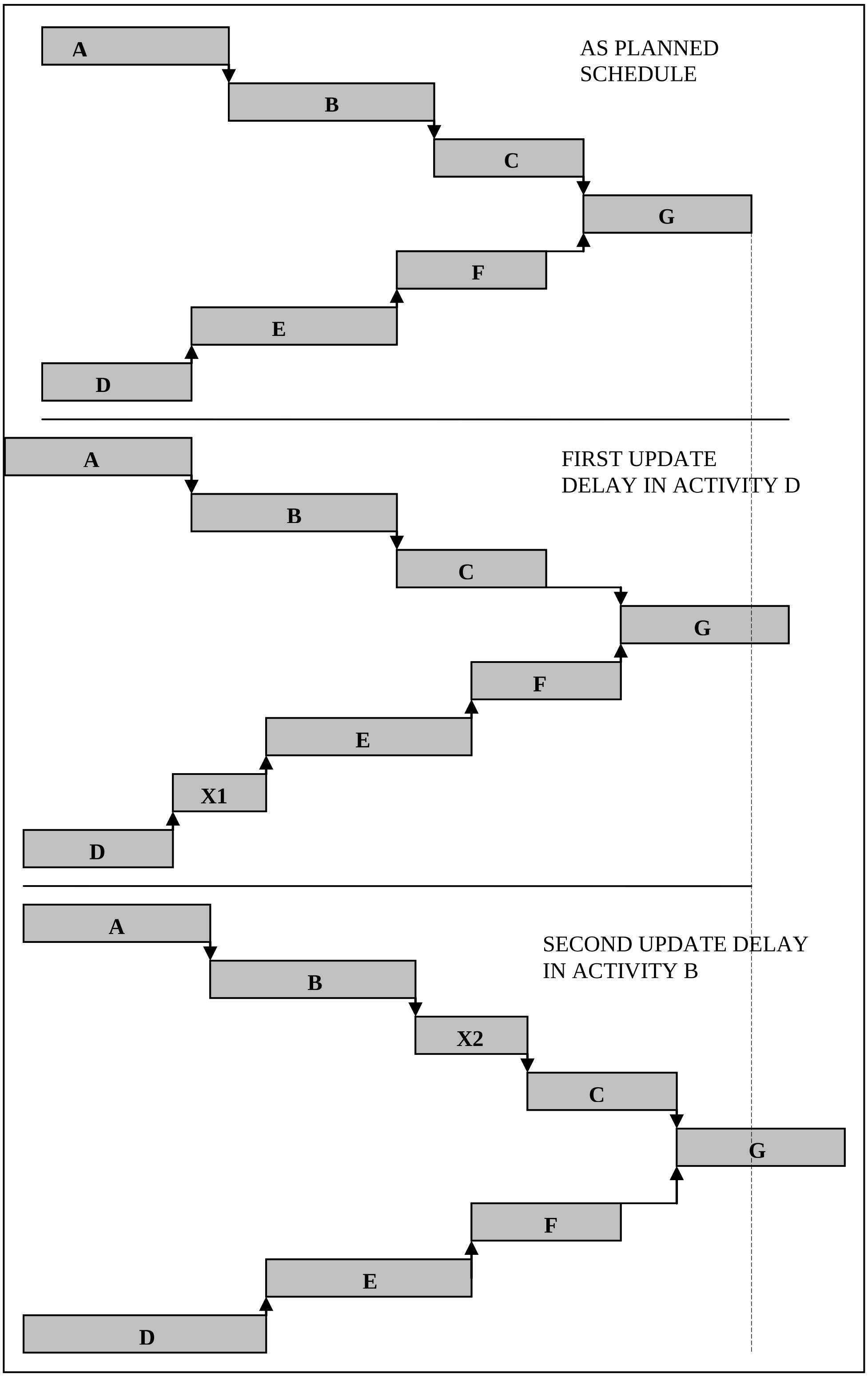


Figure 3.6 Time Impact Analysis Model

Another important point is using as many windows as possible. If delay events have excessive durations, breaking these delay events into smaller events which reflect the duration of the windows, would result in more accurate solutions. “The longer the fragnet, and the longer the duration between each base programme, the more prospective and theoretical the results will be” (Keane ,Caletka 135). Barry states that TIA may hardly create reliable results unless it satisfies the following criteria; a reliable baseline schedule, reliable programme logic in baseline programme, detailed and accurate progress data in the as built updated programmes, contractor’s future intentions correctly reflected in updated programmes, delay events inserted should be considered contemporaneously, all delay events should be considered (Barry 6-7).

Collapsed as built method is named as modelled / subtractive / single simulation method by the AACE Recommended Practice for Forensic Schedule Analysis. The method is also called as – built but for method or simulated as built programme method (Farrow 10). It is a modelled method as it creates a simulative model such as impacted as planned and time impact analysis models. Unlike the previous additive models, collapsed as built method is based on subtracting delay events from the as built programme, hence it is subtractive. It is called a single simulation model because it uses only the as built data and not any other multiple baselines (AACE RP 29R-03 69).

Collapsed as built method is based on finding out the alternative scenario in the case of delay events not occurring so it is a hypothetical method just as the impacted as planned and time impact analysis methods which are based on finding alternative scenarios in the case of delays ‘occurring’ not ‘not occurring’ (Keane, Caletka 140).

The practice procedure of the method is as follows:

- All delay events in the project are identified using the as built data. The delay events that will be extracted include all the delay events and extracting all the delay events would be helpful in identifying near critical paths as well.
- Delay events are extracted from the programme step by step or once at a time. They may also be extracted as employer delay events and

contractor delay events. In that case contractor delay events are extracted prior to extracting employer delay events to “allow the contractor the benefit of any pacing or concurrent delays” (Keane, Caletka 145).

- Delay events are extracted from the as built schedule in chronological order starting from the one with the latest finish time. The completion dates before and after the extractions are compared and if there is any difference it is noted. If there is no difference the delay is concurrent with other critical path delays or if it is not on any critical paths, then the float changes may be noted before and after the extraction in order to find out the near critical paths and critical path changes.
- The same extraction process is repeated until no delays are available on the project. (Keane, Caletka 145-146)

If there are anomalous results obtained during any step of the extraction process then the adjustments on the as built programme should be noted, if these affect the critical path it is advisable to make adjustments in previous steps and start from the first step. During the extraction process the method chosen for the extraction is important in respect of results of the analysis. Delay events may be given ‘zero’ duration or they may be totally dissolved linking the successor of the activity to its predecessor, either method may be chosen but consistent application of the same method is essential (Keane, Caletka 145).

The method has various advantages and disadvantages. AACE Recommended Practice for Forensic Schedule Analysis finds the easy concept of the method as one of its strengths. Using only records of actual events and its elimination of any discussions on the validity of a baseline are other strengths of collapsed as built. It does not require any baselines or progress schedules so it may be practiced using relatively less data. It is also a dynamic model that can take critical path changes into account and can identify concurrent delays (AACE RP 29R-03 76, Keane, Caletka 149).

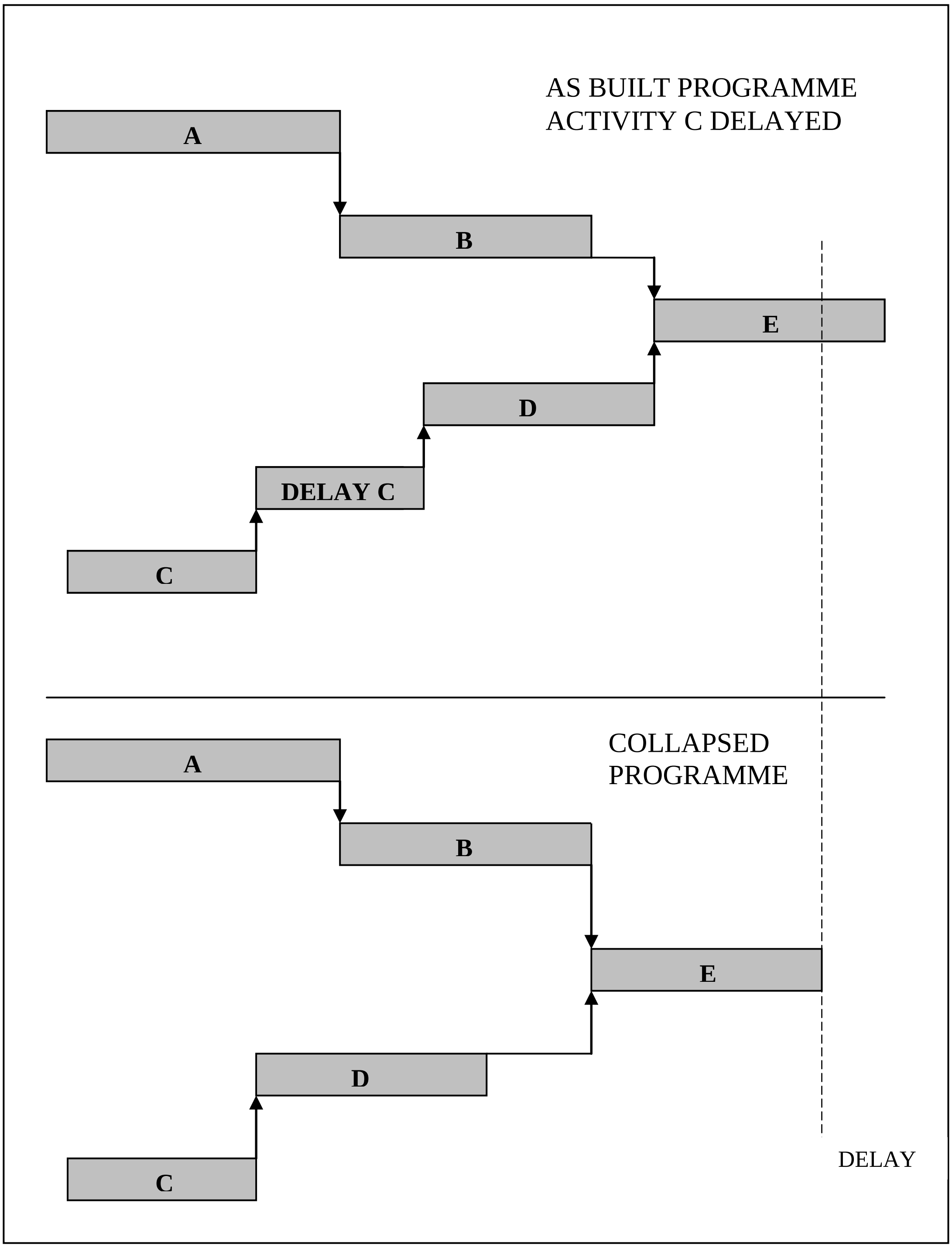


Figure 3.7 A Simple Model for Collapsed As Built Method

The method is criticised for some aspects, starting from its 'subjectivity'. When there is no as built schedule, the analyst must create one to make a collapsed as built analysis. Reconstructing an as built is also a laborious process that can result in higher costs for the analysis to take place. The creation of an as built schedule carries so much subjectivity in its own. The process of creating an as built schedule retrospectively can be manipulated in many respects. Keane, Caletka find the subjectivity of the method as its major drawback and say;

> A logic being applied in any collapsed as built model should be treated with caution and even with healthy scepticism. Often the conclusions derived from the collapsed as built models (which can only be constructed retrospectively) collapse like a house of cards when enough of these assumed as – built logical dependencies are shown to be inaccurate. (144)

Farrow also shares the view that the method is subjective; it depends on subjective logic links that were never agreed in contemporaneous programmes and carries the risk of bias on the part of the analyst (Farrow 10).

Another technical difficulty is with the pacing activities. When the driving activity is collapsed, pacing activities, if any, may seem as critical activities to the analyst. Pacing activities are not apparently visible from the programme and must be identified and collapsed with the driving activity in order to obtain accurate results from the analysis. Collapsed as built method is recommended to be used only in "appropriate projects which can be represented primarily as a linear sequence of events (tunnels, roads, bridges, earthworks, etc.). This would assist in mitigating the biggest weakness related to the creation of the subjective as built logic" (Keane, Caletka 149).

Collapsed as built method has been rejected in US as a retrospective analysis method of proof. Lowe et al. list the flaws of the method stated by US commentators as follows;

- It does not address the need the issue of time extensions on a real time basis as required to address events on the project,
- It is not forward looking, chronological and cumulative,
- To collapse the schedule, the analyst typically is forced to insert after the fact logic ties that may not reflect the thinking of the contractor during actual performance,
- Adjustments for anomalies in the adjusted schedule require

experienced judgement that is beyond the capability of many analysts and may be subject to dispute by experienced experts,

– The method is susceptible to manipulation through oversight of concurrent causes of delay,
– It fails to consider the as planned schedule upon which the contractor based its estimate for the project. (18-19)

Float mapping is a delay analysis method which uses the float values of various project activities to find out delays and their total impact on the project. It is described as a form of windows analysis models in literature (Keane, Caletka 236). It is an observational method as it is based on observing the changes of float values of activities and it does not add or extract any events on the as built or as planned programmes. Its main idea is finding out the as built critical path during the progress of the project.

The application of float mapping method is done in various steps. A guideline for application is as follows:

- All the total float values for all activities in the programme schedule are calculated and noted. Computer programmes are extremely helpful in calculating and tabulating total float values.
- Data including start and finish dates, constraints and other relevant progress notes on activities can be recorded at this level in order to be used if necessary. Noting especially constraints on activities at this stage would be helpful in next stages.
- The two first steps are repeated for all the schedule updates and all the raw data collected are tabulated.
- The next step is to identify the critical path on programme schedules using total float values obtained. The largest negative total float will typically represent the critical path activities. Besides the largest negative total float activities or the activities with zero total float, near critical activities must also be identified in order to watch possible critical path changes. Activities with critical total float values, in this step, must be carefully looked at in order to identify any 'false'

criticalities. Using constraints on activities, changing activity link logic or activities which are scheduled to start quite later than the data date shall be identified.

- Using the raw data table obtained in the previous steps, the ‘driving activities’ in each programme update are filtered. Driving activities refer to those activities that are on the longest path of the update programme and have already started or are scheduled to start until the next update period. The logic under that approach is to eliminate those activities which will not start until next update, thus not driving the critical path. One month period is often used in projects for data update period so it is assumed that longest path may change on a monthly basis. When the longest path changes on a shorter timescale than one month, due to the availability of the project documents, materials in hand, shorter updates can be created according to that new period forensically, though that would be laborious and too much subjective. Choosing another method can be more advantageous in that case.
- Next step of the analysis is linking the driving activities on different programme updates throughout the project. The result of the linking process would result in creating or obtaining the as built critical path or paths from start to finish of the project. When more than one critical path is identified then activities may need to be grouped according to the respective criteria of the critical paths such as location.
- At the end of the analysis, responsibility tables for contractor and employer are created using the as built critical path data. The table consists of columns for the programme update name, project completion date of the update programme, critical total float value of the updated schedule, and change in the total float value when compared with the previous update. Float loss and gains will represent delays and accelerations on the project.
- The next step is allocating the identified delay events to the parties. Delay events which were identified before using project documents are attributed to the project update schedule they belong to so that using the total float change in the schedule, their effect to the project completion date can be measured. Concurrency can be identified when employer

and contractor delay events occur on the same project update. (Keane, Caletka 236-250)

Float mapping has advantages and disadvantages such as other methods of analysis. It is an observational method and relies on update schedules of the project so it does not require adding or subtracting activities from the project schedule. It is a dynamic method which relies on the CPM logic and can identify changes in critical path and logic of the programme. Float value changes can be identified positively or negatively so it can identify gains achieved through the project as well which may be helpful in finding accelerations on the project. It can identify concurrency and its effect on the project completion date better than the additive methods of analysis. (Keane, Caletka 246)

On the other hand, float mapping is laborious and needs experience and careful evaluation of project schedules and documents. As it basically relies on the float values of activities, it is vulnerable to any manipulations done on the total float values. In order not to have unfair and unreasonable results at the end of the analysis, analyst needs a thorough study of all activities and must be familiar with the project logic. Using total float analysis may not give correct results if the project programmes are created such that constraints are overused and necessary alterations require the analyst to change most of the programme (Keane, Caletka 240).

3.2.2.2 SELECTION OF A DELAY ANALYSIS METHOD

In order to obtain fair and reasonable results from a delay analysis, qualitative factors must be taken into account. Each method has its own strengths and weaknesses which may either be suitable or not, for a project. The documentary requirements, contractual obligations, data available in hand, time of the analysis are all factors that affect the choice of the method. Barry lists the criteria for choosing the method of analysis as; contractual requirements, choosing correct – sustainable – appropriate approach, availability of information and time – cost constraints (Barry 10).

AACE Recommended Practice for Forensic Schedule Analysis discusses eleven main factors for an analyst to take into account when deciding which method of analysis to use. These are;

- Contractual Requirements
- Purpose of Analysis
- Source Data Availability and Reliability
- Size of the Dispute
- Complexity of the Dispute
- Budget for Analysis
- Expertise of the Analyst and Resources Available
- Forum for Resolution and Audience
- Legal or Procedural Requirements
- Past History / Methods and What Method the Other Side Is Using. (99-104)

SCL Delay and Disruption Protocol has also got a similar factor list for choosing the right method;

- Relevant conditions of contract
- Nature of the causative events
- Value of the dispute
- Time available
- Records available
- Programme information available
- Programmer's skill level and familiarity with the project. (46-49)

When a specific method of analysis is expressly specified in a contract, analyst does not have much options and needs to use that method of analysis, unless there are factors that prevent him from doing so. It is stated that analysts will most likely be required to use additive methods either single or multiple based (AACE RP 29R-03 99). Supportive documents and contractual language should also be taken into account in the absence of any express requirements of analysis technique, in the main contract document (SCL Delay and Disruption Protocol 46).

Purpose of analysis is another factor that AACE Recommended Practice for Forensic Schedule Analysis finds important in choosing the analysis method that will be used. Delay analysis may have different aims, if it specifically aims to find out concurrency in a project, then, methods that can identify concurrency will be chosen, if the aim is to find out excusable, non compensable delay then concurrency would be irrelevant and other techniques will be applied to the project. Purpose of analyst will motivate him in using the appropriate method that will give him the best results (AACE RP 29R-03 100).

Another major factor is the availability of necessary data. Different analysis methods use different resources for the analysis as was seen above. Availability of a CPM schedule, a baseline programme, update programmes, as built programme all affect the choice of the analysis method. Without an as built programme available a subtractive analysis method cannot be applied to a project. If the analyst wants to use a specific technique and wants to create the necessary project programmes using the data available to him, the reliability of the data available should be considered. Analyst must be aware of the possible manipulations done on available data and must not go on creating new programmes is he does not have reliable data resources (AACE RP 29R-03 101, SCL Delay and Disruption Protocol 47-48).

Size of the dispute, complexity of the dispute, and budget for analysis are all factors that are closely related with the characteristics of the project. Delay analysis process might be expensive for a client if the damages sought are relatively small. It must be kept in mind that, analysis expenditures should not be in contrast with the size of dispute. Claims in which heavy damages are required from the opposite party, which are for a complex project with many activities and require an experienced analyst team who have to work for long hours on project, would require, naturally, large costs. Cost effective and suitable analysis techniques should be chosen for corresponding project. It is recommended that focusing on the critical path and sub critical paths rather than analyzing every activity on the schedule can reduce costs and complexity of the analysis (AACE RP 29R-03 102, SCL Delay and Disruption Protocol 48).

Time allowed for delay analysis is an important factor in determining analysis method. There may be times that the analysis has to be prepared in a relatively short time and the method of analysis should be chosen as suitable for that time limit. In some projects, adjudication or arbitration procedure may require the employer and the client to prepare their cases in strict time limits or the analyst may be included in the process in a later stage so that the time allowed for analysis is tight. Preparing a detailed analysis in a short time interval may increase costs or a simpler method can be chosen. Analyst must make the client aware of the situation (AACE RP 29R-03 103, SCL Delay and Disruption Protocol 48).

Expertise of the analyst should also be decisive in the choice of the analysis technique. The delay analyst may have experience in some techniques and may be unfamiliar with some other. The choice must be in accordance with the experience. Some techniques, especially additive or subtractive, rely on the subjective choices of the analyst more than the other and inexperienced use of these methods may give unfair results. Analyst must also be familiar with the project itself, being unaware of project logic or the construction technique can make him give wrong results and choose the wrong method of analysis (AACE RP 29R-03 103).

When there is a requirement of chosen method from the resolution board, analyst must use that method. It is recommended that analyst be aware of the resolution forum, whether it is arbitration, adjudication or litigation and take his suitable steps for its requirements. He must also be aware of the legal rules requiring him to take certain steps; different jurisdictions may have different rules on delay analysis and expert testimony. Past experiences in project and methods, if any, which have not been accepted before the analyst started his work should not be tried again. It is stated that agreement by the parties on a common method will be extremely helpful and “failure to consider these factors could lead to substantial difficulties later on in claim settlement negotiations” (AACE RP 29R-03 104).

Tables used by SCL Delay and Disruption Protocol and AACE Recommended Practice for Forensic Schedule Analysis for the choosing of the correct method have been given below. AACE Recommended Practice for Forensic Schedule Analysis uses numeric categorisation for different analysis methods. Delay Analysis Methods used by AACE Recommended Practice for Forensic Schedule Analysis are as follows;

3.1 – Observational / Static / Gross

3.2 – Observational / Static / Periodic

3.3 – Observational / Dynamic / Contemporaneous As – Is

3.4 – Observational / Dynamic / Contemporaneous Split

3.5 – Observational / Dynamic / Modified or Recreated

3.6 – Modelled / Additive / Single Base

3.7 – Modelled / Additive / Multiple Bases

3.8 – Modelled / Subtractive / Single Simulation

Table 3.6: Types of Analysis - Types of Factual Material Available.
(SCL DELAY AND DISRUPTION PROTOCOL 48)

TYPE OF ANALYSIS	AS PLANNED PROGRAMME WITHOUT NETWORK	NETWORKED AS PLANNED PROGRAMME	UPDATED AS PLANNED NETWORKED PROGRAMME	AS – BUILT RECORDS
AS – PLANNED v. AS – BUILT	X	OR X	AND X	OR X
IMPACTED AS PLANNED		X		
COLLAPSED AS – BUILT				X
TIME IMPACT ANALYSIS		X	OR X	AND X

Table 3.7 Some Methods Are Better Suited For Certain Purposes Than Others. (AACE RP 29R-03 101)

FORENSIC USE OF ANALYSIS	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8
NON COMPENSABLE TIME EXTENSION	OK	OK	OK	OK	OK	OK	OK	OK
COMPENSABLE DELAY	OK	OK	OK	OK	OK			OK
RIGHT TO FINISH EARLY COMPENSABLE DELAY								OK
ENTITLEMENT TO EARLY COMPLETION BONUS	OK	OK	OK	OK	OK	OK	OK	OK
DISRUPTION WITHOUT PROJECT DELAY	OK	OK	OK	OK	OK	OK	OK	
CONSTRUCTIVE ACCELERATION				OK		OK	OK	

3.1 – Observational / Static / Gross

3.2 – Observational / Static / Periodic

3.3 – Observational / Dynamic / Contemporaneous As – Is

3.4 – Observational / Dynamic / Contemporaneous Split

3.5 – Observational / Dynamic / Modified or Recreated

3.6 – Modelled / Additive / Single Base

3.7 – Modelled / Additive / Multiple Bases

3.8 – Modelled / Subtractive / Single Simulation

3.2.2.3 COMPARISON OF DELAY ANALYSIS METHODS

Delay analysis methods have strengths and weaknesses as seen above, a comparison of the various methods, in fact, means a comparison of the fields where they have strengths and where they have weaknesses and is a contribution to selection of the right method.

Observational methods of delay analysis have the advantage of simply observing the project schedules and not adding or subtracting the project programme. Modelled methods, on the other hand, add or subtract delay events to programme to create a theoretical model in order to find out the answer to the question; ‘what if?’. The problem with the modelled analysis methods is that they are hypothetical in nature, creating a model which is not in fact available. When additive models are used prospectively they create a model and try to guess the effect of the delay to the project completion date, which may be real or not. On the other hand, using observational methods, it is less easy to find out the effects of individual delays to the overall programme. An example is the as planned v. as built method. Using as planned v. as built simply using the project schedules on a single base on a project does not give much idea about the details of the delays on the project, unless it is a simple one. In order to achieve a detailed result, as planned v. as built can be done on a daily basis, multiple based comparison, which would of course require a labour intensive time consuming work of the analyst team especially on a large project. One of the major points in analyzing delays is applying a static or dynamic logic to the project. Static logic analysis methods are simpler to perform but dynamic logic takes the changes in critical paths into account, thus are more reliable (Farrow 7-18).

3.3 DISPUTES RELATED TO EXTENSION OF TIME IN CONSTRUCTION PROJECTS

3.3.1 PREVIOUS CASES

There have been many disputes concerning time extension claims in the past. Many of these disputes have been resolved using an amicable solution or in arbitration though some were only resolved in courts. Case law concerning delay claims is quite thick when compared with other kind of cases. It was the usual practice by the courts to give extensions of time to contractors if they thought it was the fair and reasonable solution however calculation of extension periods did not bother courts much and arbitrators often calculated these extension periods. With the advent of computers and application of new technologies to construction processes, using new techniques to calculate delay amounts came into issue. Progress of delay analysis techniques using computers and approval of these methods as proof by courts became increasingly popular in Western jurisdictions. One of the key points was achieved in the famous case of John Barker v. London Portman Hotel when the judge considered the architect's assessment of delay claims "impressionistic rather than calculated" and rejected it as "not logical". Cases such as Ascon v. McAlpine (1999), Royal Brompton Hospital v. Hammond (2002), Great Eastern Hotel v. Laing (2005), Skanska v. Egger (2004) and City Inn v. Shepherd (2007) all contributed to this process of building up precedence on court's approach to delay analysis cases (Eggleston, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 10-15, Winter 17).

3.3.2 RESOLUTION OF PREVIOUS CASES

In this part of the research, some of the key cases that have been often cited in literature have been summed up. The cases in this section do not cover all the cases in which delay analysis, extension of time and related concepts have been discussed but it sums up the major well known cases with the approach of the courts to different arguments and their decisions about these delay related disputes. Cases in this section are UK and US based as the basic concepts of delay claims and delay analysis have been developed and discussed mainly in these jurisdictions. The cases are in chronological order.

First case to consider is Walter Lawrence & Sons Ltd. v. Commercial Union Properties Ltd. (1984). The contract that was used for the project was a JCT Standard Form of Contract 1963 edition. The dispute was about an extension of time claim by the contractor as a result of adverse weather conditions. Architect obtained weather data from Meteorological Office and compared the data with the planned programme and reached his results. Contractor claimed a longer extension period while the architect entitled the contractor only two weeks extension. In the court, judge stated that the true test for extension of time claims due to weather conditions was "whether the weather was 'exceptionally inclement' so as to delay the works actually being carried out at the time; and not whether the time lost was exceptional" (Gibson 82). The reasoning in the case was held to be helpful when considering weather related delay claims. (Eggleston, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 268)

H. Fairweather & Co. v. London Borough of Wandsworth (1987) is another case that has considered an extension of time issue. The contract model used was the JCT Standard Form 1963. The case is important in respect of the comments of the judge about the dominant theory. Contractor was entitled to extension of time as a result of strikes but claimed direct losses and expenses with the time extension. Architect agreed with extension of time however rejected the claims for direct loss and expenses. In his judgement, judge rejected that extension of time as a result of clause 23 was not directly connected with clause 24 claims, loss and expenses. The major point in his judgement was the rejection of dominant cause of delay theory and its application for extension of time claims. He expressed his view that "each separate cause of delay should be assessed on its own individual merits". (Lyden 7-12, Eggleston, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 291-292)

The case The Glenlion Construction Ltd. v. The Guiness Trust (1987) concerns a claim by the contractor for prevention of the works by the employer. The contract form used for the project is a JCT 63 Standard Form of Contract with Quantities. The contractor submitted a programme showing an early completion in the beginning of the project and then claimed damages for prevention when the works was delayed beyond the projected completion date. The discussion is on who owns the 'termination float' in technical terms. It was held by the judge that employer had no duty to help the contractor comply with his projected early completion date schedule hence shortened programme. Contractor has the freedom to finish early but that freedom does not in itself put any liabilities to the employer. Judge had stressed the point that contractors often produce over optimistic programmes when starting projects and employers are well aware of the fact. (Bunni 346,363) He continued; "It is not suggested by the Glenlion that they were entitled and obliged to finish by the earlier completion date. If there is such an implied term, it imposed an obligation on the Trust but not on the Glenlion. It is not immediately apparent why it is reasonable or equitable that a unilateral absolute obligation should be placed on an employer. The unilateral imposition by a contractor of a different completion date would result in the whole balance of the contract being lost" (Gibson 85).

McAlpine Humberoak v. McDermott International (1992) was about an extension of time claim by the contractor due to variation orders given during the project. Contractor's approach was to add durations for each individual variation and claim the total amount of durations from the employer as employer responsible delay time. Court of Appeal rejected contractor's approach stating that it did not take the individual effects of variations to project completion time and insufficient. According to the judgement, a recreation of an as built schedule was essential so that liability of each party could be found. Court also considered the non – culpable delays occurring during culpable delay period, an issue also considered in Balfour Beatty v. Chestermount Property Ltd. case. The net calculation of non – culpable delays in culpable delay period was supported by the court. (Gibson 85-89, Bunni 337)

The case Balfour Beatty Building Ltd. v. Chestermount Properties Ltd. (1993) was about a project where the contractor risk event delaying the project completion occurred prior to the occurring of a relevant event. The relevant event caused further delay in project completion. Contract form used for the project was JCT 80. The case is an important one for the arguments on employer responsible delays occurring during period of contractor culpable delay, after completion date has passed. Contractor claimed that the time was to be at large and he had to finish at reasonable time, also the employer had lost his rights to liquidated damages for the period of non – culpable delay. Another point of discussion was about the calculation of delay periods. Contractor claimed that the calculation should have been done on a gross basis taking the date the variation order was given as a reference. In this method, though in culpable delay, contractor would have obtained an automatic extension between the previously fixed completion date and variation order date. Employer counter claimed that the calculation should be done on a net basis. The completion date should be calculated with reference to the previous fixed completion date. (Bunni 344,365, Eggleston, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 139-142, Lyden 7, Winter 5)

Court confirmed the approach of the employer and decided that the calculation of the delay period should be done on a net basis. “The net basis is simply the amount of delay occasioned by the relevant delay event added onto the last revised completion date. This is often referred to as the dot on principle” (Gibson 94).

John Barker Construction Ltd. v. London Portman Hotel (1996) case has been a start point in respect of the use of delay analysis techniques in courts for extension of time cases. The contract used was a JCT 1980 Standard Form of Contract with Quantities, incorporating the sectional completion supplement. In his judiciary comment judge said that logical analysis methods for calculating extensions of time was a prerequisite for a fair and reasonable allocation. CPM based methods was underlined as a reasonable way of assessing delays.

Judge stated that:

“1. The architect did not carry out a logical analysis in a methodical way of the impact which the relevant matters had or were likely to have on the Plaintiff’s planned programme.

2. The architect made an impressionistic, rather than a calculated, assessment of the time which he thought was reasonable for the various items individually and overall.

3. The architect misapplied the contractual provisions,

4. Where the architect allowed time for relevant events, the allowance which he made in important instances […] bore no logical or reasonable relation to the delay caused" (qtd. in Eggleston, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 239, Lyden 9).

Ascon Contracting Ltd. v. Alfred Mcalpine Construction (1999) has been one of the important cases in respect of the issue of 'float ownership' and delay. The dispute in this case was between a subcontractor and the main contractor on the ownership of the float. The main contractor claimed losses from subcontractors stating that they used his float and had the float not existed, they would have to pay losses to him.

Judge said in his comments that;

> the float is certainly of value to the main contractor in the sense that delays of up to that total amount, however caused, can be accommodated without involving him in liability for liquidated damages to the employer, or if he calculates his own prolongation costs from the contractual completion date rather than from the earlier date which might have been achieved, in any such costs. He cannot, however, while accepting that benefit as against the employer, claim against subcontractors as if it did not exist. That is self evident if total delays against sub programmes do not exceed the float. The main contractor, not having suffered any loss of the above kinds, cannot recover from the subcontractors the hypothetical loss he would have suffered had the float not existed, and that will be so whether the delay is wholly the fault of one subcontractor, or wholly that of the main contractor himself, or spread in varying degrees between several subcontractors and the main contractor. No doubt those different situations can be described, in a sense, as ones in which the benefit of the float has accrued to the defaulting party or parties, but one could suppose that the main contractor has, or should have, any power to alter the result so as to shift the benefit. The issues in any claim against a subcontractor remain simply breach, loss and causation. (qtd. in Gibson 98)

It is stated by the commentators that although he does not expressly say so judge prefers the 'first come first served' basis on the issue of float ownership in this case. (Eggleston, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 318-319, Gibson 99)

Henry Boot Construction Ltd. v. Malmaison Hotel (Manchester Ltd.) (1999) is one of the leading cases on the issue of concurrency. It was decided that if it can be shown that there are concurrent causes of delay, for each of which the employer and contractor were responsible, then the contractor is still entitled to an extension of time. In his comments, judge gave the example of a project in which the completion is delayed by exceptionally adverse weather conditions while contractor also suffers shortage of labour, not a relevant event according to the conditions of contract. In this situation contractor should be awarded extension of time for the period of exceptionally adverse weather condition, said the judge, and extension should not be denied on the ground that contractor had also delayed the project due to his default as shortage of labour. Judge summarized his approach as follows: "if there are two concurrent causes of delay, one of which is a relevant event, and the other is not, then the contractor is entitled to an extension of time for the period of delay caused by the relevant event notwithstanding the concurrent effect of the other event" (qtd. in Winter 20). This approach to concurrency has been famously called the 'Malmaison' approach. (Winter 6-7)

In the case Royal Brompton NHS Trust v. Frederick Alexander Hammond and Others (2000) the judge had to consider issues related to concurrency and ownership of float. The contract model used for this project was a JCT Conditions of Contract. On the matter of concurrency judge said:

> However, it is, I think, necessary to be clear what one means by events operating concurrently. It does not mean, in my judgement, a situation in which work already being delayed, let it be supposed, because the contractor has had difficulty in obtaining sufficient labour, an event occurs which is a relevant event and which, had the contractor not been delayed, would have caused him to be delayed, but which in fact, by reason of the existing delay, made no difference. In such a situation although there is a relevant event, the completion of the works is not

likely to be delayed thereby beyond the completion date. The relevant event simply has no effect on the completion date. This situation obviously needs to be distinguished from a situation in which, as it were, the works are proceeding in a regular fashion and on programme, when two things happen, either of which had it happened on its own would have caused delay, and one is a relevant event, while the other is not. In such circumstances, there is real concurrency of causes of delay.
(qtd. in Gibson 103)

Judge distinguished here the concept of true concurrency from sequential delaying events. In fact this approach is similar to the approach taken in Malmaison case and means that the contractor shall be entitled to extensions of time by reason of the occurrence of the relevant events notwithstanding its own default in case of concurrency (Bunni 365). Another point of importance was the liability of the architect in awarding extensions of time in JCT contracts. It was commented by the judge that an analysis of critical path was to be done by the architect before awarding extensions of time as extensions for non – critical activities shall be avoided. Gibson summarizes the important matters that are considered in this case as follows:

1) In determining a fair and reasonable extension of time, architect should consider critical and near critical activities in relation to their effect on completion time of the project.
2) Sequential and truly concurrent delays should be distinguished, when considering any delay event; other critical delays that occur at the time of delay should be considered as well. (Gibson 104)

On the issue of float ownership the judge commented as follows:

Under the JCT conditions, as used here, there can be no doubt that if an architect is required to form an opinion then, if there is then unused float for the benefit of the contractor, then the architect is bound to take it into account since an extension is only to be granted if completion would otherwise be delayed beyond the then current completion date. This may seem hard to a contractor but the objects of an extension of time clause are to avoid the contractor being liable for liquidated damages where there has been delay for which it is not responsible, and still to establish a new completion date to which the contractor should work so that both the employer and the contractor know where they stand. ..In that way the purposes of the clause can be met: the date for completion is always known, the position on liquidated damages is clear, yet the contractor is not permanently deprived of 'its' float…Thus to grant an extension which preserved the contractor's float would not be 'fair and reasonable'. (qtd. in Eggleston, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 318-319)

Motherwell Bridge Construction Ltd. v. Micafil Vacuumtechnik (2002) required the judge to reconsider the issue of concurrency in extension of time claims. His reasoning was supportive of the approach of the judge in Henry Boot v. Malmaison case, thus he applied Malmaison test. He stated that two crucial questions in considering concurrent delays are; is the delay on critical path and who caused the delay. It is also stated by the judge that the results of the test should always be considered in the light of common sense and fairness. Judge rejected the approach of 'net' calculation of delays, method of calculation accepted in Balfour Beatty v. Chestermount Property Ltd. case for non – culpable delays during culpable delay period; he awarded a full extension of time for the entire delay period to the contractor. The restatement of the approach of the judges that, delays must be on critical path to be taken into account for entitlement to extension of time, is an important point in this case. (Gibson 104-106)

The case Balfour Beatty Construction Ltd. v. The Mayor and The Burgesses of The London Borough of Lambeth (2002) concerns an extension of time claim by the contractor and discussion of issues relating to delay claims. The contract model used for the project was a JCT 1988 Local Authorities without Quantities. In his comments, judge underlined the importance of correct programmes with correct updates and critical paths. The contractor did not prepare an accurate programme schedule; he neither updated the original programmes nor stated the critical paths on them. According to the judge presence of original programme with realistic updates was crucial for an analysis of delays. He stated that the changes in critical paths throughout the project should be followed in order to reach a proper result (Winter 18).

Gibson lists the important results obtained from the judgement of the case as follows;

- Proper work programmes should be maintained during the execution of the works.
- Reliable and valid original work programmes should be the foundation of delay analysis.
- Valid critical paths should be determined, taking the changes in critical path into account.
- Concurrent delays should be demonstrated where necessary. (Gibson 108)

In Skanska Construction UK Ltd. v. Egger (Barony) Ltd. (2004), the issue for the consideration of the judge was again delay analysis methods. Two parties employed different experts to support their claims and the experts conducted analysis' that gave different results. Of the two experts, the one that Skanska employed used Power Project software to reach his results while Egger's expert conducted a time impact analysis that gave data of hundreds of pages. The original programme used in construction was a bar chart form and Egger's expert converted that bar chart into a network programme to make a time impact analysis. Furthermore, there were sub-programmes submitted by Skanska but they were not taken into account in time impact analysis. Judge considered in his decision that; all the methods of delay analysis, whether sophisticated or not, are only as good as the input data used for them. Making complex analysis is not a guarantee to success but using reliable data is. Baselines used for time impact analysis, in judge's opinion were not reliable. (Braimah 69, Gibson 109-110)

Judge commented that;

> Mr. S, a planning consultant originally employed by and later retained by Skanska Construction Ltd. as a consultant gave evidence at the liability trial. His analysis was accessibly depicted in a series of charts accompanying his evidence. Mr. P. produced a report of some hundreds of pages supported by 240 charts. It was a work of great industry incorporating the efforts of a team of assistants in his practice. It is

> evident that the reliability of Mr. P.'s sophisticated impact analysis is only as good as the data put in. The Court cannot have confidence as to the completeness and quality of the input into this complex and rushed computer project. Egger submit that the software used by Mr. S. is incapable of producing a reliable analysis since Power Project is primarily a planning tool creating a graphic representation, it is a dated system and does not have the sophistication of the P system but I am satisfied that it also has a significant capacity for logical connections and for identifying critical paths and for rescheduling activities to show how events change. Mr. P. stated that the effective application of Power Project is with its inherent limitations was also dependent upon the 'intuition' of its user. A term, it seems, that includes the power of selection of facts and interpretive judgement of them. As a criticism, it is difficult to see how this differs from the process followed and applied by Mr. P's own team of assistants prior to input into his computer programme. I was not impressed with the evidence of Mr P for the reasons I have set out above. It was not thorough. It was not complete. He only directly considered critical delay and did not really address disruption and he proceeded from the wrong premise in relation to subcontract periods which proceeded on the basis of that which is agreed between Skanska Construction Ltd. and the subcontractor. I preferred the evidence of Mr S as to programming and planning matters to that of Mr P. (qtd. in Eggleston, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 323)

Gibson summarizes the importance of this case in two main parts. First, complexity of analysis results does not ensure reliable results. 'Keep it simple' philosophy is always recommended. Difficult to understand results shall be avoided however analysis results lacking detailed supporting programmes, hammocks, sub – nets and alternative critical paths are not recommended as well. Second, the delay analyst must be 'objective, meticulous as to detail, and not hide bound by theory as when demonstrable facts collide with computer programme logic'. Delay analyst should not insist on the analysis results when the data is not reliable and shall not make subjective analysis. He must weigh the reliability of the data and purpose of the analysis and proceed objectively. He must be familiar with his analysis as in complex projects, assistants are used to help analysts and the expert may not be familiar with the details of his reports. (Gibson 111)

Great Eastern Hotel Company Ltd. v. John Laing Construction Ltd. & Anor (2005) has been one of the cases in which using delay analysis methods in extension of time claims was considered by the court. Choice of method, whether a retrospective one or a prospective one shall be used, the subjective character of the analysis methods were discussed by the judge. Though the different experts used different types of methods, the results they reached were similar; however the manipulation done by the contractor throughout the project on the programme update data caused significant problems. Judge said in his comments that;

> It is evident in my judgement that Laing consistently underplayed mention of the true causes of critical delay and assert other reasons for delay that would not reflect upon them. They consistently misreported the delays actually occurring and manipulating the data in the programme update to obscure the accurate position. (qtd. in Eggleston, Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 315)

Of the two experts one conducted a retrospective analysis using collapsed as built method. The other expert preferred a variation of an impacted as planned, a window method on a monthly basis. This method was based on a prospective analysis technique. Experts reached similar results about the extent of delay and the as built critical path. Judge criticized the collapsed as built technique as being hypothetical when the as built data does not take into account the actual events.

As told above, one of the issues in this case was that contractors update programmes did not reflect the actual delays and were manipulated so it was stressed that collapsed as built technique is not the ideal one when as built data is not realistic. In this case judge preferred the prospective analysis method rather than the retrospective one, the as planned impacted delay analysis on a monthly basis. He considered it as an analysis of ‘what had actually happened’. (Gibson 111-115)

In Multiplex Construction (UK) Ltd. v. West India Quay Development Company (Eastern) Ltd. (2006), matters concerning extensions of time claims have been discussed by the judge. Judge, first, gave the opinion of the adjudicator on the issue of delay analysis methods used by the experts. One party used an impacted as planned analysis while the other one used an as built windows analysis. In his decision the adjudicator said on the methods; “For my part I have considerable concerns that the 'Impacted As-Planned' method is reliable, primarily because it by definition completely ignores progress such that unrealistic results can be generated by slavish application of the software” (qtd. in Ramsey J, 5). He, then goes on expressing his own views on impacted as planned as follows;

> This method of analysis shows the impact against the "as-planned" programme and therefore may well show a greater extension than is required, if actual progress and reprogramming is taken into account. This is one of the major concerns with the method. It attempts to show the impact on the "as-planned" programme by adding the event. It is therefore the period of extension derived from that programme which is of relevance. (Ramsey J, 6)

City Inn Ltd. v. Shepherd Construction Ltd. (2007) was about an extension of time claim and judge had to consider the approaches of experts who used different delay analysis methods. Contract used in the project was an amended form of JCT Private with Quantities 1980. Contract provided a clause, requiring the contractor to give a notice including details of extra works if he is given an instruction, by the architect, which would cause delay or extra costs to works. Contractor failed to give notice but claimed that the notice requirement was not enforceable though it was rejected by the court stating that the clause is not a penalty clause and the contractor has to comply with its requirements. (Bunni 349)

Another issue judge had to consider was about the delay analysis methods. One of the experts preferred an as planned vs. as built analysis while the other experts made an analysis using the as built critical path created in a network logic. The analyst that used the as planned vs. as built method defended his analysis claiming that the data available was not sufficient to conduct a network analysis, he did not have the data in electronic network format and the results would not be reliable if an as built programme was created by him. He, therefore, decided to make an as planned vs. as built analysis using the available data. The other experts, on the other hand, created an electronic version of as built programme using the available data and conducted their analysis using this as built critical path. They claimed that as planned vs. as built method would not give accurate and meaningful results as it does not take the critical activities into account.

Judge expressed his views as;

> In my opinion, the pursuers went clearly too far in suggesting that an expert could only give a meaningful opinion on the basis of an as built critical path analysis. I am of the opinion that such an approach has serious dangers of its own. I further conclude that Mr. L's own use of an as built critical path analysis is flawed in a significant number of important respects. On that basis, I conclude that that approach to the issues in the present case is not helpful. The major difficulty it seems to me is that in the type of programme used to carry out a critical path analysis any significant error in the information that is fed into the programme is liable to invalidate entire analysis. Moreover, I conclude that it is easy to make such errors. That seems to me to invalidate the use of an as built critical path analysis to discover after the event where the critical path lay, at least in a case where full electronic records are not available from the contractor. That does not invalidate the use of a critical path analysis as a planning tool, but that is a different matter, because it is being used then for an entirely different purpose. Consequently I think it necessary to revert to the methods that were in use before computer software came to be used extensively in the programming of complex construction contracts. That is essentially what Mr W did in his evidence. Those older methods are still plainly valid, and if computer based techniques cannot be used accurately there is no alternative to using older, non computer based techniques. (qtd. in Eggleston Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 324)

In London Underground Ltd. v. Citylink Telecommunications Ltd. (2007) judge had to discuss the analysis methods and their role in extension of time cases once again in that case. It was shown by the decision of the judge in this case that simplicity shall be preferred to complicity and technical superiority, volume or sophistication of analysis method does not make it reliable in itself. He criticized relying only on analysis methods and added that;

> whilst analysis of critical delay by one of a number of well known methods is often relied on and can assist in arriving at a conclusion of what is fair and reasonable, that analysis should not be seen as determining the answer to the question. It is at most an area of expert evidence which may assist the arbitrator or the court in arriving at the answer of what is fair and reasonable extension of time in the circumstances. (qtd. in Eggleston Liquidated Damages and Extensions of Time in Construction Contracts 3rd Ed. 322)

Following cases have been discussed in the research held by Prateapusanond in relation to the approach of the courts in US to the issue of total float ownership. Cases show that adjudicators may reach to different results, on the ownership of float in the project, according to the facts of different cases.

Dawson Construction Co., GSBCA No.3998, 75-2 BCA 11563 (1975) concerned arguments covering delay analysis and ownership of total float. Government consultant prepared an analysis using as built schedule and analyzing employer responsible delays. The result was claimed to be inaccurate by the contractor who claimed that employer responsible delays consumed float in project that belonged to him. The Board of Appeals held the view that in order to be taken into account delays should effect project completion, thus be on critical path and the total float of non – critical activities belonged to owner who consumed them as long as project completion is not effected. (Prateapusanond 91-93)

Weaver Bailey Contractors Inc. v. The United States, 19 Cl.Ct.474, 475, 81-2 (1990) was about an extension of time claim and the main issue was the ownership of total float. Contractor had prepared a work programme which was to be finished before the winter came and had total float in some activities which were consumed by the employer's variation order. Employer responsible delays not only consumed float in activities but also extended project duration. Contractor defended that the total float in the programme schedule belongs to him and employer cannot consume his float. Employer claimed that float was available to all parties as long as they acted in a reasonable manner. The Board has decided that total float was to be awarded to the contractor in this case. They found contractor's claim reasonable and reliable (Prateapusanond 85-89).

Ealahan Electric Co., DOTBCA No. 1959, 90-3 BCA 23,177 (1990) concerns delays occurred during the project, for which both parties were responsible. Contractor caused delays occurred concurrently with variation orders from the employer. The Board of Appeals had to consider issues of float ownership and concurrency in this dispute. Board entitled the contractor for employer caused delays which occurred in different time periods than contractor caused delays, so took the literal concurrency approach as relevant. In respect of the ownership of float, Board decided that in this case total float belonged to the contractor whose delays occurred in the early time period. It was stated that due to delays from originally non – critical activities whose floats were consumed by the contractor and became delayed after variation orders, contractor was entitled to time extensions. (Prateapusanond 95-96)

MCI Contractors, Inc., DCCAB No. D-924, 1996 WL 331212 (June 4, 1996) concerns extension of time and cost claims by the contractor and counter claim of concurrent delays occurred as a result of default of the contractor by the employer. Employer claimed that though the project was delayed as a result of its delays on critical paths, contractor caused delays occurred at the same time so there was concurrent delays, which would entitle the contractor to an extension of time but not costs. Contractor argued that it used the additional float that was created as a result of employer responsible delays and argued that the concurrent delays were part of pacing, 'why hurry and wait' approach. In its decision, Board found contractor entitled to extension of time as well as costs, hence accepted contractor's argument for pacing. Total float consumption by the contractor was found acceptable. (Prateapusanond 98-100)

3.4 SUMMARY OF LITERATURE REVIEW

In the literature review, topics related to the delay analysis and delay related disputes have been reviewed. The topics were determined under three main headings; contracts, delay analysis and disputes.

The first topic was about the contracts used for international projects or popularly used standard forms. The contract models have been listed in respect of their extension of time related clauses. A summary of results were shown on a contract – delay clause matrix and some concepts related to extension of time clauses that are generally included in contracts have been explained. Events that will trigger an award of time extension that are specified in the contracts have been detailed and reviewed under this part of the research. One of the main issues observed was that standard construction contracts have changed in time to comply with the requirements of the industry. Industry trends have been determinate in this change. Contracts that can be used in more popular risk sharing types of projects like Build Operate Transfer or Design Build are now drafted to be used by the industry. Another issue is the eagerness of the different contract drafting bodies to have their contracts used by a more general and larger community of which an example is IChemE. They have been drafting contracts for mainly use in process plants however the last set of contracts prepared by IChemE are prepared in a manner so that they can be used in other construction projects as well. Earlier versions of the contracts reflect the approach that contracts were more employer based, recent versions on the other hand are more partnership based, partnering of the risks are relatively more highlighted in recent versions. New dispute resolution techniques were introduced by new versions to overcome problems arising from litigation processes and to allow faster and potentially cheaper dispute resolution. It is seen that contracts have been evolving in accordance with the requirements of the industry and developments in the case law. Comments of the judges or adjudicators on the delay related disputes have been illuminating for the drafters of the contracts and they have been trying to introduce new concepts into newer versions of their contract forms. Work programme requirements, float and other CPM logic concepts are more introduced in recent versions, clauses like damages and rights and duties of the employer's representative on site have been evolving accordingly. New standard contracts aim ‘flexibility, clarity and good project management’, as one of the revolutionary contracts recently published, NEC, describes its aims. Though, developments come after the industry practices and number of cases resulting from delay related disputes show the need for further improvements.

Second topic analysed under literature review was the delay analysis in construction projects. Main concepts relating to delay analysis in construction projects, delay analysis methods used to quantify delays are reviewed and selection criteria in respect of the limitations, merits and disadvantages of the methods are examined under this topic. Concepts have been explained with various discussions about the ‘thorny issues’. Delay analysis methods have been classified under five main methods and their methodology was shown. It has been observed that each method of analysis has its advantages and disadvantages respectively and can be used in only appropriate cases for realistic results. Besides, the subjective character of analysis methods revealed the need for consensus among parties for the method and project documents to be used for analysis.

Last topic of literature review is on disputes related to extension of time claims in construction projects. Topic mainly consists of reviewing case law on disputes that arose due to delay claims and extensions of time related matters. Cases are selected among those that are most important and most cited in literature. Cases are often important in respect of the commentaries of the judges about the subject matter as they reflect the approach of the courts towards main points of discussion in delay claim disputes. Courts view of the delay analysis methods is of importance; generally as a material of proof they consider it explanatory and a necessary requirement however they take its subjective character into account and treat the results of delay analysis methods only one of the factors to be taken into account amongst others. The facts of each case differ and so do the appropriate method of analysis however it is seen from the literature review that some methods are more preferred than the others by courts. An example is the Time Impact Analysis; it is more preferred by judges in UK in accordance with the advices of Society of Construction Law.

4. CASE STUDY

4.1 OVERVIEW OF PROJECT

In order to obtain data related to delays and delay analysis processes site study has been performed on a real project. Name of the project, locations, cost and activities has been changed due to confidentiality reasons. Data concerning the progress of project reflects the progress until August 2009; date of end of case study.

Project A is one of the largest infrastructure projects ever realized in *Country X* and in *Region X*. The first feasibility studies were done nearly 25 years ago, though it was not until 1997 that the feasibility studies were revised and ground investigations were carried out in 2002, 2003 and 2004. The consultancy agreement was signed in 2001 and the construction was physically started in 2004. The projected completion date was 2011. Project has a total cost of approximately *N* billion USD and its projected design life is 100 years.

Project A consists of mainly three parts all of which are separately contracted; first part is the *River B* tube crossing, tunnels and stations construction shortly called the *BC1*. Second part is the *District C* to *District D* and *District E* to *District F* Commuter Rail shortly called *AB1*, which includes upgrading of civil, electrical and mechanical systems. The third part is the Rolling Stock Production called the *AB2*.

City X, as the largest city of *Country X*, with a population of nearly *R* million people has problems in solving its traffic problems. City's residential areas are denser in Side A and the two bridges that link the city over *River B* are almost locked in traffic jam all day long. *Project A* aims to solve the traffic problem in *City X* by connecting the *Side E* of the city to its *Side A* using a railway connection constructed under the *River B*. It also comprises the upgrading of two existing railway lines of the city which will connect to *River B* crossing. It is projected that the new lines will not only solve the traffic problems in the city but also will be a part of a larger project that will connect train lines coming from *Side A* to *Side E,* by letting intercity train lines use the track system. The next stage will, hopefully, be the connecting of airports of the city to the *Project A* lines and create a linked, fully effective city train line. It is expected that when the project finishes number of passengers in one direction will be approximately 75000 per hours. Using the railway system, the project will provide cheap, safe, high capacity and integrated transportation which will reduce air pollution and noise problems in the city.

Project A obtains its unique character not only from its huge budget or long term aims but also from its technical difficulties in construction phase. The geographical location the project takes place causes extra difficulties; *River B* crossing is constructed under one of the busiest trade channels in world, there are differing ground conditions all along the project line and seismic conditions require a careful design and construction of the project.

River B crossing is projected to be constructed using immersed tubes of approximately *Y* km. length. The immersed tube crossing will connect between *District E* and *District H* stations in *Side E* and *Side A* of the city. Later, this tunnel will be connected to the tunnels bored between *District G – District H* in *Side A* and *District I - District J – District E* in the *Side E*. These tunnels will be bored by five tunnel boring machines of two different types. *District G – District H* and *District J – District E* tunnels will be bored by four slurry type TBMs and *District I – District J* tunnel will be bored by one EPB type TBM. *District E* station and crossover tunnels are constructed using the New Austrian Tunnelling Method (NATM) and the other stations are constructed using the cut and cover method.

4.2 CURRENT STATUS OF THE PROJECT

Project A has been subject to considerable delays during the construction phase. The project is being constructed in one of the oldest, historical regions in the world and archaeological excavations are one of the major obstacles to the progress of the project. Prior to the bidding stage, the historical structures along the alignment were collected in an inventory and it was planned that the historical findings would be exhibited in a museum that will be constructed in a cultural park. The archaeological excavations commenced with the project commencement on 2004. During the excavations in *District H* and *District J* sites, it was found that the historical heritages in the sites were quite numerous and more important from the historical perspective than was expected in the studies done before. In *District J* site, construction of one station on the commuter line was totally cancelled and the project was changed accordingly. As a result of the archaeological excavations, the contractor was given an extension of time, though, the excavations are still not finished and the *District J* site has not been handed over to the contractor. *District J* site is currently on the critical path of the project and current delays from the excavations are delaying the overall completion date of the project.

The project was subject to changes during the construction stage to overcome difficulties from the archaeological excavations and other reasons. *District J* station, cited above, was one of these changes. Another important change was on the *District J* to *District I* tunnel construction. The variation was in fact on the construction method rather than the alignment. Initial project design was done so that the TBMs would start boring the *District J - District I* tunnel from the *District J* shaft, however, the archaeological excavations did not let the tunnel boring activity begin. In 2006, contractor made an offer to the employer stating that, in order to facilitate the progress of the project, the tunnel could be constructed starting from the *District I* site in the direction of *District J* so that the delay to project completion date from the excavations would be shortened. The employer gave the variation order for the construction of the tunnel from the *District I* site and the project was changed accordingly. However, problems occurring from the *District J* site and condition survey of the buildings along the tunnel line caused other problems which prevented the tunnel construction from being constructed on time. Currently, the TBM 1 which will construct the tunnel is waiting in the tunnel progress towards *District J* station.

Another major obstacle for the progress of the project is the condition survey for the buildings along the tunnel alignments. The condition surveys for the buildings were not done properly and both parties blamed each other for the responsibility of the condition survey. Along the project line, there are buildings most of which are old and are not in a good condition. The nationalization of the buildings was required in order to collapse those which are not in a good condition to resist the construction of the tunnels. Problems with the law and contractor's position made it almost impossible to progress on the site. Currently, there are still buildings on the site which will be nationalized and collapsed.

On the *Side A*, the TBMs, though delayed, are progressing towards the *District H* station and the tunnels are almost finished there, however the progress rate is lower than initially planned. It seems that the relative float that is being created by the excavations on *District J* site, which is on the critical path, is being consumed on the *Side A* tunnels by activities of TBM4 and TBM5. The immersed tube tunnel is finished and waiting for the tunnel connections to finish. As the tunnel construction cannot progress from *District J* to *District E* by TBM 2 and TBM3, immersed tube connection is currently delayed. An optional start from the *District E* station cannot be applied in this site due to the conditions of the *District E* shaft. Currently the tunnel between *District J* and *District E* is waiting for the problems from archaeological excavations and building conditions on the alignment to be solved.

4.3 MAJOR OBSTACLES FOR DELAY ANALYSIS ON PROJECT

As a part of this research, delays that occurred during *Project A* are analyzed using two of the analysis methods. During the analysis process, some obstacles due to the nature and current practice in the project were faced. These obstacles were often preventive and difficult to overcome; they led to using of subjective decisions by the analyst which created hypothetical simulative scenarios.

One of the major obstacles for delay analysis was the programme schedules. During the project different baseline programme schedules were submitted by the contractor. The initial baseline programme submitted by the contractor was called *BM01*. However, during the project process baseline programmes were changed and *FN* programmes have started being used. One of the major difficulties with using baselines was that though the contractor continued submitting baseline programmes and programme updates using the new baselines, the employer had never approved the new baseline programmes. The employer insisted on using the initial *BM01* which is the only approved programme but had been changed since the submittal considerably.

Another difficulty faced in the programme schedules was the structure of the programme, it was seen that, even in the approved baseline programme, there were activities without predecessors or successors. The activities which do not have links cause the programme schedules become unrealistic and avoid obtaining realistic float data, critical paths and prevent applying the CPM logic to the project. Besides unlinked activities, loops have been observed in the programme. Some activities in the project were linked to each other creating loops, thus, starting and finishing with same activity. Hammock activities were used to create loops and these closed parts of the project were not linked to the other activities on the project. Creating loops, such as unlinked individual activities, result in the programme schedule becoming unrealistic, as the data available is not confident. Analyst has to use subjective decisions in deciding which activities were linked to which activities in creating a baseline.

The as-built programme schedules need to reflect the project logic and variations in the updates. It was seen in the *Project A* that the programme updates do not reflect the project logic. Throughout the project there have been many variation orders given to the contractor. The ideal practice is that, when the variation orders are claimed, then, the contractor has to submit a fragment schedule which reflects the variation on a fragmental network or if the variation is such that the logic of the project shall change considerably, a new programme schedule has to be prepared that reflects the new project logic. The new programme has to be approved and thereon be used as the baseline programme for the consequent updates in the project. *Project A* schedule does not reflect the effect of variation orders or logic changes in time. The variation orders were given without approved programme updates and it is seen in the programme updates that the old logic was continued. The new activities were not added to the programme and the activities were updated and progressed though site documents do not reflect the same progress. This approach was continued until a new baseline was submitted by the contractor. Contractor chose to prepare a new baseline programme reflecting the new logic, though it was later than the progress on the site. However, the new baselines were not approved and accepted by the employer. The approaches in the initial phases of the project led to bigger problems in the later stages.

An example for the unrealistic schedule updates is the *District J* to *District I* tunnel line change. The tunnel could not be constructed due to the delays from the archaeological excavations on the *District J* site, as stated above. Contractor made an offer to change the construction direction demanding the mobilization costs from the employer. It was accepted by the employer that the direction could be changed and a variation order was given. Contractor had mobilized its crew and equipment accordingly and started the excavation from *District I* site in direction of *District J* on January 2007. The initial excavation was done for a 10 days period and the tunnel boring machines were stopped due to other reasons on the site. When the programme schedule updates are inspected during this stage, it is seen that the logic change in the construction was not reflected on the programme updates. The initial excavation on January was reflected on the programme as initial excavation but the direction still seemed as from *District J* to *District I*. The necessary activities to have the construction started from *District I* were not shown on the schedule and the activity sequence stood the same on the consequent updates as well. To have a fair and reasonable result from the delay analysis, these updates should be prepared so as to reflect the real logic and sequence of activities should be reflected as they happen on the site.

Besides the construction logic problems, schedule updates need to reflect the real progress of the activities on site. Progress updates in *Project A* did not reflect the real progress on sites. When the documents, correspondences between the employer and the contractor, notices of claim and demand for variations are investigated and are compared with the programme updates, the construction activity on site is not as reflected on programme. *District I* to *District J* tunnel variation order part of the project is again an example for unrealistic progress rates on the programme. Some activities have been progressed to 90 percent rate in one month and some others have been shown not progressed though some progress seems on the documents. It is thought that possible problems regarding variation orders and condition survey of the existing buildings led the contractor to take such a step in updating programme schedules but for a reasonable delay analysis to be performed, the as built data has to be changed accordingly, but also subjectively.

One of the major problems with the programme schedules were activities that were not described in detail and because of the lack of necessary project links, though critical, appeared as non critical activities. An example to such an activity is the condition survey in *Project A*. Condition survey was planned to be made in 365 days time and was to be finished in November 2005 according to the baseline submitted to the employer. Condition survey activity was not linked to any activity as predecessor and had only commencement as its successor activity. In subsequent updates of the baseline programme the condition survey seemed 90 percent complete but though may have critical effect on the progress of the works according to the site documents, did not seem as a critical activity since it has not been linked to any other activity. Condition survey was put in the programme as one activity, though in fact it comprised several surveys for different locations throughout the project. The survey for the *District I* to *District J* tunnel alignment became problematic in the later stages of the project, but this could not be traced from the schedule updates. Probably, if there had been condition survey activities that had been divided according to their locations and were linked, in accordance to the project logic, to other activities, criticality and possible concurrency with other critical delays could have been easily observed. In the update schedules, it is observed that though condition survey is actually started and has duration of 365 days, its late finish and early finish dates seem 3 and four years respectively. In the latest programme updates (February 2009), which were updated using the baseline that was prepared according to the altered logic but was not approved by the employer, condition survey activity seemed 96 percent complete, its latest finish time seemed May 2009 and its only successor relationship is start to start with *stage A excavation 1*. According to the contract documents, condition survey has to be finished before starting initial excavations and in *District I* region initial excavations started on January 2007. There is no logical link between *District I* region and condition survey in the approved updated programmes. This example shows that unlinked activities allow the project updates to be manipulated and the analyst has to be aware of the possible consequences of the manipulated activities.

Another problem observed in the programme updates was for the float values. In order to make analysis using float values, there must be realistic float values in the programme however, in *Project A* float values were not realistic due to the problems similar to those stated above; unlinked activities, manipulated start and finish dates, progress rates that do not reflect the actual progress on sites and programme schedules that do not reflect the real logic of the construction activity on site. Before starting an analysis based on float values, these factors have to be taken into account and corrected accordingly, if possible.

One of the problems of delay analysis in *Project A* was the difficulty in determining the delays that occurred on the project. Delay analysis on programme schedules help the analyzer find out the effect of individual delays to the completion time of the total project and possible concurrencies. Before starting analysis on programme schedules using analysis techniques, an initial study of the project documents is essential to find out the delays that occurred on the project activities and their durations. In *Project A*, the notices of claim and variation orders were not given as it should have been, due to some bureaucratic and procedural reasons, the variations were not reflected on programmes as stated above and most delays have been difficult to find out. The difficulty in determining delays reflected itself in the hypothetical nature of the analysis and its results.

4.4 DELAY ANALYSIS OF THE PROJECT USING TIME IMPACT ANALYSIS METHOD

In this part of the research, one of the most problematic parts of the *Project A* was analysed using time impact analysis method. The aim of the analysis is to provide a model for analysing delay claims using time impact analysis and determine the possible problematic points and obstacles in progressing with the analysis. The problems that are observed during the analysis phase will be useful in writing a proposal for a specification clause that can be used to prevent problems in construction projects.

District I to *District J* tunnel alignment was chosen for the analysis stage. The background to the analysis in this part of the construction is summarily as follows; as stated above, this part of the project was one of the most problematic parts. The archaeological excavations in *District J* site prevented the tunnel construction from proceeding as the construction method for the tunnel was such that it would be bored from *District J* to *District I* by TBM1. In order the project to proceed, the contractor made an initial offer to the employer stating that the construction could start from the *District I* shaft on condition that the mobilization costs are paid. Employer has accepted the offer and has given a variation order though it may be argued whether a variation order for the tunnel construction direction was necessary. After duration of about 10 months, contractor stated that the excavations can be started from the *District I* site and starts the excavations on January 2007. Though after the initial excavation, the TBM1 stops and does not proceed boring the tunnel. Opposing accusations started at this point between the parties and each party claimed that the delay in tunnel construction was due to the risks that had to be borne by the other. Contractor stated that the excavation cannot continue as the exit shaft in *District I* site has not been prepared and before an exit shaft has not become definite TBM1 cannot bore the tunnel. Employer’s counter argument was that the offer to start from *District I* site came from the contractor having the knowledge of situation at the time in *District J* and claimed that excavation should continue until the TBM comes at a point near to the District J site where an exit shaft will be prepared for the TBM1 to exit. Contractor's argument that the technical conditions of TBM1 does not give possibility to wait at a point near the exit shaft was given credit by DAB and accepted. One of the controversial points that were not on the table when the issue went to DAB was the condition survey activity. It was pointed in the previous part of this chapter that condition survey was shown on the programme schedules updated at the time as an activity that would take 365 days for all locations and was not linked to any other activity. The condition survey was contractually to be done by the contractor and the risk of damages on the buildings from the construction over the tunnel alignment was to be borne by the contractor. On this issue, employer claimed that the contractor has not fulfilled the contractual requirements and the condition survey was not finished when the initial excavation in *District I* started. As a consequence, when it was realized that the building stock over the tunnel alignment was weaker then expected the contractor tried to relieve from his contractual duties by blaming the employer for other reasons, according to the employer. In technical words, it is easy to see that if there were any delays on the construction caused by the contractor, and concurrent with the employer delay event which is the archaeological excavations, it is possible that extension of time is given but not the costs. In this part, a hypothetical simulative time impact analysis was done and the results were observed, in order to define problems occurring in the delay analysis of the project.

First step in conducting a delay analysis using time impact analysis method is to find out the delays that occurred on the project and their durations. In order to find out the delays, the documents, correspondences, notices of claim between the employer, consultant, contractor and employer's various offices were investigated. A part of the process is talking with the site staffs that are familiar with the project. It is essential to talk with the engineers, technicians and programmers who know the project because programme schedules and documents do not mean much without the people who experienced the processes. In this research, documents have been investigated with the engineers and technicians of the employer, their experiences of the project and delays have been considered in deciding delay events and their durations. At the end of this *Stage 6* individual delay events were defined. These delay events comprised the delays that happened on *District I* to *District J* tunnel part of the *Project A* between April 2006 and May 2007. The delay events are listed as follows:

- Delay event 1: Delay in Condition Survey.

- Delay event 2: Delay due to the variation order 28.
- Delay event 3: Delay in making the TBM ready for operation.
- Delay event 4: Delay in starting the initial excavation.
- Delay event 5: Delay in activity TBM excavation.
- Delay event 6: Archaeological Excavations in *District J* site.

First delay is the delay in condition survey. According to the contract, condition survey of the buildings on construction alignments had to be done by the contractor before starting excavation and the risk of damage to the buildings belonged to the contractor. In the approved baseline programme, the condition survey activity would start in October 2004 and would be 365 days long, however, in 2006 April the condition survey was still not completed. In May 2007, where the analysis was stopped, the condition survey was still not completed so during all the stages of the analysis, condition survey delay was ongoing. Delays resulting from condition survey are the responsibility of the contractor.

Second delay in the analysis is the delay due to the variation order 28. The variation order 28 is about the change in the construction direction from *District J* to *District I* to *District I* to *District J* in the tunnel that will be bored by TBM1. Approving the change in the direction of the tunnel by variation order 28, employer approved to own the risk of delays caused by the change in the project. The variations done to the project may cause delay in the project completion time, the mobilization time, new construction activities to start the excavation from the *District I* site added new activities to the schedule, all of which may delay the project completion. The risk of variation orders are on the employer, so variation order 28 caused delays are employer's delays. On the other hand, there is already archaeological delay on the project, so delays from variation order would possibly not delay on itself the project completion. There is also no issue of concurrency. The duration of the delay was decided with the comments by the experienced staff of the employer, the variation order was given on April 2006 and the duration of the preparation of *District I* site was decided as 121 days for the analysis.

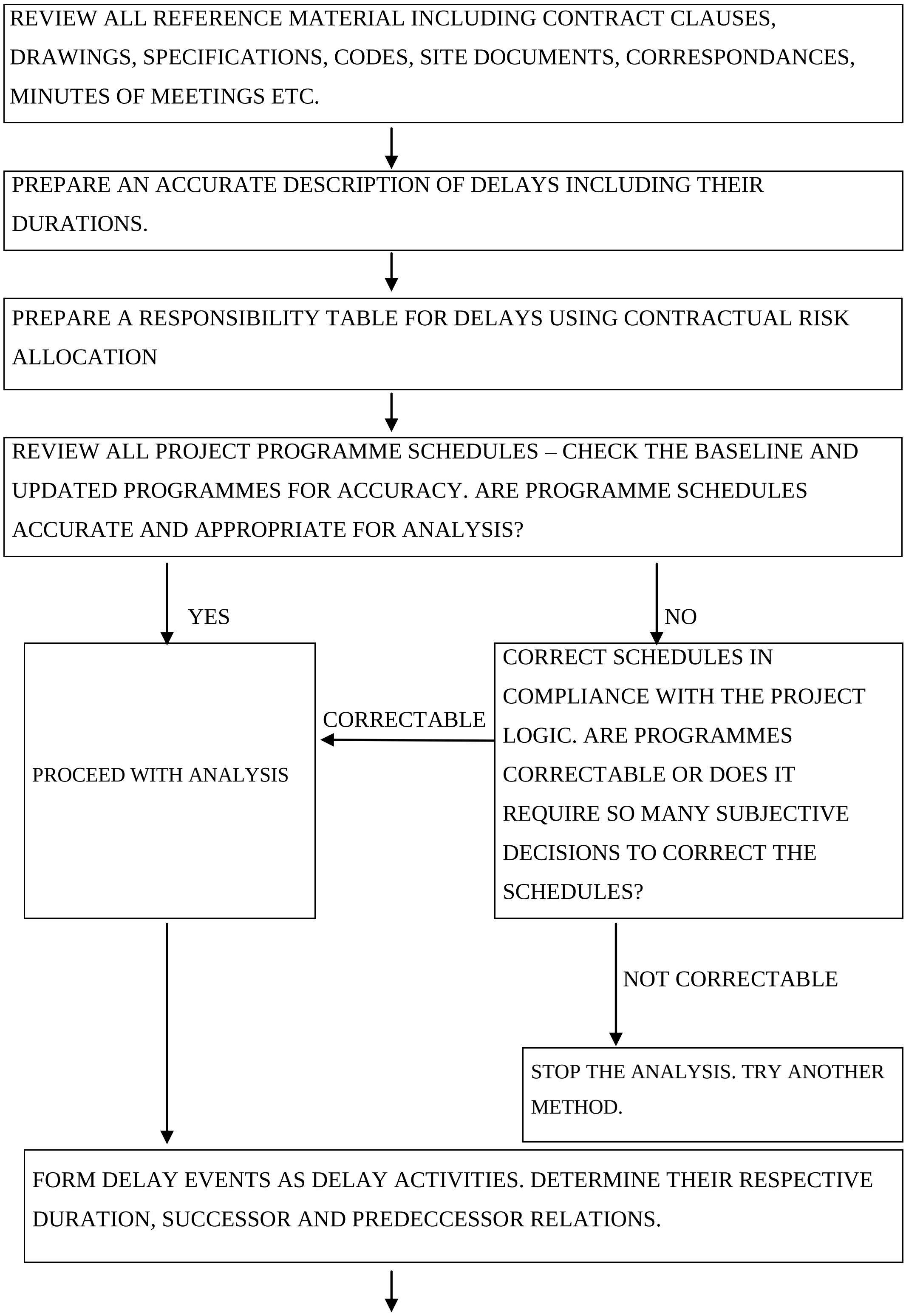
Third delay on this stage of the project is the TBM1 being ready for operation. TBM1 should have started the excavation as soon as the site gets ready in *District I*.

It was assumed that *District I* site would have been ready in about four months so TBM1 should have been ready for operation in August 2006, however site records and minutes of meetings between the employer and the contractor show that contractor has made the TBM1 ready on December 2006. The duration between this four months is a delay in the project caused by the TBM1 not being ready. The delay is the contractor's responsibility and has been used in the analysis as such.

Fourth delay is the delay in starting the initial excavation. Contractor has expressed that TBM1 can start excavating on December 2006 though the site documents and programme schedules show that it has not done so until January 2007. The delay in starting the excavation is a result of contractor's conscious choice due to some other reasons. Delay in this activity is contractor's responsibility. The duration of the delay is between when the TBM1 was ready to excavate and when the initial excavation has started.

Fifth delay is the delay in TBM1 excavation activity. Site records show that after starting initial excavation TBM1 has stopped and did not carry on excavating. Contractor has decided to stop excavating and asked the employer to decide an exit shaft in *District J* site where the archaeological excavations were taking place. Delays that occur as a result of TBM1's stop are taken as contractor caused delay in this analysis. The TBM1 has not been started when the end of analysis at May 2007 came. Duration of the delay has been taken as between February 2007 when the TBM1 stopped and May 2007 when the analysis fragment ends.

Table 4.1 Time Impact Analysis Procedure



TAKE PROGRAMME SCHEDULE JUST PRIOR TO THE FIRST DELAY EVENT AND INSERT DELAY ACTIVITY INTO PROGRAMME SCHEDULE. IS THERE MORE THAN ONE DELAY EVENT, OCCURING IN SAME TIME INTERVAL THAT IS UNDER DIFFERENT PARTIES' LIABILITY?

NO

RECORD THE CHANGE IN PROJECT COMPLETION DATE AND PROCEED WITH THE ANALYSIS.

YES

INSERT DELAY ACTIVITIES INDIVIDUALLY AND RECORD THE CHANGE IN PROJECT COMPLETION. THEN, INSERT DELAY ACTIVITIES TOGETHER AND RECORD THE PROJECT COMPLETION AGAIN.

REPEAT THE PROCESS UNTIL ALL DELAY EVENTS ARE INSERTED IN PROJECT SCHEDULES.

PREPARE A RESULTS TABLE SHOWING THE RESULTS OF TIME IMPACT ANALYSIS THAT COMPRISES DELAY NAME, DURATION, RESPONSIBLE PARTY AND ITS EFFECT ON PROJECT COMPLETION.

Archaeological excavations are the main delay event for the project at this stage. The excavations in *District J* site were still proceeding during April 2006 and May 2007. The excavations in *District J* site are contractually employer's risk and the delays caused by excavations are on critical path of the project. Time impact analysis done on this research, aims to find out possible concurrent delays to archaeological excavations which do readily delay the project at the time, so is not inserted in the analysis fragment as a delay event.

After finding out the delays on the project and their durations using project documents, next step in analysis is converting these delays into separate delay events and inserting them into project schedules. The durations and start and finish dates for delays were already defined, in order to convert delays into delay events the predecessor and successor relationships should be created. Creating the relationships in this project was done with the help of experienced staff of the project who have the knowledge and experience of the project logic and construction process. Contractual requirements were another important factor in deciding the relationships for delay activities.

Table 4.2 Delay Activities Relationship Table

Delay Description	Predecessor Activity	Successor Activity	Contractual Responsibility
Condition Survey Delay	• Condition Survey	• Initial Excavation	Contractor Responsible
Variation Order No.28 Delay	• Fence & Secure - District I Area • Detail Design – District I Ventilation Building TBM Port – Civil Review • Re-route Existing Railway to North (District I)	• TBM 1 Ready for Operation	Employer Responsible
TBM Ready for Operation Delay	• Stationary Shell Manufacturing	• Initial Excavation	Contractor Responsible
Delay in Start of Initial Excavation Activity	• TBM 1 Ready for Operation • End Support Installation	• Initial Excavation	Contractor Responsible
Delay due to TBM Stop	• TBM 1 Ready for Operation	• Initial Excavation	Contractor Responsible

Time impact analysis is done using snapshots. When a delay event occurs, the programme schedules just prior to the delay event are taken and delays are inserted into these windows in order to observe the possible delays. If this analysis is done on a periodic basis, of which the period is generally the update period of the programme schedules, then the method is called windows analysis.

In this research, the first method was chosen and programme updates prior to the delay events were used. Four updates and a baseline programme schedule were obtained using this method. The baseline used is the project schedule prior to the first delay, April 2006. The selected baseline is the approved baseline programme *BM01* by the contractor. The baseline has been modified for the analysis. The analysis is based on a simulative model to create an example for time impact analysis. *BM01* schedule has been filtered so that only activities that take place or are linked to tunnel construction between *District I* and *District J* are on the schedule. The activities that were not linked to any other activities have been linked in the proper construction logic and a baseline schedule was created.

The first snapshot date is April 2006, the second snapshot date is August 2006, the third snapshot date is December 2006 and the fourth snapshot date is February 2007. The update in time impact analysis is done using the previous updated, impacted schedule. This is the main difference between time impact analyses and impacted as planned techniques. If the employer delay events and contractor delay events were separately taken and the baseline schedule was impacted then the analysis would be an impacted as planned whereas in time impact analysis multiple baselines, the already impacted schedules were used for analysis.

The next step is creating a table for summarizing the analysis results. In the table, baseline and impacted schedule names, impacting dates and effects of delays to project completion date shall be stated. The impact of delays belonging to each party and concurrent delays shall also be stated separately.

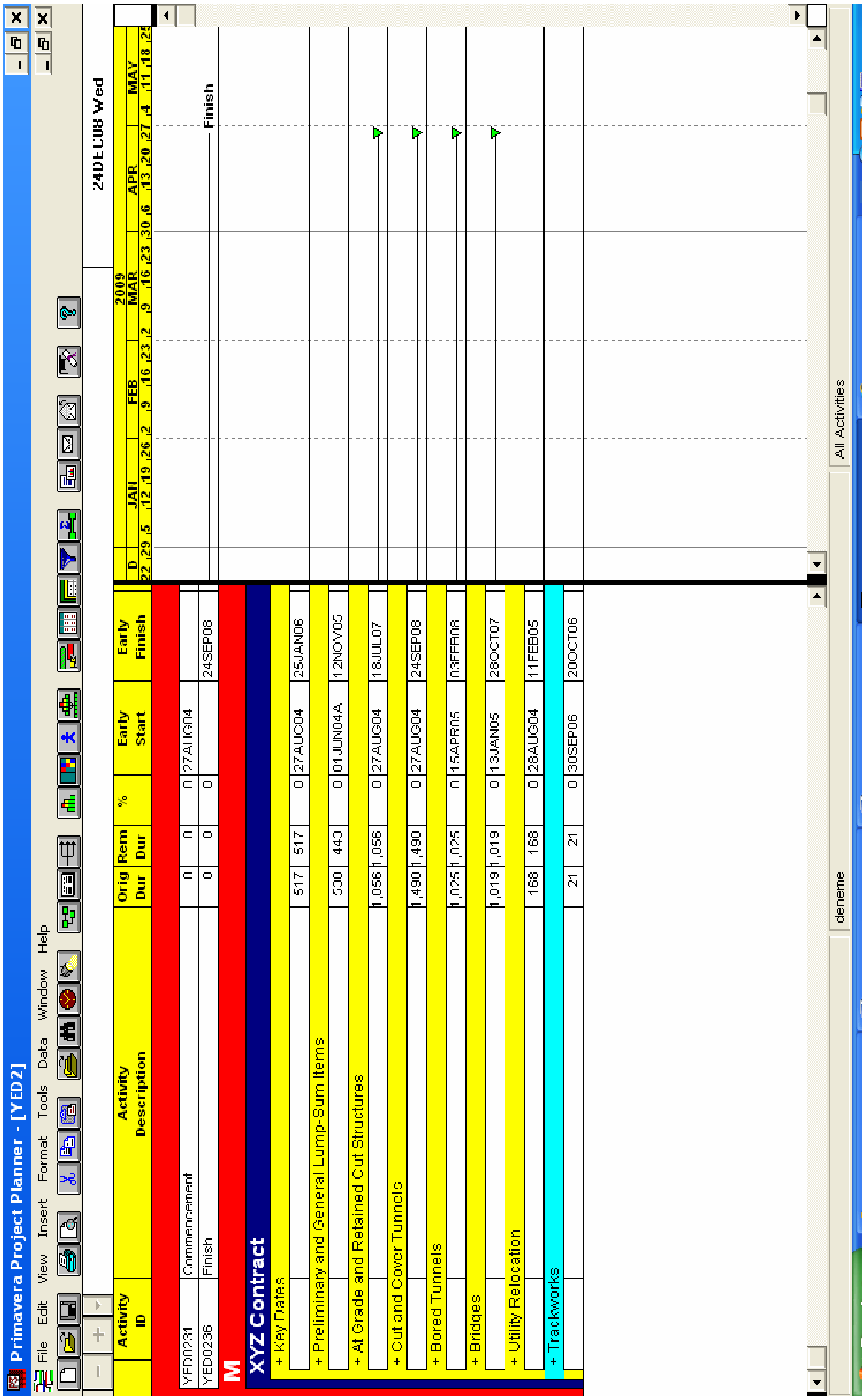


Figure 4.1 Part of the baseline programme used for Time Impact Analysis.

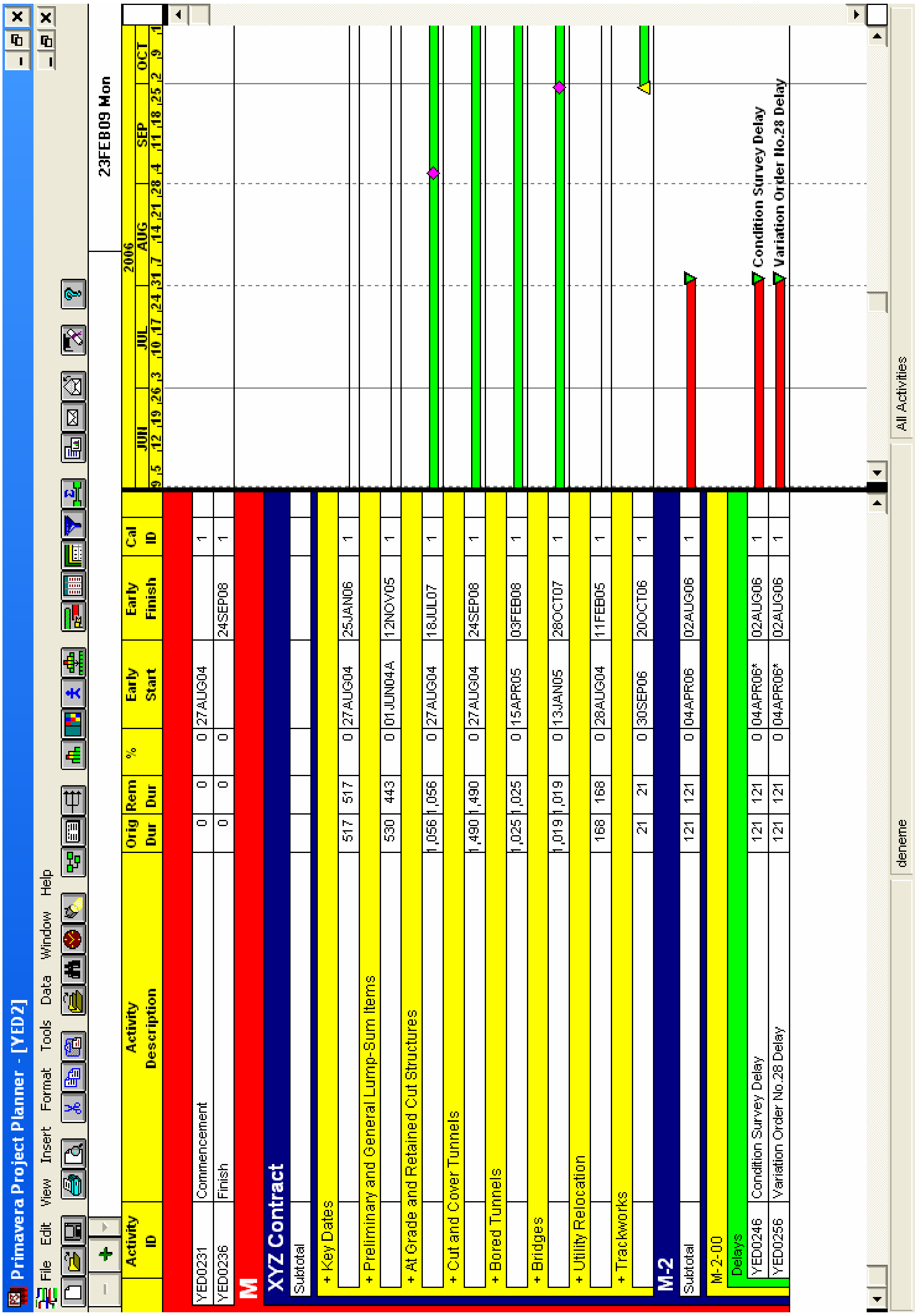


Figure 4.2 1st programme update used for Time Impact Analysis - including two delays

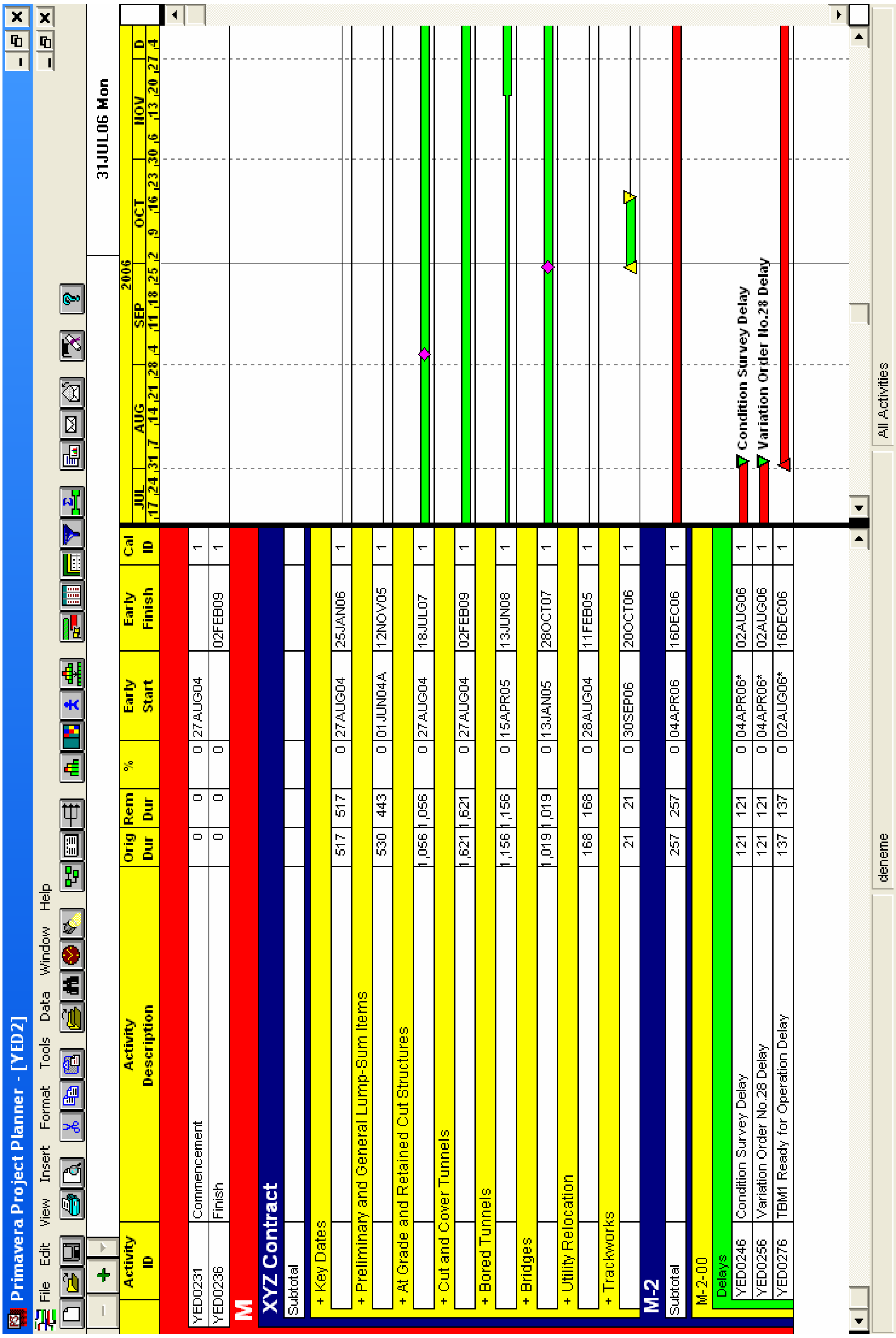


Figure 4.3 2nd Programme Update used for Time Impact Analysis - including three delays

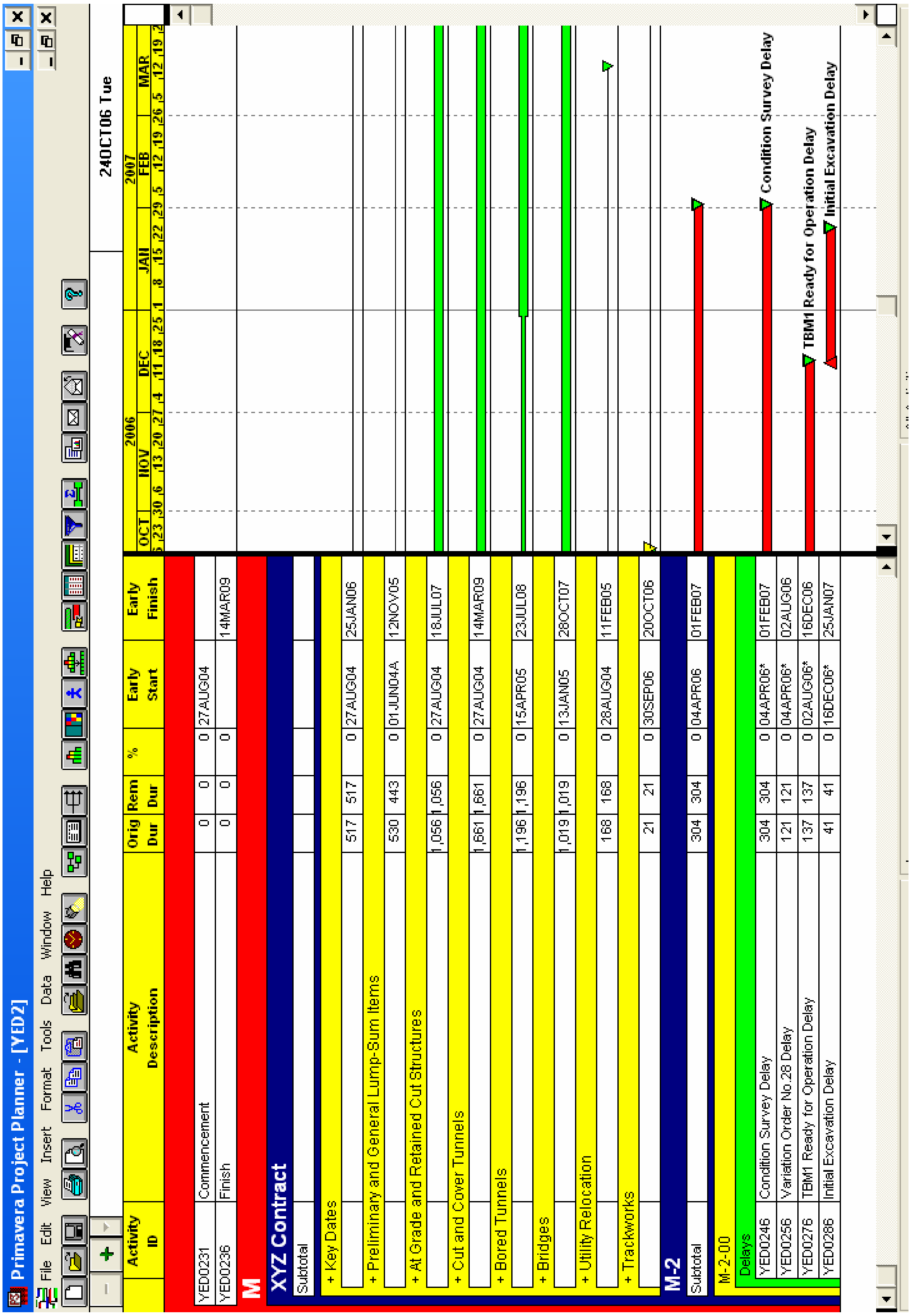


Figure 4.4 3rd Programme Update used for Time Impact Analysis - including four delays

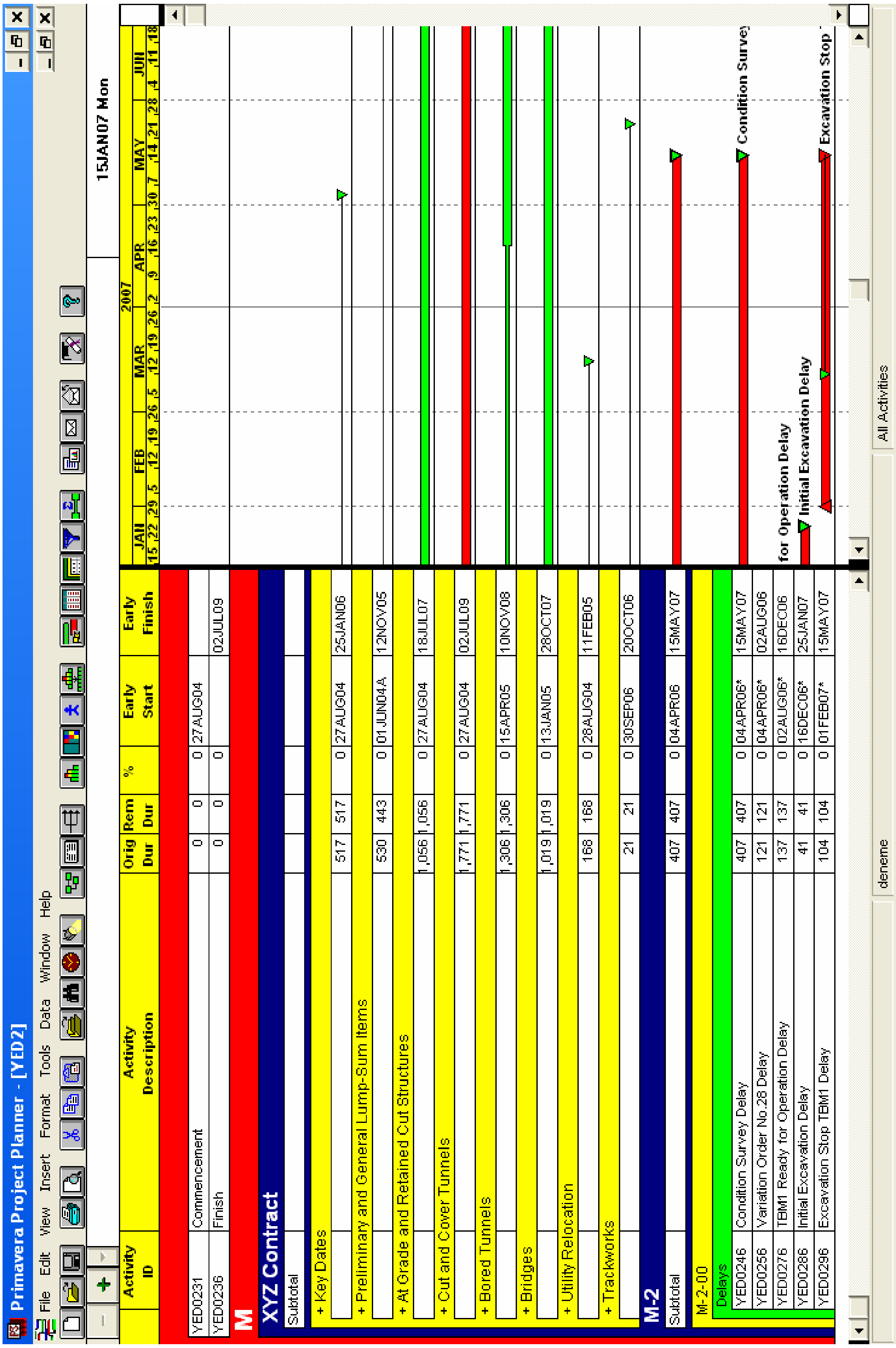


Figure 4.5 4th Programme Update used for Time Impact Analysis - including five delays

Table 4.3 Time Impact Analysis Results Table

DELAY DESCRIPTION	WINDOW NO.	DELAY START	DELAY FINISH	PROJECT COMPLETION DATE	PROJECT CONTEMPORENOUS FINISH DATE	DELAY ATTRIBUTABLE TO EACH PARTY		
						EMPLOYER	CONTRACTOR	NEUTRAL
CONDITION SURVEY DELAY	1	04.04.2006	02.08.2006	24.09.2008	24.09.2008		0	
VARIATION ORDER NO.28 DELAY	1	04.04.2006	04.07.2006	24.09.2008	24.09.2008	0		
CONDITION SURVEY DELAY	2	02.08.2006	16.12.2006	24.09.2008	24.09.2008		0	
TBM 1 READY FOR OPERATION DELAY	2	02.08.2006	16.12.2006	24.09.2008	02.02.2009		130	
CONDITION SURVEY DELAY	3	16.12.2006	01.02.2007	02.02.2009	02.02.2009		0	
INITIAL EXCAVATION DELAY	3	16.12.2006	01.02.2007	02.02.2009	21.03.2009		48	
CONDITION SURVEY DELAY	4	01.02.2007	15.05.2007	21.03.2009	21.03.2009		0	
EXCAVATION STOP TBM1 DELAY	4	01.02.2007	15.05.2007	21.03.2009	02.07.2009		107	
						0	285	0

4.5 DELAY ANALYSIS OF PROJECT USING FLOAT MAPPING METHOD

As an alternative analysis method, an explanatory example of analysis using float mapping was applied to *Project A District I* to *District J* tunnel. The first step in the analysis is to define the programme schedules that will be used. The baseline and update programmes must be in consistence with each other in respect of both activity names and programme logic. Inconsistencies between programmes may cause unfair results. Another important issue is to link activities that have not been linked in the baseline and update programmes. Unlinked activities damage continuity in programme schedule and prevent paths occurring, thus CPM logic cannot be applied to programme. Float values will not be realistic in such a work programme. Constraints in programme activities should also be noted, as they tightly effect float formation.

In this research, baseline programme, *BM01*, used for time impact analysis was also used for analysis in float mapping technique. Activities in *BM01* that are related to the construction of *District I* to *District J* tunnel are filtered and activities that have not been linked to any other activities have been linked in the proper construction logic by the help of the staff working in the project. Activities that have constraints are noted so that they do not adversely affect the analysis results. The other programme schedules used for analysis are the monthly updated programmes from April 2006 to May 2007. The programme schedules have been observed and activities are listed so that continuity between programme schedules is maintained. The first phase of the analysis is completed by observing the raw data obtained from consecutive programme schedules, including their total float values. In this step main aim is to define activities and find out their continuity, constraints and links in the programme.

Second step of the analysis is to tabulate the raw data obtained from the first step. A table is created which shows the activity names and their total float values in different programme updates. Activities that have zero float values are recorded with zero values on the table. This table gives the opportunity to chase the changes in float values in activities during the progress of the project.

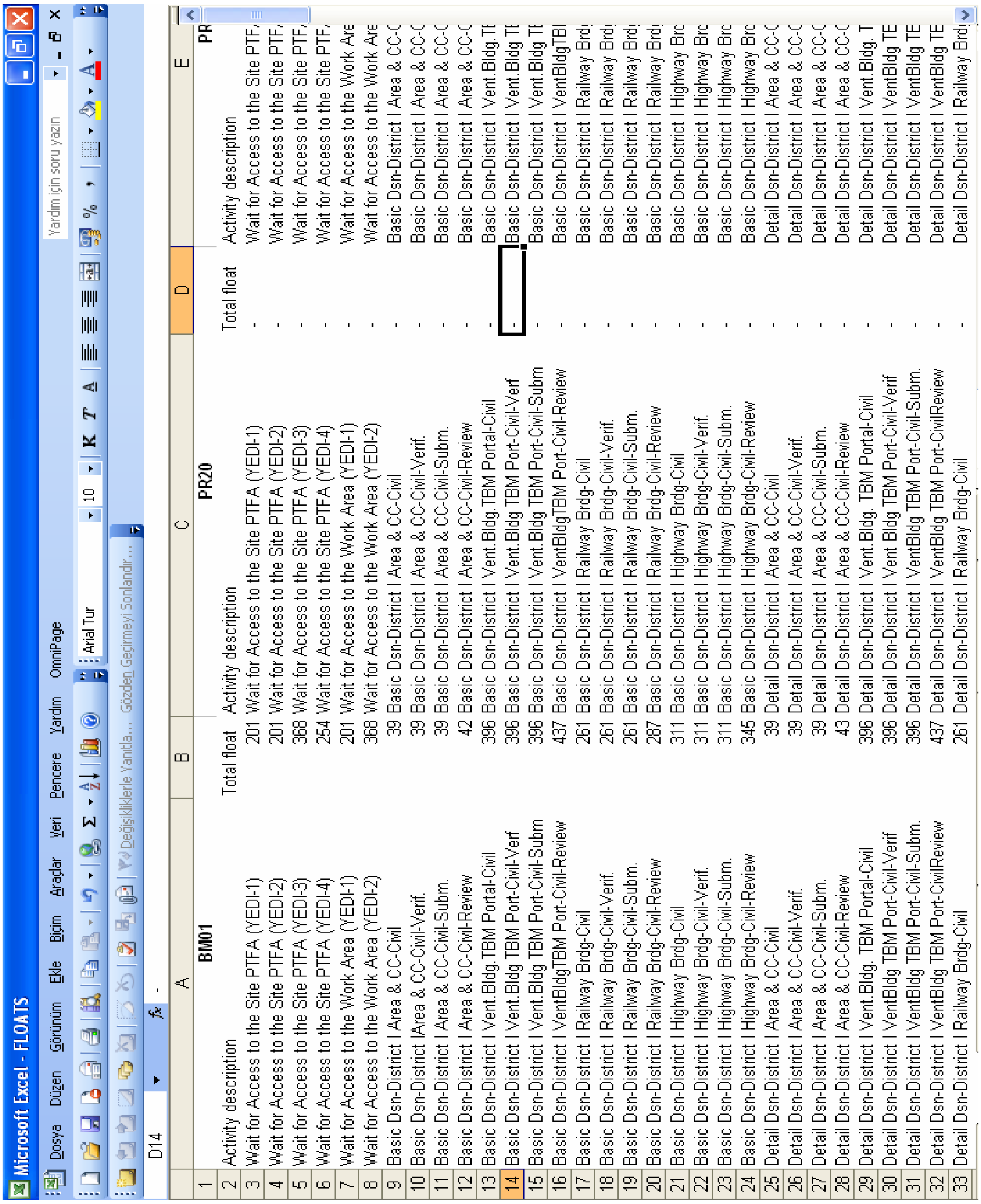
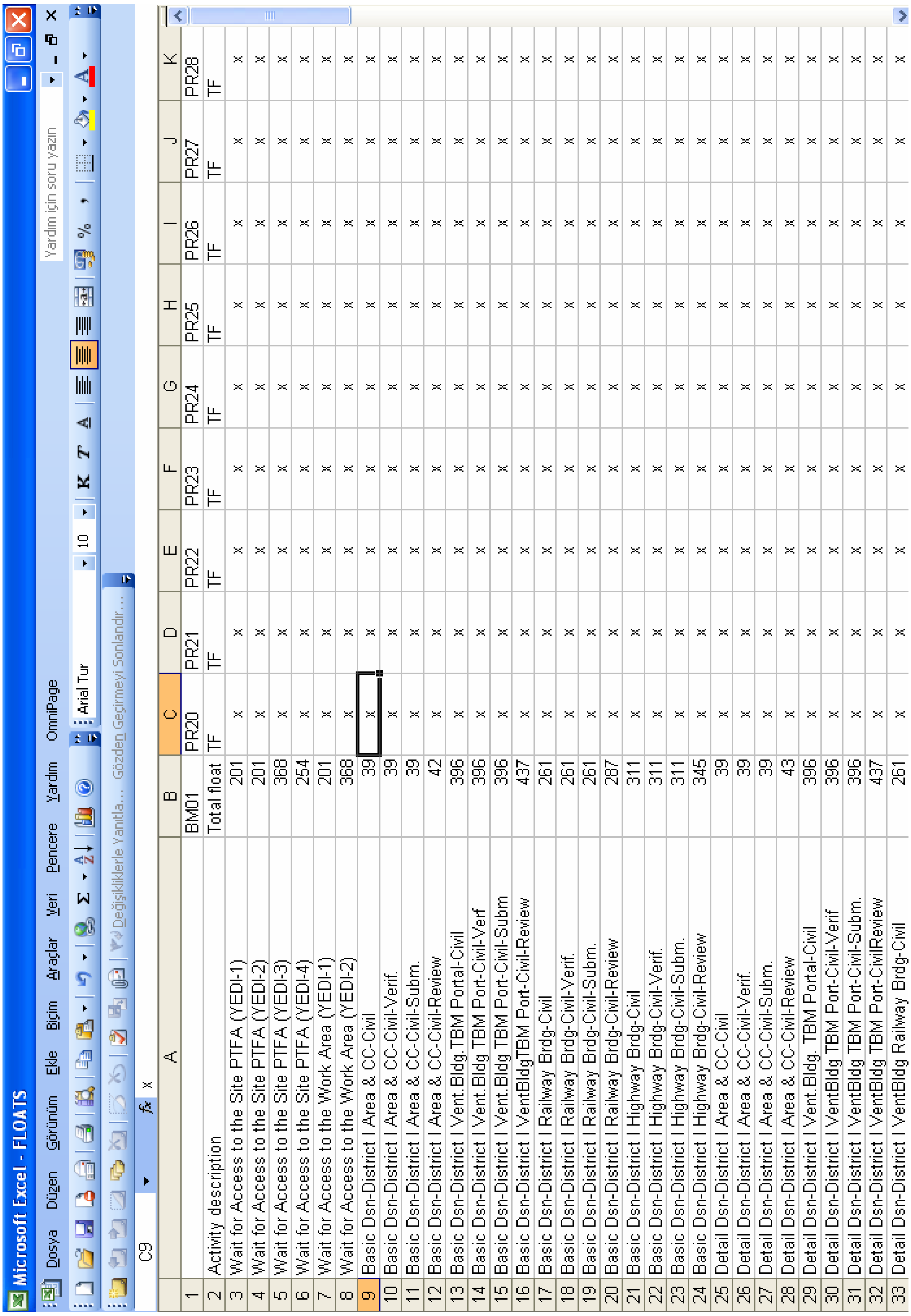
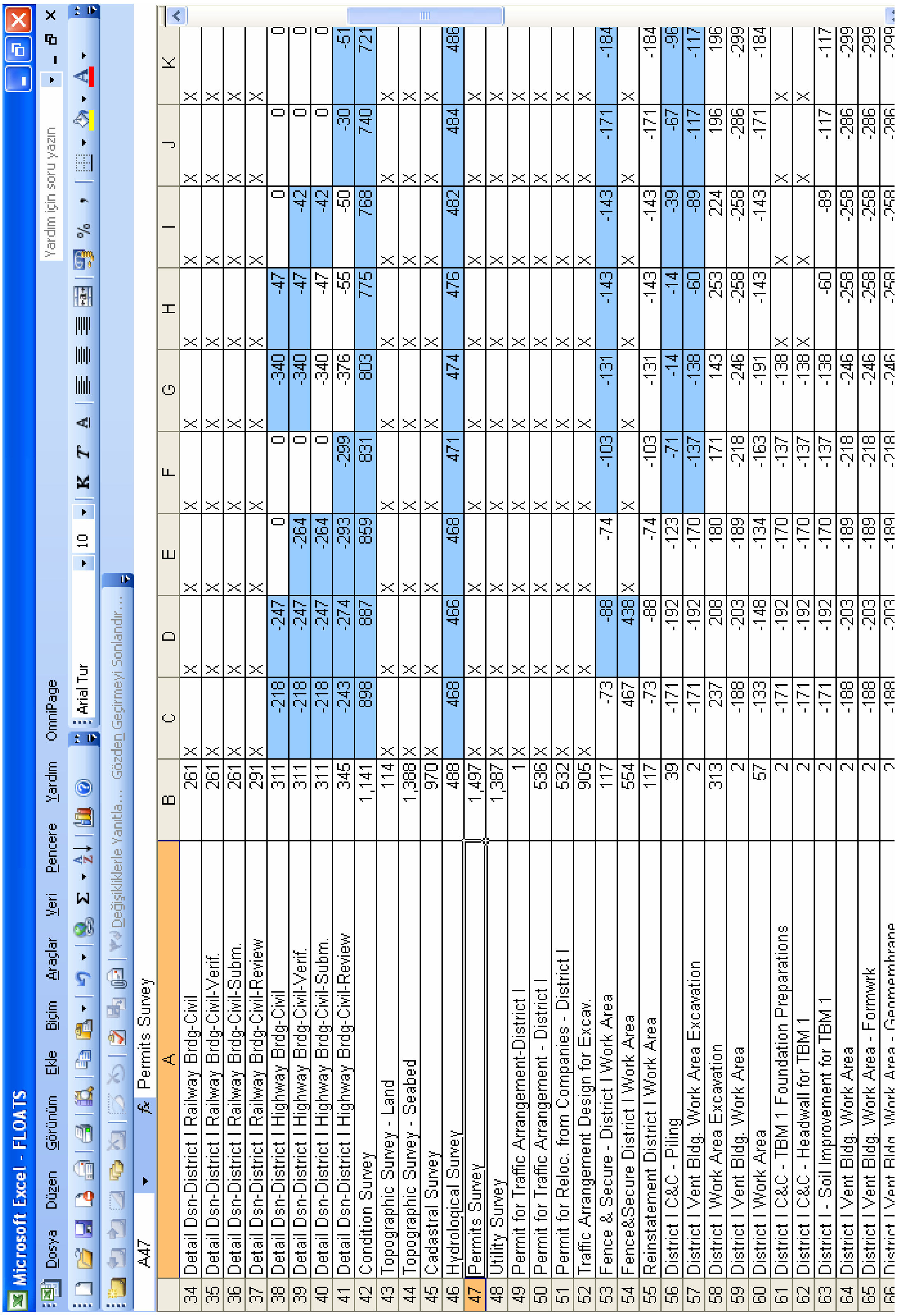


Figure 4.6 Part of Raw data sheet reflecting activity names and total floats used for float mapping



	A	B	C	D	E	F	G	H	I	J	K
1		BM01	PR20	PR21	PR22	PR23	PR24	PR25	PR26	PR27	PR28
2	Activity description	Total float	TF	TF	TF	TF	TF	TF	TF	TF	TF
3	Wait for Access to the Site PTFA (YEDI-1)	201	x	x	x	x	x	x	x	x	x
4	Wait for Access to the Site PTFA (YEDI-2)	201	x	x	x	x	x	x	x	x	x
5	Wait for Access to the Site PTFA (YEDI-3)	368	x	x	x	x	x	x	x	x	x
6	Wait for Access to the Site PTFA (YEDI-4)	254	x	x	x	x	x	x	x	x	x
7	Wait for Access to the Work Area (YEDI-1)	201	x	x	x	x	x	x	x	x	x
8	Wait for Access to the Work Area (YEDI-2)	368	x	x	x	x	x	x	x	x	x
9	Basic Dsn-District I Area & CC-Civil	39	x	x	x	x	x	x	x	x	x
10	Basic Dsn-District I Area & CC-Civil-Verif.	39	x	x	x	x	x	x	x	x	x
11	Basic Dsn-District I Area & CC-Civil-Subm.	39	x	x	x	x	x	x	x	x	x
12	Basic Dsn-District I Area & CC-Civil-Review	42	x	x	x	x	x	x	x	x	x
13	Basic Dsn-District I Vent.Bldg.TBM Portal-Civil	396	x	x	x	x	x	x	x	x	x
14	Basic Dsn-District I Vent.Bldg TBM Port-Civil-Verf	396	x	x	x	x	x	x	x	x	x
15	Basic Dsn-District I Vent.Bldg TBM Port-Civil-Subm	396	x	x	x	x	x	x	x	x	x
16	Basic Dsn-District I VentBldgTBM Port-Civil-Review	437	x	x	x	x	x	x	x	x	x
17	Basic Dsn-District I Railway Brdg-Civil	261	x	x	x	x	x	x	x	x	x
18	Basic Dsn-District I Railway Brdg-Civil-Verif.	261	x	x	x	x	x	x	x	x	x
19	Basic Dsn-District I Railway Brdg-Civil-Subm.	261	x	x	x	x	x	x	x	x	x
20	Basic Dsn-District I Railway Brdg-Civil-Review	287	x	x	x	x	x	x	x	x	x
21	Basic Dsn-District I Highway Brdg-Civil	311	x	x	x	x	x	x	x	x	x
22	Basic Dsn-District I Highway Brdg-Civil-Verif.	311	x	x	x	x	x	x	x	x	x
23	Basic Dsn-District I Highway Brdg-Civil-Subm.	311	x	x	x	x	x	x	x	x	x
24	Basic Dsn-District I Highway Brdg-Civil-Review	345	x	x	x	x	x	x	x	x	x
25	Detail Dsn-District I Area & CC-Civil	39	x	x	x	x	x	x	x	x	x
26	Detail Dsn-District I Area & CC-Civil-Verif.	39	x	x	x	x	x	x	x	x	x
27	Detail Dsn-District I Area & CC-Civil-Subm.	39	x	x	x	x	x	x	x	x	x
28	Detail Dsn-District I Area & CC-Civil-Review	43	x	x	x	x	x	x	x	x	x
29	Detail Dsn-District I Vent.Bldg. TBM Portal-Civil	396	x	x	x	x	x	x	x	x	x
30	Detail Dsn-District I VentBldg TBM Port-Civil-Verif	396	x	x	x	x	x	x	x	x	x
31	Detail Dsn-District I VentBldg TBM Port-Civil-Subm.	396	x	x	x	x	x	x	x	x	x
32	Detail Dsn-District I VentBldg TBM Port-CivilReview	437	x	x	x	x	x	x	x	x	x
33	Detail Dsn-District I VentBldg Railway Brdg-Civil	261	x	x	x	x	x	x	x	x	x

Figure 4.7 Part of Raw Data Sheet that lists activity names and floats consequently according to programme updates used for first step of float mapping.



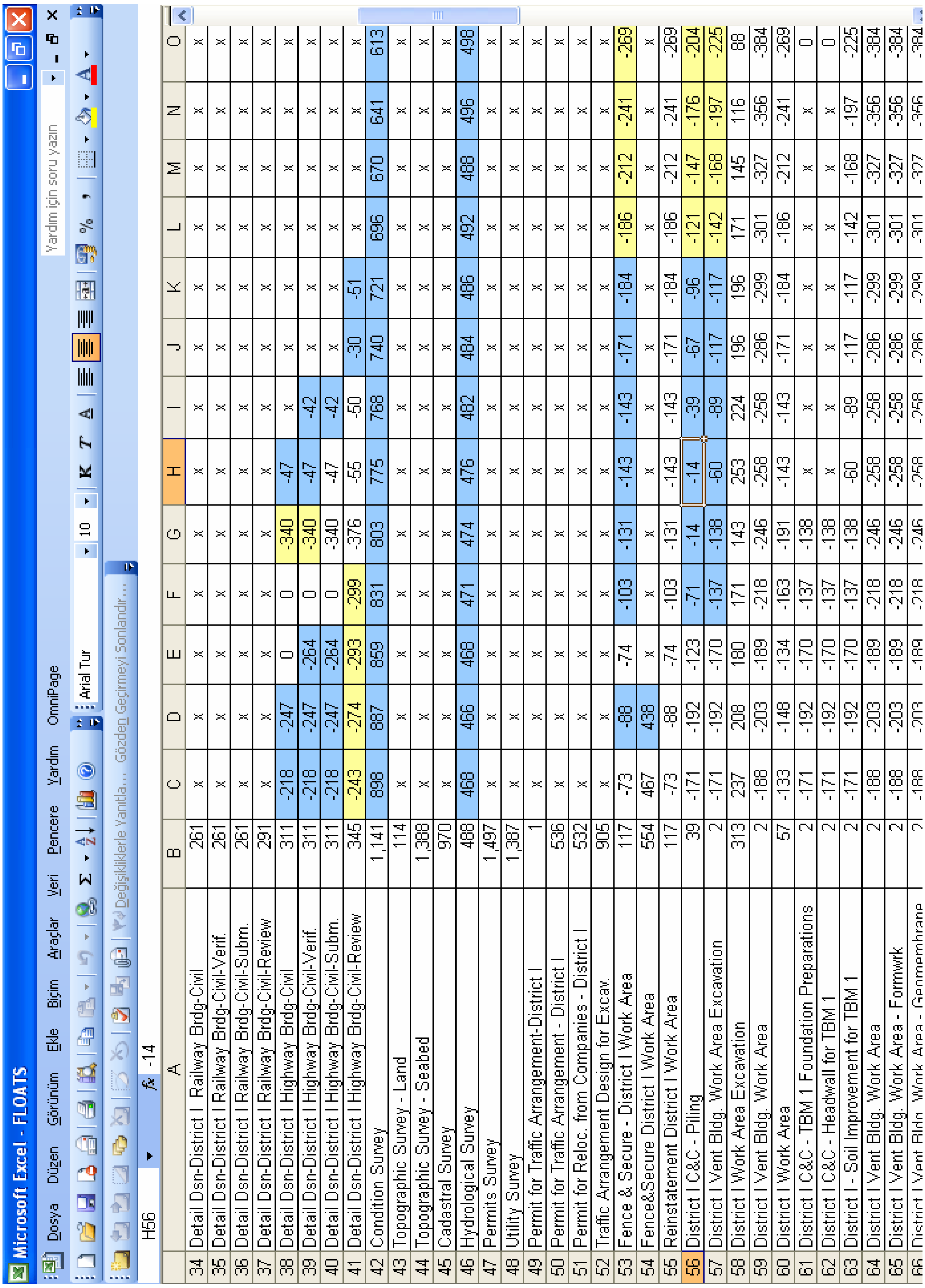
	A	B	C	D	E	F	G	H	I	J	K
34	Detail Dsn-District I Railway Brdg-Civil	261	X	X	X	X	X	X	X	X	X
35	Detail Dsn-District I Railway Brdg-Civil-Verif.	261	X	X	X	X	X	X	X	X	X
36	Detail Dsn-District I Railway Brdg-Civil-Subm.	261	X	X	X	X	X	X	X	X	X
37	Detail Dsn-District I Railway Brdg-Civil-Review	291	X	X	X	X	X	X	X	X	X
38	Detail Dsn-District I Highway Brdg-Civil	311	-218	-247	0	0	-340	-47	0	0	0
39	Detail Dsn-District I Highway Brdg-Civil-Verif.	311	-218	-247	-264	0	-340	-47	-42	0	0
40	Detail Dsn-District I Highway Brdg-Civil-Subm.	311	-218	-247	-264	0	-340	-47	-42	0	0
41	Detail Dsn-District I Highway Brdg-Civil-Review	345	-243	-274	-293	-299	-376	-55	-50	-30	-51
42	Condition Survey	1,141	898	887	859	831	803	775	768	740	721
43	Topographic Survey - Land	114	X	X	X	X	X	X	X	X	X
44	Topographic Survey - Seabed	1,388	X	X	X	X	X	X	X	X	X
45	Cadastral Survey	970	X	X	X	X	X	X	X	X	X
46	Hydrological Survey	488	468	466	468	471	474	476	482	484	486
47	Permits Survey	1,497	X	X	X	X	X	X	X	X	X
48	Utility Survey	1,387	X	X	X	X	X	X	X	X	X
49	Permit for Traffic Arrangement-District I	1	X	X	X	X	X	X	X	X	X
50	Permit for Traffic Arrangement - District I	536	X	X	X	X	X	X	X	X	X
51	Permit for Reloc. from Companies - District I	532	X	X	X	X	X	X	X	X	X
52	Traffic Arrangement Design for Excav.	905	X	X	X	X	X	X	X	X	X
53	Fence & Secure - District I Work Area	117	-73	-88	-74	-103	-131	-143	-143	-171	-184
54	Fence&Secure District I Work Area	554	467	438	X	X	X	X	X	X	X
55	Reinstatement District I Work Area	117	-73	-88	-74	-103	-131	-143	-143	-171	-184
56	District I C&C - Piling	39	-171	-192	-123	-71	-14	-14	-39	-67	-96
57	District I Vent Bldg. Work Area Excavation	2	-171	-192	-170	-137	-138	-60	-89	-117	-117
58	District I Work Area Excavation	313	237	208	180	171	143	253	224	196	196
59	District I Vent Bldg. Work Area	2	-188	-203	-189	-218	-246	-258	-258	-286	-299
60	District I Work Area	57	-133	-148	-134	-163	-191	-143	-143	-171	-184
61	District I C&C - TBM 1 Foundation Preparations	2	-171	-192	-170	-137	-138	X	X	X	X
62	District I C&C - Headwall for TBM 1	2	-171	-192	-170	-137	-138	X	X	X	X
63	District I - Soil Improvement for TBM 1	2	-171	-192	-170	-137	-138	-60	-89	-117	-117
64	District I Vent Bldg. Work Area	2	-188	-203	-189	-218	-246	-258	-258	-286	-299
65	District I Vent Bldg. Work Area - Formwrk	2	-188	-203	-189	-218	-246	-258	-258	-286	-299
66	District I Vent Bldg. Work Area - Geomembrane	2	-188	-203	-189	-218	-246	-258	-258	-286	-299

Figure 4.8 Part of Data Sheet used for the second step of the float mapping analysis. Driving activities in each programme update are found according to related criteria.

In the third step, driving activities are found for each project update. Driving activities are found by applying two criteria; activities those are on the longest path and that have started or will start in one month are driving activities for the project. In this project activities that are on the longest path and started or will start until next update period have been found and are highlighted on the table. Activities that are on longest path but which will not start until next month is not highlighted, thus it is important to apply the both criteria.

Next step is to find the as built critical path. In this step activities that have already been found as driving activities in each update are listed and those which have least total float values or highest negative total float values are found. Those activities which have near total float values are also found as they can be near critical activities. Activities found in this step form together the as built critical path during the project. Activities having the above properties in this research are found and marked on the table comprising the driving activities.

Having found the as-built critical path using the float values, next step is creating the results table. In the results table, the name of the update programme schedule, the data date for the update, the project completion date according to the relevant programme schedule, the total float value of the as built critical path activity, the change in the total float value with respect to the previous programme schedule and delays are written as columns. After writing the relevant values to the columns, delays that have been previously found using the document observation are written in the relevant places on the table using their dates. In this research, three contractor delays were found in document investigation phase. These are stated in the delays table. These delays are written in the results table and delays that have been observed in completion dates are expressed as the result in these delays. Results table is prepared for the contractor responsible delays and employer responsible delays separately. Concurrent delays are those that occur where both employer and contractor responsible delays occur at the same time, thus together on the same place in the results table.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
34	Detail Dsn-District I Railway Brdg-Civil	261	x	x	x	x	x	x	x	x	x	x	x	x	x
35	Detail Dsn-District I Railway Brdg-Civil-Verif.	261	x	x	x	x	x	x	x	x	x	x	x	x	x
36	Detail Dsn-District I Railway Brdg-Civil-Subm.	261	x	x	x	x	x	x	x	x	x	x	x	x	x
37	Detail Dsn-District I Railway Brdg-Civil-Review	291	x	x	x	x	x	x	x	x	x	x	x	x	x
38	Detail Dsn-District I Highway Brdg-Civil	311	-218	-247	0	0	-340	-47	x	x	x	x	x	x	x
39	Detail Dsn-District I Highway Brdg-Civil-Verif.	311	-218	-247	-264	0	-340	-47	-42	x	x	x	x	x	x
40	Detail Dsn-District I Highway Brdg-Civil-Subm.	311	-218	-247	-264	0	-340	-47	-42	x	x	x	x	x	x
41	Detail Dsn-District I Highway Brdg-Civil-Review	345	-243	-274	-293	-299	-376	-55	-50	-30	-51	x	x	x	x
42	Condition Survey	1,141	898	887	859	831	803	775	768	740	721	696	670	641	613
43	Topographic Survey - Land	114	x	x	x	x	x	x	x	x	x	x	x	x	x
44	Topographic Survey - Seabed	1,388	x	x	x	x	x	x	x	x	x	x	x	x	x
45	Cadastral Survey	970	x	x	x	x	x	x	x	x	x	x	x	x	x
46	Hydrological Survey	488	468	466	468	471	474	476	482	484	486	492	488	496	498
47	Permits Survey	1,497	x	x	x	x	x	x	x	x	x	x	x	x	x
48	Utility Survey	1,387	x	x	x	x	x	x	x	x	x	x	x	x	x
49	Permit for Traffic Arrangement-District I	1	x	x	x	x	x	x	x	x	x	x	x	x	x
50	Permit for Traffic Arrangement - District I	536	x	x	x	x	x	x	x	x	x	x	x	x	x
51	Permit for Reloc. from Companies - District I	532	x	x	x	x	x	x	x	x	x	x	x	x	x
52	Traffic Arrangement Design for Excav.	905	x	x	x	x	x	x	x	x	x	x	x	x	x
53	Fence & Secure - District I Work Area	117	-73	-88	-74	-103	-131	-143	-143	-171	-184	-186	-212	-241	-269
54	Fence&Secure District I Work Area	554	467	438	x	x	x	x	x	x	x	x	x	x	x
55	Reinstatement District I Work Area	117	-73	-88	-74	-103	-131	-143	-143	-171	-184	-186	-212	-241	-269
56	District I C&C - Piling	39	-171	-192	-123	-71	-14	-14	-39	-67	-96	-121	-147	-176	-204
57	District I Vent Bldg. Work Area Excavation	2	-171	-192	-170	-137	-138	-60	-89	-117	-117	-142	-168	-197	-225
58	District I Work Area Excavation	313	237	208	180	171	143	253	224	196	196	171	145	116	88
59	District I Vent Bldg. Work Area	2	-188	-203	-189	-218	-246	-258	-258	-286	-299	-301	-327	-356	-384
60	District I Work Area	57	-133	-148	-134	-163	-191	-143	-143	-171	-184	-186	-212	-241	-269
61	District I C&C - TBM 1 Foundation Preparations	2	-171	-192	-170	-137	-138	x	x	x	x	x	x	x	0
62	District I C&C - Headwall for TBM 1	2	-171	-192	-170	-137	-138	x	x	x	x	x	x	x	0
63	District I - Soil Improvement for TBM 1	2	-171	-192	-170	-137	-138	-60	-89	-117	-117	-142	-168	-197	-225
64	District I Vent Bldg. Work Area	2	-188	-203	-189	-218	-246	-258	-258	-286	-299	-301	-327	-356	-384
65	District I Vent Bldg. Work Area - Formwrk	2	-188	-203	-189	-218	-246	-258	-258	-286	-299	-301	-327	-356	-384
66	District I Vent Bldg. Work Area - Geomembrane	2	-188	-203	-189	-218	-246	-258	-258	-286	-299	-301	-327	-356	-384

Figure 4.9 Float Data sheet used for third step of float mapping analysis. As-built critical path is determined using float values.

Table 4.4 Delay Responsibility Table for Contractor - Table showing the delays that the contractor is responsible for. Data is obtained from site documents and studies prior to analysis. Similar employer responsible delay table may be prepared as well.

CONTRACTOR RESPONSIBLE DELAYS				
DELAY NO.	DELAY NAME	START	FINISH	DURATION (DAYS)
DELAY 1	READY FOR OPERATION DELAY	02 AUG 2006	16 DEC 2006	137
DELAY 2	EXCAVATION START DELAY	16 DEC 06	25 JAN 07	41
DELAY 3	TBM 1 STOP DELAY	01 FEB 2007	15.May.07	104

Table 4.5 Results Table for Float Mapping Analysis

CONTRACTOR RESPONSIBILITY TABLE					
PROGRAMME NAME	DATA DATE	PROJECT FINISH DATE	TOTAL FLOAT	FLOAT CHANGE	DELAYS
BM01	27.08.04	22.12.08			
PR20	30.04.06	16.07.09	-208		
PR21	31.05.06	01.08.09	-227	19	
PR22	30.06.06	17.07.09	-208	-19	
PR23	31.07.06	*17.08.09*	-245	37	
PR24	31.08.06	*17.09.09*	-275	30	1
PR25	30.09.06	*02.10.09*	-287	12	1
PR26	31.10.06	*02.10.09*	-287	0	1
PR27	30.11.06	*03.11.09*	-317	30	1
PR28	31.12.06	*17.11.09*	-331	14	1,2
PR29	31.01.07	19.11.09	-197	-134	
PR30	28.02.07	20.12.09	-223	26	
PR31	31.03.07	21.01.10	-252	29	
PR32	30.04.07	20.02.10	-280	28	
PR33	31.05.07	24.03.10	-309	29	
92 DAYS CONCURRENT CONTRACTOR DELAY					

4.6 COMPARISON OF ANALYSIS RESULTS

The results obtained from both analyses are valid for only the limited, defined scope of the analysis data. The analyses have not been done on the whole of the project, which would certainly give different results if done, thus the analyses results are only descriptive of the methodologies and their practical problems in respect of a problematic part of the project and hypothetical in nature when the whole of the project is considered. Analyses results are definitely not binding for any party and do not comprise the whole of the project.

Time Impact Analysis study gives the result of 285 days delay that the contractor is responsible for. The delays attributable to the contractor occurred while the archaeological excavations on the critical path of the overall project still continued. On the other hand, the analysis aimed at finding out possible concurrent delays on the *District I* to *District J* tunnel line part of the project. The Time Impact Analysis results mean that during the 407 days that the analysis was conducted for; there had been 407 days employer responsible archaeological excavations delay and 285 days contractor responsible concurrent delays. In the light of the literature review on concurrent delays that would possibly mean 407 days of time extension award for contractor of which 122 days will be compensated by the employer.

Float mapping analysis, on the other hand, gave contractor delays of 92 days for the same time interval of analysis. Contractor delay of 92 days would be treated as concurrent delays as while they occur there is concurrent archaeological excavations delay that the employer is responsible for. The result would be 407 days of time extension to contractor of which 92 days are not compensated.

The difference of the two analysis results are mainly as a result of difference in their application procedure. Time Impact Analysis uses as planned and as built programme schedules such that delay events are inserted as activities into programmes. Inserting and subtracting activities from schedules make the analysis become subjective in nature. In order to make the analysis, the original programme schedules had to be changed accordingly without changing the fundamental logic of the project. However, this includes changing some of the predecessor and successor relationships, linking unlinked activities or finding out absurdities on original programmes that were created for different aims and changing them accordingly. Inserting activities with links into programme schedules that were not originally in the schedule add subjective decisions into analysis as well. Float mapping on the other hand is descriptive in nature and does not require adding or subtracting any activities.

During the research there had been many problems related to programme schedules and programme schedule amendments largely affected different results of the analyses. Conditions survey activity which is possibly critical and would give further concurrent delays for which the contractor is responsible for could not be analysed in float mapping as the activity has been created with large float in each respective updates by the programmers, thus taking the activity as driving could not be possible. Float values in some activities used for the analysis was hardly realistic in most update programmes as programme schedules used throughout the project did not wholly reflect project logic or progress but were rather subject of debate between the contractor and the employer because of the problems explained above in Chapter 4.3.

Besides such problems about the validity of analysis data which cause different results of the analyses, analyses process have been illuminating in respect of possible problems that occur during delay analysis process and, further, about the problems that occur throughout the project stemming from contractual uncertainty about matters concerning project delays and extension of time. The problematic, defective, incomplete and insufficient practices that were observed in the project has been directive for the next part of this research which aims to provide a checklist model for use in construction projects to avoid problems resulting from construction delay disputes.

5. A PROPOSAL FOR A TIME EXTENSION SPECIAL PROVISION FOR USE WITH STANDARD FORMS OF CONTRACT IN CONSTRUCTION PROJECTS

Chapter 5 aims to develop a guide for the management of delay processes in construction projects. The main aim of the proposal is to provide a guide to the contracting parties so as to manage the delay processes without further disputes. The guide is prepared in the light of the major obstacles that have been observed during the delay analysis process in case study and literature review.

The guide is prepared in two interrelated parts:

1. Proposition of a checklist and a process flow to aid the parties' understanding and management of the delay analysis process.
2. Formulation of a special provision that may be used with the standard contract form to be incorporated into the specifications of the contract. This part of the proposal aims to provide a model provision for the contracting parties, which will prevent the occurrence of problems during the project due to delays, as a result of lack of clarity. The proposed model is based on predetermining and specifying possible problems that may arise because of delays during the project and their outcomes by making basic concepts of delay process clear and agreed prior to a possible dispute.

5.1 MAJOR CONCERNS IN DEVELOPING A TIME EXTENSION CLAUSE

Prior to explaining the proposal guide for the management of delay processes, major problematic issues that were faced during delay analysis in case study need to be remembered as they constitute the base of the proposed model. These issues are listed below:

Reliability of baseline programmes:

The first issue to consider is the reliability of the programme schedules. In order to avoid problems due to programme schedules; the baseline work programmes should be realistic. Contractors may submit programmes just to fulfil the contractual liability completed as a checklist item or they may submit unrealistic programmes that contain items that would create disputes in case of delays. Such a practice should be avoided to preserve reliable data in hand that can be used to perform a fair delay analysis in the future.

Linking of activities:

There should not be unlinked activities in the programme schedules; all the programme activities should have predecessor and successor relationships. Creation of loops using hammock activities should be prevented. Some activities may be linked internally as a loop; they may start and finish with the same activity, often with a hammock activity. This should not be permitted as it breaks the chain of events in the whole of the project and effect of any delay in an activity in the loop to the whole of the project can not be analysed.

Lag relationships:

Using negative lag relationships should also be avoided; instead, finish to finish or start to start type relationships should be preferred in the programme schedule. Negative lags would result in difficulties in determining real critical paths and would create unrealistic float values. Constraints should also be used as less as possible throughout the programme schedules; constraints such as zero float constraints affect float values which would create false floats and wrong results in float analysis methods.

Approval issues:

Creating the programme schedule and risks due to mistakes in the original programme schedule are the contractor’s responsibility. However, in order to avoid further problems, employers should not just approve the work programme without looking at its details. An approved baseline programme would be used as the basic data for a cause and effect analysis when a delay in project completion time occurs . Therefore, the logical relationship of activities should be controlled by the employer or its agent prior to approving the baseline programme. Major changes in the baseline programme according to the actual construction logic during the project would make the original approved baseline programme redundant and meaningless as it does not comply with the actual construction logic on site.

Activity durations should not be kept so long; longest duration that should be permitted is a matter related with the scope of the project but long activity durations should be avoided in the programme schedule. Dividing activities into smaller parts by using more detailed activity descriptions should be preferred. Long activity durations would make it more difficult to analyse delays in parts of that activities. Float value based analysis techniques or daily delay measure type detailed analysis methods are hard to practice when activity durations are kept long. Long activity durations would create critical activities which would contain non – critical parts when divided into smaller activities. In order to have more detailed analysis results, long activity durations should not be permitted in programme schedules. Employers should also be aware that contractors are more likely to prepare programme schedules that contain critical paths on which employer based delays are likely to occur. Activity relationships and duration of activities should be analysed taking this possibility into account.

Resource allocation:

The Employer or his representative should also check the resource allocation of the programme schedules submitted for approval. Unrealistic resource allocation and overloaded resources would create programme schedules that give unrealistic data of the project. Throughout the project, the approved baseline programme and real project progress on site would differ and baseline programme would be meaningless to use with unrealistic resource allocation. Float values obtained from the programme will not be realistic and would not be helpful for any delay analysis using float values.

Updating and logic:

Updated programme schedules submitted during the project should be coherent with approved baseline schedules. Updated programmes are very important to analyse delay claims so they must be given additional importance. Changes in construction logic should be incorporated into the update programme schedules on time. Contractors may submit updated programmes that do not reflect the construction logic on site, especially, when there are matters of dispute. This practice should be avoided by regularly checking updated programmes and not permitting the use of any unapproved programmes by the contractor. When there is a change in construction logic or a variation order is given by the employer, contractor should submit a fragnet reflecting the effect of the variation on the original programme schedule and variation orders should only become effective with submission of this fragnet. If the variation order is such that the construction logic should be considerably changed and original programme schedule cannot be changed accordingly without changing the whole programme, then a new programme schedule should be prepared by the contractor that would be the new baseline programme.

Activity progress rates:

Activity progress rates on update programmes should be carefully observed by the employer or his representative. Progress rates should be realistic; they should reflect the progress on site. Progress rates would be helpful in after – the – fact analysis of delays and unrealistic progress rates would be misleading. Earliest start, earliest finish, latest start and latest finish dates should be observed for each activity in each update programme so that progress rates are in line with these data.

Documentation:

In order to obtain accurate results delays should be rightly determined by the analyst and delays can only be accurately determined using the project data. Project documents should be carefully and regularly kept in order. Notices of claims, notice of prospective delays, variation orders, and minutes of meetings are all documents that should be properly kept by the parties.

Float ownership:

It would be the best practice to clarify the issue of float ownership prior to the project start, possibly in the contract. Parties may either choose to use floats as if they belong to the contractor or on a ‘first come first served’ basis as float belonging to the project. Whether it belongs to the contractor or the project, employer or his representative should be aware of the details of the floats of the activities prior to the programme. Activities that are directly linked to the project finish, thus having large float values must be avoided as much as possible.

Selection of a delay analysis method:

Another matter that would be of great advantage to both parties in resolving delay disputes that occur throughout the project would be deciding which delay analysis method to use prior to project start. All delay analysis methods are not suitable for every project so parties must consider the facts of each project, selection criteria used in literature and courts approach to delay analysis methods should all be taken into account when deciding the appropriate analysis method. Both parties using the same method will be very efficient and helpful in obtaining a fair result with less cost.

Pacing:

It would be the best practice to clarify the issue of pacing and relevant details regarding pacing delays in the contract documents. When there are concurrent delays any defence of pacing delay would thereby be easy to determine if procedural requirements are clearly specified in the contract documents. The Contractor should notify the employer when he is pacing works within predetermined time limits. In his notification the contractor should include the details of pacing and possibly benefits obtained by him due to pacing.

5.2 A CHECKLIST FOR THE FORMULATION OF A DELAY ANALYSIS PROVISION

This section aims to develop a checklist for the contracting parties that will aid the management of the delay analysis process with as few problems as possible. The checklist consists of points that must be controlled prior to a delay analysis so that analysis process would be as accurate as it can. It may also be used as a checklist that will avoid further problems in case of delays so it may be used prior to any delay throughout the project for a better management of the process.

1. Check the update programme. Update programme must be approved and updated version of the approved baseline programme. Do not use unapproved baseline or update programmes.
2. Check all the activity relationships in programme schedules. Be sure that there are not any unlinked activities in the schedule. All the activities from the start to finish of the project must have predecessor and successor relationships.
3. Activities may be linked such that they create loops in themselves. Avoid loops in programme schedules. Check hammock activities as they are often used for creating these loops.
4. Check the logical relationships of the activities in programme schedule. Unrealistic programme schedules may cause further disputes and would avoid analysis processes from being fair.
5. Check resource allocation in programme schedules. Unrealistic resource allocation would result in the programme schedules being unreliable and new programme schedules would be necessary throughout the project.
6. Check the critical paths of the project carefully, if you are looking from employer's side. Critical paths on programme schedules may have been created such that employer based delays are more likely to occur on these paths.
7. Check activity durations in programme activities. Try to avoid long activity durations. If a delay has resulted in an activity with a long duration, try to split this activity into activities with shorter durations. New activities may either be critical or not, thus, delay on any part of these activities may be analysed with more detail. This would help analysis results becoming more detailed and fair.
8. Check activities in programme schedule for relationship logics. Avoid use of negative lags, constraints as much as possible. Prefer using finish to finish type relationships rather. If float values are used for analysis of delays, do not

forget to check constraints for each critical or near – critical activity as they would effect float values.

9. Always require fragnets with variation orders. The Fragnet should reflect the variation order and should be inserted into programme with suitable relationships. If the variation order changes the project logic considerably, so that inserting fragnets into current programme schedule is not possible, require a new programme schedule that reflects the variation accordingly. Note the effect of variation order to the project finish date.
10. Check the activity progress rates. Progress rates must be in line with the real progress on site. Delayed activities progress rates must be followed carefully throughout the delay process. Start and finish dates of activities must be checked and controlled in comparison with previous update programmes.
11. Keep all documents carefully. Notice requirements shall be strictly complied with. Notices of delays, variation orders, minutes of meetings, correspondences should all be kept tidily and be accessible in future.
12. When a critical delay occurs, check whether there have been prior delays on non – critical paths that the other party is responsible for and that consume available floats. Check contract documents for whether a pre - allocation of total floats have been determined in the contract.
13. Check near critical activities. Determine the near critical activities in each schedule update and keep track of them as they may become critical after delays.
14. Check the contract document for delay analysis method to be used for analysis. If a method has been specified that method has to be used. If a method has not been specified, select the appropriate method taking scope of the project, time available for analysis, cost of analysis, available documents and other relevant facts into account.
15. When a delay occurs on a critical path check whether there is concurrent delay on another path. If there is a delay on another path, check whether that delay is consuming available floats or whether it is on a critical path.
16. If the concurrent delay is on critical path, check whether there is pacing or not.

17. When there is pacing delay check the contract documents for notice requirements in case of pacing. If there is no requirements check whether conditions for pacing is available or is the delay a concurrent delay?

The following flowchart is designed to demonstrate a model of the 'what – to –do's in case of a delay in the project. The flowchart is created from the viewpoint of an employer's representative and assumes that the project is proceeding. However, the flowchart can be used from the viewpoint of the contractor and in retrospective manner with small amendments. The flowchart aims to remind parties of the essential issues in case of occurrence of delays.

Table 5.1: Flowchart of Delay Process

1. A delay occurred in project. Look at the contract, there may be notice requirements. Are all requirements of contract complied with?

No ↓ | Yes ↓

Extension of time claim May be rejected if fair and reasonable to do so.

2. Is the delay on critical path so that it affects the project completion date?

No ↓ | Yes ↓

Look at the contract. Are there any clauses on float ownership?

3. Find the cause of delay. Look at the contract to find out contractual risk allocation. Look at the documents of project to find out facts of delay. Is the delay an employer responsible delay?

No ↓ | Yes ↓ | No ↓ | Yes ↓

Float may;

- ✓ Be owned by the contractor, then, continue with section 4.
- ✓ Be owned by the Project, then, contractor is not entitled to extension of time for float consumption.

Float allocation should be done under contractual requirements.

If the delay is a contractor risk event, the contractor is not entitled to an extension of time. If the delay is third party delay, look at the contract for force majeure events and follow section 5.

4. The Contractor is entitled to an extension of time. An extension of time should be given according to the contractual requirements of assessment and delay analysis. Continue with section 5.

5. Perform a delay analysis to calculate the effects of delay on the project completion date. Delay analysis can either be done retrospectively or prospectively. Even if done prospectively, when the project still proceeds, it would be best practice to wait for the delay event to finish before analyzing its effect on the whole of the project. Before proceeding with selection of the method to make analysis, consider the material in the hand for analysis and relevant factual data. First, look at the programme schedules; do you have an as planned baseline schedule in hand?

No

You have to use an analysis method that uses only as built data. Collapsed as built method may be used if you have the as built data. It may be preferred especially if the project is linear in nature.

Yes

If you have only as planned schedule you may prefer impacted as planned. If you have both as planned schedule and update programmes you may make in addition Time Impact Analysis, Float Mapping, As planned vs. As Built Analysis.

6. Now look at your programme schedule, is your data reliable? Check the following;

- ✓ Baseline and update programmes must be coherent.
- ✓ All activities must be linked to another activity.
- ✓ Programme updates must be realistic. Site progress should be reflected in programme logic and progress rates should be in line with real progress.
- ✓ Check constraints, especially if you will make float analysis. Constraints would affect float values.
- ✓

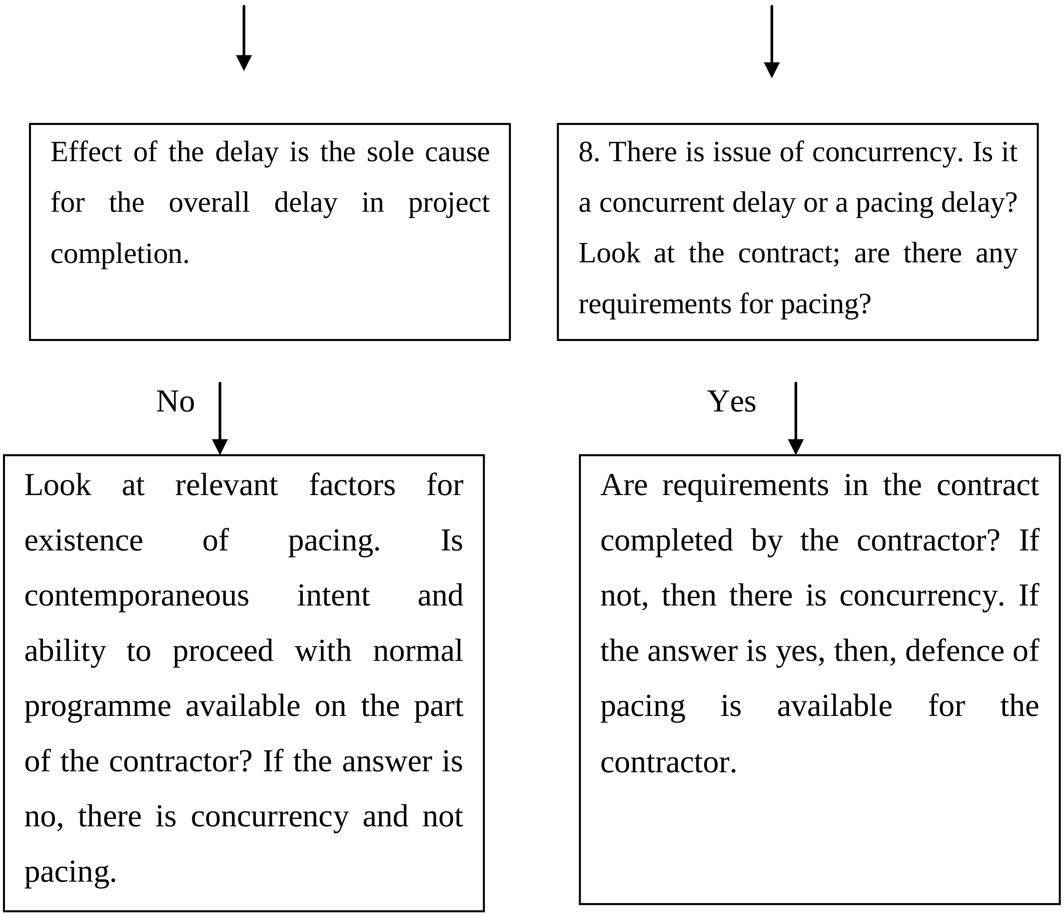
After checking your schedules, if you have unreliable data, try to correct data according to contract documents, site personnel opinion, your experience etc. If correction is not possible try to create a new schedule or try another method. Do not forget that more subjective decisions inserted in analysis, more hypothetical results will be. Now look at other factors before method selection.

7. Consider these facts when giving your decision;

- ✓ Scope of the project. If the project and dispute is relatively smaller, costly methods should not be chosen. Try cheaper and simpler methods such as As planned vs. as built if the dispute is relatively small in respect of time and cost.
- ✓ Do you have enough time? Time impact analysis, collapsed as built, float mapping may be laborious and time consuming. As planned vs. as built or impacted as planned may be conducted in shorter time.
- ✓ Have you got the expertise? Analysis procedures often require subjective decisions. Do not attempt to conduct analysis if you do not have the expertise enough to do so.
- ✓ Do you have enough money? Analysis processes may be costly; often they require more than one person to work for a few months on the analysis. Consider the budget available.

After deciding the method to use check whether there are concurrent delays on the project. Are there any concurrent delays on the other critical paths of the project?

No ↓ Yes ↓



5.3 SUGGESTED PROVISION MODEL

This section aims to propose a model provision that can be used as a schedule specification to be incorporated into the contract documents in construction projects. The model provision does not include all the subjects related to construction management such as payment, measurement etc. but rather includes matters that have been observed as problematic in case study part of this research and aims to provide a contractual model for clarification of these problematic issues. Proposed provision may either be incorporated in contract specifications altogether or subject by subject according to the wish of the contract drafters. A limitation of this study is that observations were based on a single case study using FIDIC Silver Book Conditions of Contract for EPC/Turnkey projects and the proposal, therefore, is bound by this limitation. A different proposal might be appropriate for projects with a programme shorter than 1 year or has limited costs as programme and other requirements.

A. PROGRAMME REQUIREMENTS

This particular section of the provision has been prepared to minimize problems that have been observed during the case study. According to the suggested provision, the baseline programme schedule is required in CPM network format; in order to conduct a realistic and fair delay analysis when a delay occurs during the project. A 'notice of revision' is required by the provision before making any changes on the schedule. This prerequisite is added in the provision to prevent parties from using different baseline schedules during the project. Parties shall only be able to use the same baseline schedules that have the same and approved revisions.

The proposal includes programme schedule requirements to achieve clear programme schedules that present the construction logic, covering all the necessary details about the activities and their relationships. These requirements have been added to the provision to ensure precise records of the project before starting delay analysis in the future. Approved baseline schedules including explicit records demonstrating the intent of the contractor prior to the project start will reduce the amount of subjective decision making by the expert during the delay analysis stage. Problems that have been encountered in baseline schedules of the case study project have been indicative in preparing the provision in respect of prerequisite items in the baseline schedule.

In order to deal with 'out of sequence' progress during the project, the proposed method of calculation protocol is determined as 'retained logic'. This was added in the provision to avoid possible problems that may result in illogical progress sequences. The requirement aims to prevent problematic issues determined in literature review in relation to programme schedules (Keane, Caletka 66). Using of 'negative lags' is prohibited by the provision. The requirement is added to prevent occurring of false criticalities, a problem indicated in literature as a result of using negative lags in programme schedules (SCL DELAY AND DISRUPTION PROTOCOL 40). All activities that will take place during the project shall be included in the baseline programme schedules, having the necessary requirements stated in the provision. The requirement has been included in the provision to reduce problems related to activities not included in project schedules but could influence finish dates, a problematic point observed in literature (SCL DELAY AND DISRUPTION PROTOCOL 36).

The requirement about the activity durations has been added to provide a solution to the problems observed during case study project. Excessive activity durations have been an obstacle in conducting delay analysis, as well as providing a base for conducting float sequestering (Keane, Caletka 195). Time requirement has been determined considering the size of the projects that the model provision is prepared for.

Critical path requirements are included to provide efficiency and clarity during the delay analysis process. Critical path changes during the project and their deviation from the critical path in the baseline schedule can be traced easily through these documents. Using the longest path for the calculation of the critical path is chosen to avoid using the lowest float value criterion to calculate the critical path, as critical paths calculated with different techniques may differ when advanced scheduling techniques are used (AACE RP 29R-03 87).

Limiting use of constraints has become part of the provision model as a result of difficulties faced during the case study project and in literature review. Constraints cause manipulations in float values, thus avoid fair analysis of delays (Keane, Caletka 195). Part (A) (I) of provision containing the issues related to baseline programme schedules is as follows;

I) Baseline Programme Schedule

a. Contractor shall submit to the employer / employer's representative – hereafter employer – programme schedule in CPM network format prepared using a computer software programme in 30 days after commencement date. Contractor shall also submit other necessary reports, stated in this clause, with the programme schedule. Employer shall approve or require changes in submitted programme schedule by a ‘notice of revision’ no later than 10 days after submission of the programme schedule by the contractor. Contractor shall make changes in accordance with employer’s requirements within 10 days of ‘notice of revision’ in programme schedule and submit it for approval to the employer. After approval of the programme schedule by the employer, the programme schedule is ‘approved baseline schedule’ and shall be the only programme schedule used for periodical updates unless a new programme schedule is approved by the employer as ‘approved baseline schedule’.

b. Programme schedule shall be prepared using precedence diagram format.
c. Programme schedule shall be prepared in order to show the construction logic, activity order, activities’ durations, critical path or paths, activities’ early start, early finish, late start and late finish dates.
d. All activities in programme schedule shall have predecessor and successor relationships in accordance with the construction logic and method of construction intended to adopt by the contractor. Schedule calculation logic used shall be ‘retained logic’.
e. Relationships between activities shall show interdependencies between activities such that their start and finish relationships shall be identifiable. Contractor shall use ‘lags’ if necessary but ‘negative lags’ shall not be used when showing the interdependencies of activities.
f. Programme schedule shall include all activities that may effect the completion date. Submittals, fabrication, testing, surveys shall all be available on programme schedule.
g. Commencement and finish dates stated on programme schedule shall be in accordance with the dates on main contract.
h. Activity durations shall not exceed 5 % of the overall project duration. If any activity duration exceeds this limit, it shall be divided into new activities specifying its location, time etc. Single activities such as surveys linked to start and finish dates shall be avoided or divided into shorter activities using location details. In order to use any activity duration longer than the limit duration, engineer shall submit his acceptance in writing to the contractor.
i. Critical paths shall be identified on programme schedule. Critical path shall be calculated according to the longest path on the project network. All activities on critical path shall be submitted to the employer in a separate

report including their predecessor and successor activities, duration, early and late start and finish dates and float values.

j. Constraints used in programme schedule shall be submitted as a separate report to employer. ‘Zero total float’ constraints shall not be used in programme schedule.
k. Programme schedule shall have the details of the resources that will be used for each activity.

Part (A) (II) of the provision includes the programme schedule update requirements. Programme schedule update requirements have been developed to ensure that the programme schedule updates reflect the real progress on site and any revisions on the programme schedules throughout the project are done mutually between the parties. This requirement aims to prevent the use of different programmes by the contractor and the owner and the emergence of problems occurring as a result of update programme schedules. This issue has been one of the major obstacles for delay analysis in our case study.

The arrangement regarding variation orders has been included in the provision model to prevent practices that may lead to an unreliable and subjective delay analysis. Issue has been a major obstacle in case study and the mismanaged variation order process in project prevented the researcher from conducting a realistic delay analysis. This part of provision model aims to overcome these bad practices by requiring fragnets that show the effect of variation orders on the entire project and project completion date effectively, from the contractor.

II) Programme Schedule Updates

a. Contractor shall submit to the employer ‘updated programme schedules’ showing the actual progress on site. Programme update schedules shall cover the monthly period starting from the first day of the month. End of month shall mean the last calendar day of the month. First update schedule shall cover the period from the commencement to the first day of month after the next. Updated programme schedules shall be submitted in the first five calendar days of the end of update period. Employer shall approve or require necessary revisions by giving a ‘notice of revision’ to the contractor. ‘Notice of revision’ shall be given if the programme schedule does not reflect the real progress on site or the updated programme schedule submitted by the contractor has been subject to changes, except progress rates and except the changes that have been already approved by the employer in writing.

b. ‘Updated programme schedule’ shall reflect the real progress rate on site and shall not have any changes from the previous update schedule except the progress rates and other changes approved by the employer in writing.

c. When a variation order is given by the employer, after having received a variation order, contractor shall submit to the employer a fragnet including the details of modifications to the original programme together with the other necessary documents stated in variation procedure in the main contract. Fragnet shall have all the requirements that the original programme schedule shall contain. Employer shall approve, require revisions or reject Fragnet. Fragnet shall be inserted in original programme schedule after the approval of the employer using logic predecessor and successor links that reflect the real construction method and progress on site. If the construction logic changes considerably after variation so that inserting Fragnet is not possible, a new programme schedule shall be prepared and submitted to the employer. Employer shall approve, require revisions in the programme schedule by giving a ‘notice of revision’ to the contractor or reject the submitted programme schedule. Time requirements for submission and approval of Fragnet or new programme schedule shall be the same as stated in main contract under variation procedure. The new programme schedule submitted shall be subject to all the requirements that the initial programme schedule is subject to. When a new programme schedule is approved, after being approved by the employer, new programme schedule shall be the new ‘approved baseline schedule’ for the rest of the project. When the fragnet is inserted into original programme schedule, fragnet shall be an ‘approved change in programme schedule’ for the contract.

Part (A) (III) of the provision model consists of programme schedule review arrangements. Under the provision, if a delay occurs, prospective delay analysis will be prepared so that effects of delay to the completion date can be reviewed. This part of provision has been prepared taking the proposals of Society of Construction Law into account. SCL Delay and Disruption Protocol, in turn, have taken the bad practices and past disputes into account and suggested making prospective delay analysis during the project in lieu of retrospective delay analysis (SCL DELAY AND DISRUPTION PROTOCOL 49). Sub – clause (c) of the schedule review has been added to the provision to deal with matters related to float consumption. Though the ownership of floats has been determined on a ‘first come first served’ basis under the provision, consumption of total floats by parties shall be kept on records to keep the necessary data for future disputes and create awareness of the activities that become ‘near–critical’. The literature review has shown that float ownership related disputes can end in contradictory adjudicative decisions and this part of provision shall be helpful in providing the necessary data to adjudicative bodies in making a fair decision to solve the disputes. The section related to schedule review has been formulated as follows:

III) Schedule Review

a. Each month no later than two days after the submittal of the ‘updated programme schedule’, a meeting shall be held between the contractor and employer. Progress rate of the works, updated programme schedule review, review of reports of weekly site meetings shall be held at monthly meetings.
b. If, there is delay to the works that causes delay to the Time for Completion of the works, contractor shall submit a report containing details of the causes of delay, description of problematic areas, potential effects of delay and details of corrective actions proposed at first monthly meeting held after the delay is became aware of by the parties to the contract. Each party to the contract shall prepare a

prospective delay analysis to show the effects of delay event to the Time for Completion of the works, no later than one month after the finish of the delay event. Delay analysis results shall be reviewed in the first monthly meeting held after the finish of the delay analysis. Delay analysis shall be made using the method stated in this specification clause.

c. If, there is delay to an activity in the programme schedule that does not effect the Time for Completion of the works, contractor shall, in monthly meeting after the delay is became aware of by the parties to the contract, submit a report giving the details of the causes and effects of the delay. Ownership of the total floats created as a result of 'approved programme schedule' shall be as stated under this specification clause.

B. DELAY ANALYSIS METHOD

This part of provision deals with delay analysis method that will be used to analyse delays throughout the project. Deciding on the method that will be used for analysis of delays prior to the project as part of contract requirements would avoid disputes on the method selection during analysis process. Case study and past disputes in literature shows that the parties prefer the method that will be helpful for itself rather than choosing the fairer method. Thus, agreement on the method would solve the problematic issue of method selection. The proposed delay analysis method in the provision has been proposed taking the scope of the research and the other document, data requirements in the provision into account. As planned vs. as built method has not been proposed due to its non availability for large – size projects. Impacted – as – planned method has not been chosen due to its static nature. Collapsed – as – built method has not been preferred due to its highly hypothetical structure and float mapping was not proposed as it can be used as a secondary analysis method but not the sole one. Time Impact Analysis was chosen due to its superiorities cited in literature and as it is the preferred method by Society of Construction Law. Taking the other data requirements in the provision into account, Time Impact Analysis shall give more fair results at the end of analysis than the other methods.

a. When delays are experienced during the project and in order to calculate the effect of delays to the Time for Completion of the works prospectively or when an analysis of delays is necessary to calculate the effects of delays encountered during the project to the Time for Completion of the works after the project retrospectively, delay analysis shall be conducted by the parties as stated under this specification clause.
b. Delay analysis, for the purposes of this specification, shall mean Time Impact Analysis.
c. Time Impact Analysis shall be conducted using approved baseline programme schedule and approved update programme schedules.
d. Time Impact Analysis shall demonstrate effect of delay or delays on project completion date. A report indicating details of delay, effects of delay on critical path or paths, changes in total float values of near critical activities shall be submitted with the Time Impact Analysis results.
e. Near critical activity shall mean activities with Total Float value of 30 days more than float value of critical path.
f. In case of dispute about the analysis results, delay analysis shall be conducted by an expert whose analysis results shall be binding on parties. Expert shall be decided by parties on mutual agreement at the time of the contract.

C. FLOAT

This part of the provision model is drafted to deal with the problematic issue of float ownership. As stated in literature review part of this research, adjudicative decisions may be contradictory in relation to ownership of total float by parties. Predetermining the issue, prior to the project in the contract, would be indicative for judicial decisions and would provide clearness for this problematic issue to the parties through the project process. The provision prefers the ‘first come first served’ basis for total float ownership as this approach has been the most suitable one amongst others to avoid disputes. Though, taking the cases cited in literature review of this research into account, provisional requirements would only be indicative for judicial decisions in relation to float ownership matters. This part of provision model is as such;

a. Total floats of the activities in ‘approved programme schedule’ do not belong solely to contractor or employer. Total floats shall be available for the use of either party and belong to the project. If both parties agree upon early completion subject to the conditions of main contract, terminal float created between early completion date and original completion date shall belong to the contractor.
b. No extension of time shall be given for delays that do not delay Time for Completion and consume total floats of delayed activities only.

D. PACING DELAY

Pacing and concurrent delays have been one of the most problematic issues determined in literature and our case study. Lack of arrangements regarding pacing delays can be seen as one of the major causes of disputes. The following sub – clause has been formulated to avoid such disputes. The uncertainties whether a delay is concurrent or pacing delay in project can be avoided by using the provision. Notice of pacing shall be written rather than orally so disputes regarding intent will be avoided. Ability to resume normal rate shall also be expressed in notice of pacing, so that another requirement of pacing delays, stated in literature, will be presented to the employer. Expressly providing that the notice requirement is a strict precondition of pacing, this provision prevents the claim of pacing delay by any party without written notice in his hands, in future. The suggested sub – clause is as follows.

a. When there is an event delaying the Time for Completion of the project, party to the contract that is not responsible for the delay event has the right to pace the works on equally or less critical paths of the programme schedule.
b. Each party may use its right to pace the work by giving notice to the other party no more than one day after starting pacing the works.

c. ‘Notice of pacing’ shall be given in writing and shall include details of the parent delay event, its causes and effects to the project schedule, activities that are being paced, estimated duration of pacing. Pacing party shall give details of its ability to resume normal rate of progress by submitting relevant documents with ‘notice of pacing’.
d. Failure to comply with notice requirements shall result in entitling the delay events as ‘concurrent delays’.

6. CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

Extension of time claims and delay related disputes have long been a part of construction projects. Earlier cases related to delay claims in construction industry go as back as 19th century and many of the main principles have been foundered more than hundred years ago. Although past disputes have been helpful for the development of principles, delay related disputes and their fair resolution still comprises a problematic area in construction industry. Lengthy adjudication processes cause loss of time, energy, money and carry the risk of destroying partnering attitude between employer and contractor. This research was conducted with the aim that, though it is not possible to avoid disputes resulting from delays in completion time of the projects, disputes arising from extension of time claims could be minimized by making a good management of the process and clarifying some issues that are most likely to cause disputes or cause difficulties during resolving these disputes, by predetermining some concepts in the specifications of the contract.

In order to reach this aim, literature concerning delay and extension of time related clauses of standard contracts used in international projects, delay related concepts, delay analysis methods and past delay disputes has been reviewed and reported in Chapter 3. The literature review revealed the fact that some areas of delay disputes such as float ownership, programme schedules, concurrency, delay analysis method to be used were problematic and were often subject of past disputes. In order to observe the situation and collect necessary data from site, a case study was conducted on a major infrastructure project that experienced delays and in which the adjudication process still continued. As part of the case study, delay analysis on a problematic part of the project, using two of the accepted methods was done and the results and obstacles during the analysis process is reported in Chapter 4 of this research.

Literature review and case study both showed that some main issues were common to delay disputes. These issues were problematic and were result of unclearness of some basic concepts related to delay claims and poor management of the process. As a result, this research proposes a guide for better management of delay processes that contained a checklist, a flowchart of delay process and a specification clause that can be used with particular conditions of main contract. The proposed guide is explained in Chapter 5 and finally this chapter deals with conclusions of the research and recommendations.

As a result of literature review and case study, problematic points that had to be considered when preparing the guide were found as follows;

1. Programme schedules in projects were not prepared and submitted as they should have been. When delays occur, and parties try to make delay analysis, unreliable programme schedules become the major obstacle preventing a fair execution of the analysis. Analysis results that are obtained from unreliable data are highly subjective and hypothetical in nature.

2. Baseline programme schedule may be subject to structural problems such as negative lags, zero float constraints, unlinked activities, loops, activities with excessive lengths. Baseline programmes having these features do create problems in the following stages of the project especially when an analysis is necessary to determine effects of delays on project completion date.

3. During the project, updated programme schedules may not reflect the real progress on site; activity progress rates and construction logic on site may not occur as they are occurring. If the employer approves this situation, as the project continues, the problem becomes more acute and less easy to solve when a dispute occurs.

4. One of the major problems has been identified in relation to variation orders. Delays due to variation orders by the employer during the project are at employer's risk. True effects of variation orders may not be identified if the programme schedules do not reflect the variation.

5. Project documentation has also been observed as a problematic area; in order to observe delays it is necessary to look at details of project documents. It was observed that documents are not kept as they should have been and it was not easy to identify delays with their exact occurring dates. Parties do not keep the risk of delay events occurring and necessities of looking at all documents in future so do not keep documents in a tidy form.

6. Concurrent delays occur frequently in projects, especially in large ones. Despite their frequency, past disputes have not given precise principles in relation to concurrent delays however recent studies such as those of Society of Construction Law are helpful to predict results of concurrent delays.

7. It is a very common way of dealing with claims of concurrency by counter claiming defence of pacing. However, rather than being a counter claim, an official method of pacing has not been developed and the issue is often not addressed in contracts.

8. Ownership of float is not predetermined and the issue is often resolved in adjudication process, despite the approach of courts and general academic acceptance of the 'first come first served basis' principle, surveys among practitioners reflect the thinking that they believe the float belongs to the contractor.

9. There are various methods for analysing delays. As the technology advanced different methods using computer based programme schedules have been developed and analysing delays that have occurred in large projects with as much as thousands of activities is now possible. Adjudicative bodies have accepted these methods as proofs identifying effects of delay events on project completion though they have been conservative in relying solely on

technology based analysis methods and rather preferred simple and right method of analysis that is more likely to produce fair results in a given case, as a proof. Delay analysis methods have all drawbacks and the facts of each case require a different method to be applied. Parties to a contract often prefer analysis methods that is most likely to give results supporting his claims and adjudicative bodies need to decide on the appropriateness of the selected method to the case. The issue is often not addresses in main conditions of contract and parties may even be unaware of the analysis procedure.

6.2 LIMITATIONS AND RECOMMENDATIONS

Findings obtained from case study and literature review were used to prepare a model guide that comprises a checklist, process flow and specification clause model that shall be proposed as purpose of this research. Delay analysis and management of delay processes often require expertise and knowledge of concepts related to this area of project management. Employer’s and / or contractor’s staff may not have the requisite knowledge to manage the process and this situation shall result in disputes becoming more destructive for parties to the contract and most importantly to the project. As an answer to this problem, developing a guide that has the necessary data and can be used by the concerned person when a delay occurs in a project has been aimed in this research. A process flowchart has also been prepared that can be used to trace the right way throughout the delay analysis. The flowchart has been prepared from the viewpoint of the employer though it may be used by the contractors as well, the main aim is to show ‘what to do’ when a delay occurs in a project. Finally, last part of the guide contains a specification clause that can be used in particular conditions of the contract. Specification clause has been prepared to overcome problems that happened as a result of unclearness of basic concepts related to extension of time claims and resolution of these disputes. It should be noted that suggested provision model has its limitations in respect of type and size of the projects that it can be used for. Suggested provision model has been prepared as a result of data obtained from literature review and case study, thus, its use is limited to the conditions of the site data observed. The case project that was used to obtain site data used FIDIC Silver Book Conditions of Contract for EPC / Turnkey Projects, *so* suggested provision model is limited to be used with that kind of contract model. It is to be used with projects longer than 1 year and has sufficient budget to comply with provision requirements such as programme schedules, delay analysis etc. Summarily following recommendations shall be appropriate for the better management of delay processes;

1. Parties should be aware that for a successful management of delays in project, programme schedules shall not have structural or progress based deficiencies. Structural deficiencies in programme schedule are those that have been included in programme from the baseline, such as open activities, excessive activity durations and progress based deficiencies are those that occur throughout the project progress such as insufficient reflection of site progress on programme updates. Parties to the contract must use the same programme schedules during the project. Employers shall not use programme schedules that are outdated but approved and contractors, on the other hand, shall not use unapproved but contemporaneous schedules. The best practice shall be using approved and contemporaneous schedules. The problems of programme schedules must be avoided as soon as they are identified, before it becomes too late.

2. Project documents shall be kept tidily and project staff should be aware that the documents shall be used for the identification of delays in the future.

3. Both parties shall be aware that the contract is the main and most important document to be used in case of a delay occurring in the project. Contracts shall have specific definitions of concepts related to delay disputes. Contracts that address to the issues relating ownership of float, pacing, delay analysis method to be used shall be extremely helpful for a fair and amicable resolution of delay disputes. In selecting delay analysis method to be used, facts of the project shall be taken into account accordingly and it would be helpful if both parties can agree on the name of an expert or expert team to make the analysis.

This research has tried to help the industry overcome this problematic situation in the light of these recommendations by proposing the guide detailed in Chapter 5. It is hoped that using the guide would be helpful in increasing consciousness about delay related matters in industry and decrease the number of disputes by clarifying some ‘thorny issues’ before the delays occur in project.

6.3 DIRECTIONS FOR FURTHER RESEARCH

This research has been conducted to propose a specification clause that can be used in particular conditions of standard international contracts used in international projects. In addition, a guide has been prepared to be used by construction professionals to manage delay processes better. Research scope in respect of contract models has been limited as a result of material unavailability. Contracts that are used by public bodies in Turkey have not been included in research scope. Further research may be executed in relation to Turkish Public Contracts and their approach to delay disputes, concepts relating to them and delay analysis methods. Though, future researcher should be ready for difficulties in obtaining necessary data for such a research.

It was observed by the author that some areas relating to delay disputes that are outside the scope of this study also need further research. One of these areas is the delay analysis methods. Currently, there are many different delay analysis methods cited in literature. Most of these methods derive from each other and have drawbacks. The accuracy of their results and their reliability are also a matter of dispute among academics as well as adjudicative bodies. Research observing drawbacks of each method and developing a new model overcoming these drawbacks shall be an important contribution to literature on delays in construction.

The scope of the research does not include cost related matters resulting from delays. Quantification of delay damages and cost impact analysis may be considered in future research. That research should include matters related to concurrent delays as well. Though some methods of sharing delay damages when there is concurrency have been developed recently, such as by Society of Construction Law, they are also subject to criticism and a research of concurrency in relation to cost impacts of delays shall be helpful.

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