SCHEDULE DELAY ANALYSIS IN CONSTRUCTION PROJECTS: A CASE STUDY USING TIME IMPACT ANALYSIS METHOD

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ABSTRACT

SCHEDULE DELAY ANALYSIS IN CONSTRUCTION PROJECTS:
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Inadequate or weak preparatory work before starting construction of any structure may cause serious problems during the construction period. For example, projects without sufficient detailed drawings or construction schedules and a disorganized building site can create many problems in the management and completion of the construction works. Consequently, the cost of construction increases digressively, the construction duration of the project extends and the quality of construction is affected adversely.

This study dwells on the importance of construction schedules in achieving the aim of producing good quality construction work within the specified duration. Monitoring continuously the interactive relation concerning delays in construction schedules and contractor demands is a complicated process. Here the simplest and basic approach is that, both for owner and contractor, time is money and for this reason construction schedule delays should be analyzed and corrective measures should be taken in a timely manner. The main purpose of this study is to investigate the causes of construction schedule delays and the methods of schedule delay analyses. In this context completion construction works of a covered swimming pool building in Ankara was selected as a case study for analyzing project scheduling and the delays therein. The “Time Impact Analysis Method” (TIA) was applied to the case study project using PRIMAVERA® software in order to determine the construction schedule delays; to measure the impacts of these delays on the project completion duration; and to allocate responsibility amongst the project participants for preventing delay claims.

After the application of the delay analysis it was observed that the delays in the critical activities extended the project duration by 57 days in total i.e. by 15.4 % of the estimated construction period. Fines should have been paid by the contractor because of 31-days non-excusable delays. Also, the contractor should have been given a time extension of 26-days due to 22-days excusable compensable delays and 4-days excusable non-compensable delays which were beyond the control of the contractor. These delays were caused due to organizational deficiencies of the owner, the bureaucracy of the provincial municipality, the lack of detail drawings during the municipality application, the lack of experience of the contractor, problems in material procurement, unforeseeable weather conditions and shortages of qualified employees of the subcontractors. It was observed that of these all except one correspond to the important causes of delays as reported in literature concerning public projects in Turkey.

Keywords: Construction Management, Construction Delays, Schedule Analysis, Project Scheduling, Time Impact Analysis Method.

ÖZ

İNŞAAT PROJELERİNDE İŞ PROGRAMI GECİKME ANALİZİ: ZAMAN ETKİSİ ANALİZ METODUNU KULLANARAK ÖRNEK BİR ÇALIŞMA

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Bir yapının inşaatına başlamadan önce bazı ön çalışmaların yetersiz veya eksik yapılması, inşaat aşamasında önemli sorunların doğmasına neden olabilmektedir. Örneğin, proje detaylarının eksik hazırlanması, şantiye organizasyonunun düzgün yapılmaması veya inşaat iş programının detaylı ve düzgün hazırlanmaması inşaat sırasında çeşitli sorunları gündeme getirmektedir. Sonuçta inşaatın maliyeti gereksiz bir şekilde artmakta, işin gerçekleşme süresi uzamakta ve yapının kalitesi olumsuz yönde etkilenmektedir.

Bu çalışma, inşaat iş programlarının kaliteli bir yapının belirlenen süre içerisinde imalatının yapılabilmesindeki önemi üzerinde durmaktadır. İş programlarındaki gecikmelere ilişkin etkileşimin ve yüklenici taleplerinin sürekli takip edilmesi oldukça karmaşık bir süreçtir. Burada en basit ve en temel yaklaşım, hem işveren hem de yüklenici açısından zamanın para demek olduğunu unutmamak; bu nedenle, gecikmelerin derhal analiz edilip gerekli önlemlerin zamanında alınabilmesini sağlamaktır. Bu çalışmanın temel amacı, inşaat sürecinde yaşanan iş programındaki gecikmeleri, nedenlerini ve bunları analiz etme yöntemlerini araştırmaktır. Bu kapsamda Ankara'da bulunan bir kapalı yüzme havuzu binasının ikmal inşaatı, proje programını ve üzerindeki gecikmeleri analiz etme açısından

örnek çalışma olarak seçildi. “Zaman Etkisi Analiz” yöntemi (TIA) PRIMAVERA® bilgisayar programı kullanılarak örnek proje üzerinde uygulandı. İnşaat iş programı gecikmelerini araştırıp ortaya çıkarmak, bu gecikmelerin proje bitiş süresi üzerindeki etkilerini ölçmek aynı zamanda proje katılımcıları arasında gecikmelerin sorumluluğunu paylaştırmak elde edilmek istenen amaçlardır.

Metodun uygulanması sonrasında kritik aktivitelerin üzerinde oluşan gecikmelerin proje süresini toplamda 57 gün diğer bir deyişle 15,4 % oranında uzattığı izlendi. 31 günlük mazur görülemez gecikme karşılığında yükleniciye para cezası uygulanması gerektiği belirlendi. Ayrıca 22 günlük mazur görülebilir tazmin edilebilir gecikme ve 4 günlük mazur görülebilir ama tazmin edilemez gecikmelerin toplamı olarak 26 gün yükleniciye süre uzatımı verilmesi gerektiği belirlendi. Bütün bu gecikmelerin sebepleri, işverenin yer teslimi sırasındaki organizasyon eksiklikleri, yerel belediyeden kaynaklanan bürokratik sıkıntılar, belediyeye başvuru sırasında detay çizimlerinin eksik olması, yüklenicinin taşeronlarla arasındaki organizasyon eksiklikleri, malzeme tedarikindeki problemler, tahmin edilemeyen hava koşullarının oluşması ve taşeron firmalardaki kalifiye eleman eksikliği olarak belirlendi. Bu gecikme sebeplerinden tahmin edilemeyen hava koşulları hariç hepsinin Türkiye inşaat sektöründeki kamu projelerinde oluşan önemli gecikme sebepleri ile çakıştığı gözlemlendi.

Anahtar Kelimeler: İnşaat Yönetimi, İnşaat Gecikmeleri, İş Programı Analizi, Proje Programlaması, Zaman Etkisi Analizi Metodu.

To my late father,

and to my husband,

and our dearest son;

with love

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TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF FIGURES

FIGURES

LIST OF ABBREVIATIONS

ABBREVIATIONS

CCD	Contractor Caused Delays
CD	Concurrent Delays
CDCA	Computerized Delay Claims Analysis
CPM	Critical Path Method
CR	Contractor Related
DA	Delay Analysis
DAM	Delay Analysis Methodologies
DAMUDS	Delay Analysis Method Using Delay Section
ED	Excusable Delays
ECD	Excusable Compensable Delays
ENCD	Excusable Non-compensable Delays
EF	External Factor
FLORA	Float, Logic, and Resource Allocation
IAP	Impacted As-planned
IAC	Impacted Activity Code
IDT	Isolated Delay Type
NCD	Non-concurrent Delays
NED	Non-excusable Delays
OCD	Owner Caused Delays
OR	Owner Related
RII	Relative Importance Index
TIA	Time Impact Analysis
TPCD	Third Party Caused Delays
UAE	United Arab Emirates

CHAPTER 1

INTRODUCTION

In this chapter the argument for and the objectives of the study are presented, together with a brief overview of its procedure. The chapter is concluded with the disposition of the various chapters within the thesis.

1.1 Argument

Planning and control of resources within the framework of a project is the main target of construction management. Construction management procedures guide managers about how the resources can be best used during construction process and aims for the timely and efficient application of the resources in construction projects. Many issues should be carefully thought in order to conduct a project successfully (Halpin, Woodhead, 1998). Construction site activities are only the second part of the whole construction process. The first part is comprised of all kinds of office work. The planning, designing, estimating, negotiating, purchasing, scheduling, controlling, accounting, etc. should be done carefully in the office before the work starts on the site to accomplish the objective of a quality project within budget and on schedule.

Construction delays are widespread in most projects around the world. Some delays may happen in the preconstruction phase which is defined as the period beginning from the initial conception of the project to the signing of the contract between the owner and the contractor; however some of them may happen in the construction phase that is the period when actual construction is under way. Project schedules are consistently dynamic and uncertain. Several controllable and uncontrollable factors can adversely affect the project schedule and cause delays. These delays definitely create negative impacts on project performance. Schedule delay in the completion of a construction project may be a major difficulty for contractors leading to costly disputes and adverse relationships between project participants. The challenge is to measure the net impact of construction delays accurately. Otherwise, there may appear delay claims between all parties involved in the construction process. The method of schedule delay analysis technique should be acceptable to all participants through the project.

There are many studies on construction schedule delays and several techniques are proposed for analyzing schedule delays. Schedule delay analysis is used in order to identify delays and to measure the net impacts of delays on a project. Basic tools which are used in the schedule analysis are known as bar chart schedules and critical path method (CPM) schedules. As stated before, many articles have presented common schedule analysis techniques and some of them also have proposed new methodologies to the construction industry. However, there is no single method used for all kind of delay claims that is applicable in all kind of projects since each of the technique has its own advantages and disadvantages. Common methodologies covered in the literature are; As-planned versus as-built, Impacted as-planned, Collapsed as-built, Window analysis, and Time impact analysis. These methods were studied and one of them was applied to the case study project.

Delays in the completion of construction projects are often unavoidable. The project schedule which is planned at the beginning of the project is prone to being changed for many times and unfortunately causes delays. As a result, schedule delays may be a major problem for contractors as well as the owners, resulting in costly disputes, controversial issues and adverse relationships between all the project participants. Therefore, the identification, quantification and analysis of delays become essential. Contractors are prone to see most of the delays in the responsibility of the owner, while owners usually want to put the blame on the contractor or third parties. Consequently, it is necessary to analyze schedule delays and research the most significant causes of delay in construction projects to avoid or minimize their adverse impacts on the project and project participants.

1.2 Objectives

The main objective of this research was to apply the most appropriate schedule delay analysis technique to the case study project in order to analyze the net impacts of construction delays on project completion duration and to allocate responsibility amongst the project participants for such delays. The other objectives of the study were:

- To study and understand project scheduling,
- To determine the major types of construction delays,
- To determine general causes of construction delays through a literature survey,
- To study the common schedule delay analysis techniques,
- To measure the impacts of construction delays on an as-planned project schedule and discuss the results.

1.3 Procedure

The study was designed to apply the most appropriate schedule delay analysis technique on the case study project. At first a literature survey was carried out on pertinent topics based on theses, books in libraries, scientific papers, articles and web sources. This literature survey was carried out on construction schedule delays, causes of schedule delays, their types, and schedule delay analysis techniques and was used to understand the difference between the concepts of project planning and project scheduling, and also to determine the objectives of project scheduling.

The Time Impact Analysis method (TIA) was selected for analyzing construction schedule delays on completion construction works of a covered swimming pool building complex in Ankara since the method could be used both in forward and retrospective analysis applications by adding impacts into the as-planned schedules. The necessary data and documents were obtained from the related construction and consulting companies.

1.4 Disposition

The study is presented in five chapters, of which this introduction is the first. In the first chapter, the argument, objectives and methodology of the study are introduced. It includes also disposition of the chapters and their contents.

In the second chapter, a brief literature survey is given on construction project planning and project scheduling. Thereafter, information on construction schedule delays, causes and types of construction delays, as well methods of schedule delay analysis are presented.

In the third chapter, the case study project which is completion construction works of a covered swimming pool building complex in Ankara is presented in the material section. And, the procedure followed for analyzing schedule delays is introduced in the section of methodology.

In the fourth chapter, a discussion on the results obtained from the application of the delay analysis technique is presented.

In the fifth and last chapter, the conclusion of this study with findings and their interpretations is given.

CHAPTER 2

LITERATURE SURVEY

In this chapter are presented the literature survey with the following headings.

2.1 Construction Project Planning

Arıkan and Dikmen (2004) give the definition of 'planning' as "Trying to anticipate what will happen and devising ways of achieving the set of objectives and targets"; and point out that in planning concept there are always objectives to be reached in future. The authors describe planning as "a process during which efforts and decisions are made to achieve the goals at the desired time in the desired way." They further line up the main objectives of a construction project as follows:

1. To complete the construction within the specified time (duration)
2. To complete it within the budget, (with a profit)
3. To complete it in compliance with technical and administrative specifications.

Project planning has been also defined as "the process of selecting the one method and order of work to be used on a project from among all the various methods and sequences in which it could be done" (Callahan, Quackenbush, and Rowings

1992). The authors also note that this process supplies detailed information used for time estimation and schedule; besides a baseline for project control.

Mubarak (2005) states that project planning works for several functions such as: cost estimating, scheduling, project control, safety management, etc. According to Arıkan and Dikmen (2004) the main purpose of planning is to provide the primary duties of the manager, namely, direction and control. The second objective of planning is to organize all the relationships and information systems among the many parties involved in the construction project. The authors further describe the third function of planning as enabling project control and forecasting.

Smith (2002) emphasizes the importance of careful and continuous project planning in the success of a realization of a project; and also notes that the activities of designers, producers, suppliers, workers and contractors, and their resources must be coordinated and integrated with the objectives of contractor. Oberlender (2000) agrees with Smith that planning coordinates all works of the construction to reach a completed quality project. The author determines the basic benefit of project planning and scheduling as an effective tool of preventing some of the problems like delays in work, cost overrun or decline in productivity and principally puts in order the desired results of project planning and scheduling as indicated below:

1. Finish the project on time.
2. Continuous (uninterrupted) flow of work (no delays).
3. Reduced amount of rework (least amount of changes).
4. Minimize confusion and misunderstandings.
5. Increased knowledge of status of project by everyone.
6. Meaningful and timely reports to management.
7. You run the project instead of the project running you.
8. Knowledge of scheduled times of key parts of the project.
9. Knowledge of distribution of costs of the project.

10. Accountability of people, defined responsibility/ authority.
11. Clear understanding of who does what, when, and how much.
12. Integration of all work to ensure a quality project for the owner.

2.2 Project Scheduling

The terms of project planning and scheduling are often mistakenly thought of as synonymous. However, as Mubarak (2005) indicates scheduling concentrates on the timing and sequence of operations in the project planning effort. Therefore, while project planning covers the issues of what is going to be done?, where?, how? and when?, the term of project scheduling covers only the issue of when?. Trauner, Manginelli, Lowe, Nagata and Furniss (2009) agree with Mubarak and define project schedule as "a written or graphical representation of the Contractor's plan for completing a construction project that emphasizes the elements of time and sequence". According to the Trauner, *et al.* (2009), the project schedule should display all the construction tasks from the beginning of the project through completion, the time periods for each tasks, and the sequence of these tasks in a logical order.

Oxley and Poskitt (1996) define project scheduling as "the process of determining the actual time periods during which the activities are planned to take place: that is, start and finish dates for each activity". In order to determine the construction activities and their time periods, project planning should have been done before project scheduling. Oberlender (2000) claims that a successful project planning is more difficult to organize than scheduling. If the activities are identified in project planning, then scheduling the project will become relatively easy.

2.3 The Objectives of Project Scheduling

After a successful planning process, the schedule of the project is prepared. There are major objectives that are expected from good project scheduling. According to Mubarak (2005) there are eight important objectives of scheduling as noted below:

1. To calculate the project completion date.
2. To calculate the start or end of a specific activity.
3. To expose and adjust conflicts between trades or subcontractors.
4. To predict and calculate the cash flow.
5. To evaluate the effect of changes.
6. To improve work efficiency.
7. To resolve delay claims.
8. To serve as an effective project control tool.

A project schedule is viewed as a valuable project control tool for Project Managers to successfully conduct construction projects (Trauner, Manginelli, Lowe, Nagata and Furniss, 2009). Trauner *et al.* (2009) further explain the basic purposes of a project schedule as effectively depicting the construction plan to the project participants, permitting management to control and measure the progression of the work, and finally accommodating the participants with information for timely decisions.

Callahan *et al.* (1992) claim that the probabilities of on-time, on-budget, dispute-free completion may be increased by means of a schedule and the purpose of the schedules is specified by the individual using the schedule. The authors further explain that the purpose to predict project completion for contractors is that they can arrange crew sizes, shifts or equipment to speed or slow progress. While, for architects or engineers the purpose is to determine how long design and construction will take for completion of the project. The authors add that subcontractors use the information of specific activities' start and finish times to predict when they are needed at the site. Also, the activity completion dates are used by owners in order to decide when to deliver owner-furnished equipment and to coordinate partial occupancy. Another purpose of scheduling for contractors is to reveal and resolve conflicts between firms or subcontractors. Both for contractors and owners schedules are used to plan cash flow.

Callahan *et al.* (1992) also indicate that schedules are used for measuring delay and time extensions. If the schedules are regularly updated including work sequences, unanticipated delays, actual activity completion dates and change orders, then the owner and contractor can measure the affect of additional works and unanticipated delays, thus avoiding disputes. The causes and different types of schedule delays are given in the following paragraphs.

2.4 Construction Schedule Delays

There are a number of definitions for delay. In the construction management context, the simplest definition of a delay is made by Mubarak (2005) as "an event or a condition that results in finishing the project later than stipulated in the contract." Callahan *et al.* (1992) define delay in construction claims as "the time during which some part of the construction project has been extended or not executed owing to an unexpected event".

In another study, Trauner *et al.* (2009) describe delay as "to make something happen later than expected or to not act timely". It is usual for delays to occur on construction projects. Callahan *et al.* (1992) claim that schedules have an important role in construction delays; since the effects of delays on the project completion date can be displayed and future delays can be anticipated by rescheduling the project through the computer.

2.4.1 Causes of Construction Delays

As Abd El-Razek, Bassioni and Mobarak (2008) studied several articles on examining the causes of construction delays in many ways; some studies determined the main causes of delay in different countries, while some of them investigated the delay analysis methods in different types of construction. The authors have listed 87 causes of construction delays which are given in Appendix A.

Mansfield, Ugwu, and Doran (1994) discussed the causes of delay and cost overruns by examining data relating to construction projects in Nigeria. Assaf, Al-Khalil, and Al-Hazmi (1995) studied the main causes of delay in large building projects in Saudi Arabia and their relative importance. In the study undertaken by Assaf, *et al*. (1995), the largest number of causes of delay (56 causes) was listed and the respondents were asked to point out their degree of importance. The authors grouped the delay factors into nine major groups: financing, materials, contractual relationships, project changes, government relations, manpower, scheduling and control, equipment, and environmental factors. The financing group of delay factors was selected as the most significant delay factor by all parties and that environment group was selected as least significant. In another observation, Odeh and Battaineh (2002) carried out a study to determine the most significant causes of construction delays with traditional type of contracts with regard to contractors and consultants. According to the results of the study, owner interference, inadequate contractor experience, financing and payments, labor productivity, slow decision making, improper planning, and subcontractors are among the top ten most significant causes of delays.

Another study was by Kaliba, Muya, and Mumba (2009) which aimed to determine the causes and effects of cost escalation and schedule delays in road construction projects in Zambia. The authors compile the main causes of delays in road construction projects which are determined according to their survey, as in the following: delayed payments, financial processes and difficulties on the part of contractors and clients, contract modification, economic problems, materials procurement, changes in drawings, staffing problems, equipment unavailability, poor supervision, construction mistakes, poor coordination on site, changes in specifications and labour disputes and strikes. In another research, Frimpong, Oluwoye, and Crawford (2003) carried out a study to determine and assess the relative importance of causes of delays and cost overruns in Ghana groundwater construction projects. The research showed that monthly payment difficulties from agencies, poor contractor management, material procurement, poor technical performances, and escalation of material prices were the main causes in the study.

In another research, Ahmed, Azhar, Castillo, and Kappagantula conducted a study on the major causes of delays in construction projects in the Florida Construction Industry through a survey (http://www.scribd.com/doc/28215106/Construction-Delays-in-Florida-a-Study). According to the authors, there are two groups of causes for delays in construction projects: external and internal causes. Internal causes of delays cover the causes, which come from four parties involved in that project. These parties are the owner, designers, contractors, and consultants. Other delays, which do not come from these four parties, are based on external causes for example from the government, material suppliers, or weather. Some of the possible causes of delays are as follows:

- Possessive decision-making mechanism,
- Highly bureaucratic organization,
- Insufficient data collection and survey before design,
- Site’s topography is changed after design
- Lack of coordination at design phase
- Inadequate review
- Improper inspection approach
- Different attitude between the consultant and contractors
- Financial difficulties

- Inexperienced personnel
- Insufficient number of staffs
- Deficiency in project coordination
- Spend some time to find sub-contractors company who is appropriate for each task
- Often changing Sub-contractors Company
- Inadequate, and old equipment
- Lack of high-technology equipment
- Harvest time

Arditi, Akan, and Gurdamar (1985) examined a large number of public projects in Turkey in order to determine and grade the level of importance of the causes of construction delays in such projects. According to the results of their research, the most important reasons of these delays and their average weights were as follows:

- Shortage of some resources like qualified manpower, technical personnel, construction materials and equipment (31%),
- Financial difficulties of contractors and public agencies (21%),
- Organizational deficiencies of public agencies and contracting companies such as bureaucratic obstacles and slow decision-making mechanism in public organizations (19%),
- Delays in design work, large quantities of extra work, frequent change orders (The total average weight of these three reasons is 14%).

Average weight of the four reasons of construction delays mentioned above is 85%. The remaining 15% was related to other minor reasons of delays.

Odabaşı (2009) investigated factors affecting construction durations and models for estimating construction durations. The author selected from the literature and listed the most significant ones under eleven headings as: cost, cash flow, productivity on site, material procurement, project related factors, technology and methodology of construction, experience, coordination, weather, construction site, and the degree of completeness of design project.

In the study of Faridi and El-Sayegh (2006), significant factors causing construction delays in the United Arab Emirates (UAE) were analyzed. This research has determined the top ten most significant causes of construction delays as shown in the table 2.1 below.

Table 2.1: Ten most significant causes of delays in the UAE construction industry (Source: Faridi and El-Sayegh, 2006)

Causes of delay	Rank	RII (Relative Importance Index)
Preparation and approval of drawings	1	2.495
Inadequate early planning of the project	2	2.429
Slowness of the owner's decision-making process	3	2.398
Shortage of manpower	4	2.348
Poor supervision and poor site management	5	2.337
Productivity of manpower	6	2.297
Skill of manpower	7	2.281
Non-availability of materials on time	8	2.280
Obtaining permit/ approval from the municipality/ different government authorities	9	2.275
Financing by contractor during construction	10	2.261

In another observation, Baldwin, Manthei, Rothbart, and Harris (1971) conducted the study to determine the causes of construction delays in the United States. The authors examined the causes of delays under seventeen categories as: weather, labor supply, material shortage, equipment failure, finances, manufactured items, construction mistakes, design changes, foundation conditions, permits, shop drawings, sample approvals, building codes, subcontractors, contracts, jurisdictional disputes, and inspections. The study of Lo, Fung, and Tung (2006) covering the issue of construction delays in Hong Kong civil engineering projects, was conducted on mainly compiling the perceptions of civil construction practitioners on how important are the causes of delay. Lo, *et al*. (2006), therefore, summarized previous studies some of which are also stated above, on causes of delay in construction, as in the Table 2.2.

Table 2.2: Summary of previous studies on causes of delay
(Source: Lo *et al.*, 2006)

Researchers	**Country**	**Major causes of delay**
Arditi *et al.* (1985)	Turkey	1. shortages of resources 2. financial difficulties faced by public agencies and contractors 3. organizational deficiencies 4. delays in design work 5. frequent change orders/ design 6. considerable additional work
Baldwin (1971)	U.S.	1. inclement weather 2. shortages of labour supply 3. subcontracting system
Okpala and Aniekwu (1988)	Nigeria	1. shortages of materials 2. failure to pay for completed works 3. poor contract management
Dlakwa and Culpin (1990)	Nigeria	1. delays in payment by agencies to contractors 2. fluctuations in materials, labour and plant costs
Mansfield *et al.* (1994)	Nigeria	1. improper financial and payment arrangements 2. poor contract management 3. shortages of materials 4. inaccurate cost estimates 5. fluctuations in cost

Table 2.2: Continued

Researchers	**Country**	**Major causes of delay**
Semple *et al.* (1994)	Canada	1. increases in the scope of works 2. inclement weather 3. restricted access
Assaf *et al.* (1995)	Saudi Arabia	1. slow preparation and approval of shop drawing 2. delays in payments to contractor 3. changes of design/design error 4. shortages of labour supply 5. poor workmanship
Ogunlana *et al*.(1996)	Thailand	1. shortages of materials 2. changes of design 3. liaison problems among the contracting parties
Chan and Kumaraswamy (1996)	Hong Kong	1. unforeseen ground conditions 2. poor site management and supervision 3. slow decision making by project teams 4. client-initiated variations
Al-Khall and Al-Ghafly (1999)	Saudi Arabia	1. cash flow problems/ financial difficulties 2. difficulties in obtaining permits 3. "lowest bid wins" system
Al-Momani (2000)	Jordan	1. poor design 2. change orders/ design 3. inclement weather 4. unforeseen site conditions 5. late delivery

According to Hinze (1993), the causes of construction delays are numerous, including strikes, adverse weather, late decisions by the owner, unforeseen changes affecting construction duration and so on. He asserts that delays affect unfavourably all the contracting parties, for example; owners get their buildings later than planned, contractors are affected adversely due to increased construction costs. The causes of construction delays are classified by the author into three groups according to their origination as follows:

- Delays caused by the contractor or the contractor's agents
- Delays caused by the owner or the owner's agents: In another study, Trauner *et al.* (2009) exemplify the causes of delays to a project caused by the owner such as; a change in the design, an error or omission in the contract documents, a differing site condition, failure to make approvals on time, failure to respond to requested information required to progress the work, or even stop work orders.
- Delays caused by force majeure or acts of God

In another field observation, Mubarak (2005) groups the causes of construction delays in six categories regardless of who is at fault; as listed below:

1. Differing Site Conditions
2. Design Errors or Omissions
3. Changes in Owner's Requirements
4. Unusually Adverse Weather
5. Miscellaneous Factors
6. Force Majeure

2.4.2 Types of Construction Delays

General types of construction delays should be clearly examined before schedule delay analysis begins. Schedule construction delays are categorized in many ways. According to Trauner *et al.* (2009), there are four main groups of construction delays:

- Critical or noncritical
- Excusable or non-excusable
- Compensable or non-compensable
- Concurrent or non-concurrent

The diagram displayed in Figure 2.1 presents a general overview of how the construction delays can be categorized. Firstly, if the delay is critical or noncritical and concurrent or non-concurrent should be determined in the process of analyzing delay effects on the project. All construction delays are either excusable or non-excusable as shown in the figure. Then, excusable delays are classified into compensable or non-compensable delays. This figure presents only one interpretation, since excusability and compensability of delays can change according to the contract.

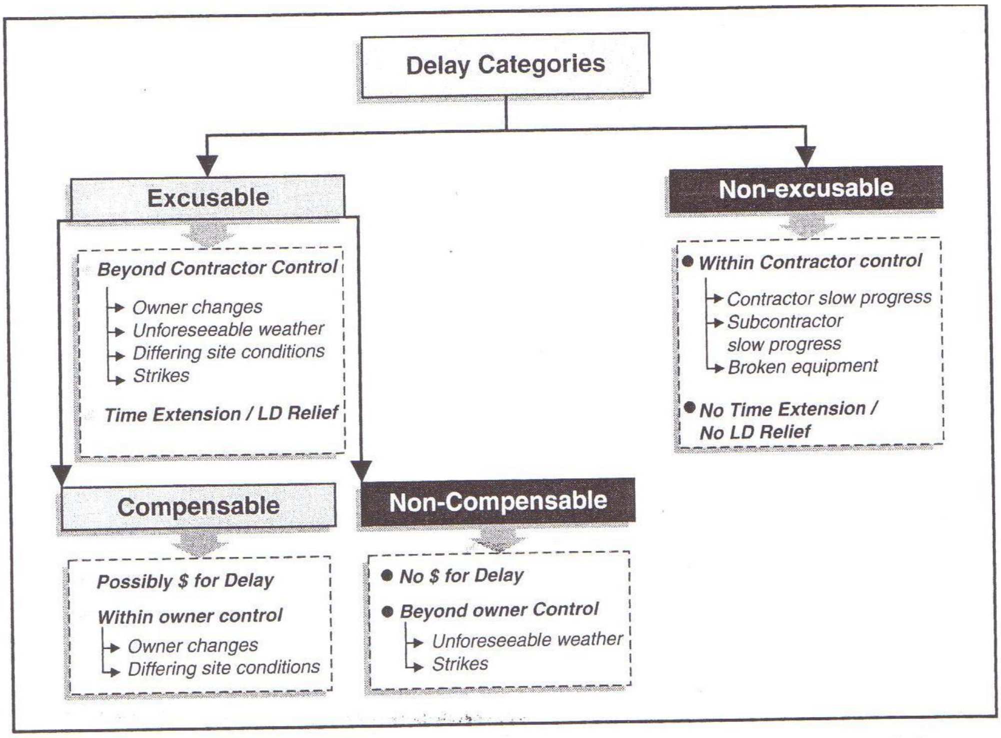

Figure 2.1: Delay Categories
(Source: Trauner *et al.*, 2009)

In the study of Yang, Yin, and Kao (2007) delay classification is given in a different manner (Figure 2.2), but similar to the concept of Trauner *et al*. In another study, Kartam (1999) classified project delays into three main groups in terms of their origin, timing and compensability as shown in Figure 2.3. These groups are as given in the following:

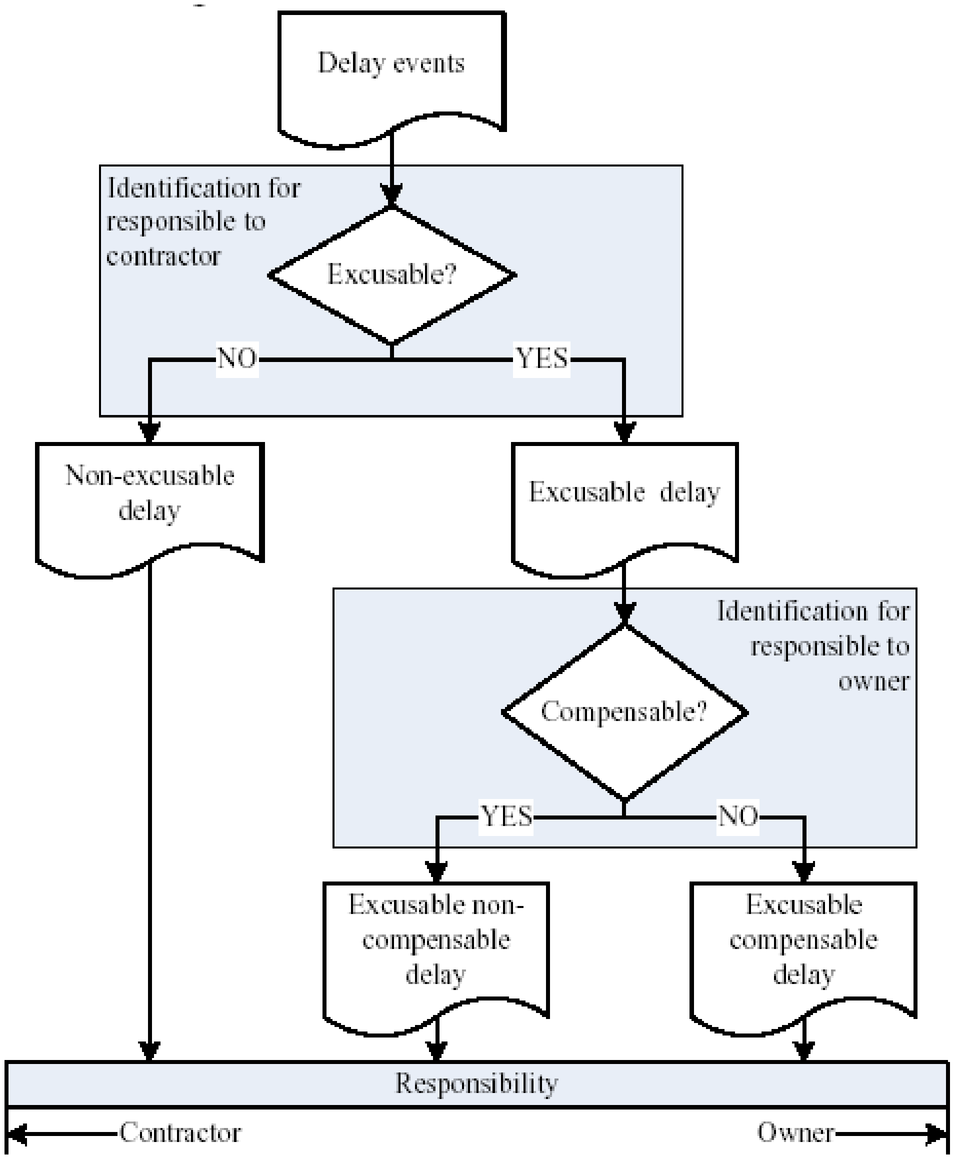

Figure 2.2: Delay Classification
(Source: Yang, Yin and Kao, 2007)

- Delays classified by their origin: Owner caused delays (OCD), contractor caused delays (CCD), third party caused delays (TPCD)
- Delays classified by their timing: These are concurrent delays (CD) and non-concurrent delays (NCD).
- Delays classified by their compensability: These are excusable delays (ED) which are also classified in itself as excusable compensable delays (ECD) and excusable non-compensable delays (ENCD), and non-excusable delays (NED).

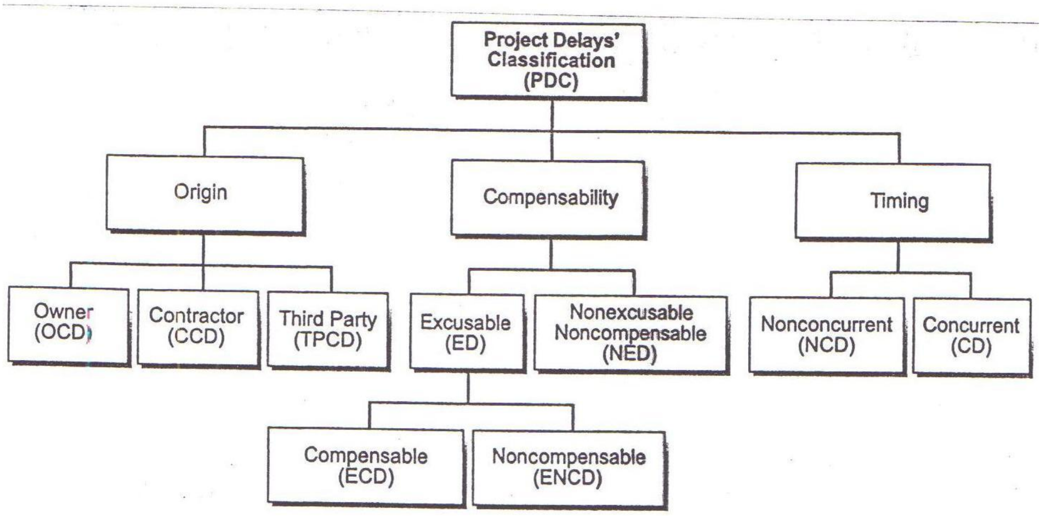

Figure 2.3: Project Delays Classification
(Source: Kartam, 1999)

2.4.2.1 Critical versus Noncritical Delays

While several authors (Mubarak, 2005; Kelleher, 2005; Levy, 2006) categorize delays into three groups as Excusable and Non-excusable, Compensable and Non-compensable and Concurrent and Non-concurrent; certain authors (Trauner *et al.*, 2009; Callahan *et al.*, 1992) add one more category to these three groups which is Critical and Noncritical delays.

According to Trauner *et al.*, (2009) and Callahan *et al.*, (1992), the primary focus in any study of delays in a project is to see if the delay affects the progress of the entire project or the project completion date. The authors further state that delays which result in extended project completion are considered critical delays, and delays that do not affect the project completion date are known as noncritical delays. Trauner *et al.* (2009) further claim that the issue of critical delays emerges from the Critical Path Method (CPM) scheduling. All projects have a critical path and if these critical activities on the path are delayed than the completion date of the project will be extended. The criteria determining the project completion date are as follows (Trauner *et al.*, 2009):

- The project itself
- The contractor's plan and schedule (particularly the critical path)
- The requirements of the contract for sequence and phasing
- The physical constraints of the project- how to build the job from a practical perspective.

2.4.2.2 Excusable versus Non-excusable Delays

Construction delays are basically either excusable or non-excusable. Callahan *et al.* (1992) and Trauner *et al.* (2009) claim that whether a delay is excusable or non-excusable depends on the clauses in the contract. The authors note that standard construction contracts specify types of delay that will allow the contractor to an extension of time. For instance, in some contracts, unexpected or unusual weather conditions are not considered as excusable and so these contracts do not allow for any time extensions. According to Trauner *et al.* (2009) an excusable delay, in general, is owing to an unforeseeable event beyond the contractor's or the subcontractor's control. The authors further explain that delays resulting from the following issues are known as excusable:

- General labor strikes,
- Fires,
- Floods,
- Acts of God,
- Owner-directed changes,
- Errors and omissions in the plans and specifications,
- Differing site conditions or concealed conditions,
- Unusually severe weather,
- Intervention by outside agencies,
- Lack of action by government bodies, such as building inspection.

In another study, Levy (2006) adds two more excusable delays to the above list as:

- Illness or death of one or more of the contractors,
- Transportation delays over which the contractor has no control.

Moreover, Kelleher (2005) supplies the above list with two more delays as:

- Epidemics,
- Quarantine restrictions.

Mubarak (2005) defines non-excusable delays as "delays that are either caused by the contractor or not caused by the contractor but should have been foreseen by the contractor". He also points out that a non-excusable delay does not entitle the contractor to either a time extension or monetary compensation. Trauner *et al.* (2009) enumerate some examples of non-excusable delays as follows:

- Late performance of subcontractors,
- Untimely performance by suppliers,
- Faulty workmanship by the contractor or subcontractors,
- A project-specific labor strike caused by the contractor's unwillingness to meet with labor representatives or by unfair labor practices.

In another observation, Mubarak (2005) adds other examples to the above list as:

- Contractor cash-flow problems,
- Accidents on the site caused by the contractor's negligence or lack of preparations,
- Late delivery of the contractor's furnished materials and equipment.

As stated in the excusable delays, again, the contract is the determinant whether or not a delay is considered non-excusable. Therefore, Trauner *et al.* (2009) warn contractors that before signing the contract it should be clearly understood which delays are defined as excusable and which as non-excusable.

2.4.2.3 Compensable versus Non-compensable Delays

In some studies, Callahan *et al.* (1992), Kartam (1999) and Mubarak (2005) claim that an excusable delay can be classified as "excusable compensable" and "excusable non-compensable". As Mubarak (2005) states compensable delays are caused by the owner or the designer (engineer or architect). The contractor is typically entitled to a time extension or recovery of the costs related with the delay, or both. Factors which are specified in the contract resulting in delays such as differing site conditions, changes in the work, access to the site are some examples of compensable delays. According to Trauner *et al.* (2009) only excusable delays may be compensable.

The authors further explain non-compensable delays as those which despite being excusable do not entitle the contractor to any compensation. Many authors such as Barrie and Paulson (1992) and Mubarak (2005), point out that excusable non-compensable delays are normally beyond the control of either owner or contractor such as unusual weather conditions, natural disasters, wars, national crises, floods, fires or labor strikes. They add that usually the contractor is entitled to a time extension, but not additional compensation.

Trauner *et al.* (2009) emphasize that if a delay is compensable or non-compensable basically depends on the issues of the contract. The contract determines the types of delays in detail and for which delay the contractor is entitled to time extension or monetary compensation.

2.4.2.4 Concurrent Delays

Mubarak (2005) states that a concurrent delay includes a combination of two or more independent causes of delay occurring within the same time frame. According to the author, a concurrent delay often includes an excusable delay and a non-excusable delay. Another definition made by Callahan *et al.* (1992) is that "more than one delay contributed to the project delay, not that the delays necessarily occurred at the same time". Although this type of delays seems like a simple issue, still there is no clear definition of concurrent delays. According to Trauner *et al.* (2009) concurrent delays are simply defined as "separate delays to the critical path that occur at the same time". Levy (2006) names this type of delays as overlapping delays. Nguyen (2007) also points out that simultaneous delays, commingled delays, and intertwined delays are other names used for concurrent delays.

Levy (2006) further indicates that concurrent delays may be generated by the contractor or by the owner, but if it happens that both parties are responsible, and these delays overlap then neither party can be able to retrieve damages.

Figure 2.4 shows the possible critical delay interactions among three parties: owner (O), contractor (C) and third party (N). The Venn diagram representation and the use of set theory to show concurrent delays are proposed as new concepts by the study of Mbabazi, Hegazy, and Saccomanno (2005) and they are very useful in apportioning delays. The diagram presents all types of critical delay combinations. Based on these critical delay types, time and cost compensation can be determined accurately for each of the seven segments in the Venn diagram. The diagram covers three intersecting sets of (O), (C) and (N). Using uppercase letters is to emphasize that all delays are critical delays. For example, OC'N' represents a one-party delay meaning only owner caused delay but not contractor or third-party caused delay. Similarly, OCN' is an example of a two-party concurrent delay that is the owner and the contractor caused delays but not third party caused delay. Using set theorems, the right side is just a mathematical representation by seven variables a, b, c, d, e, f, and g of the values on the left side shown by each segment.

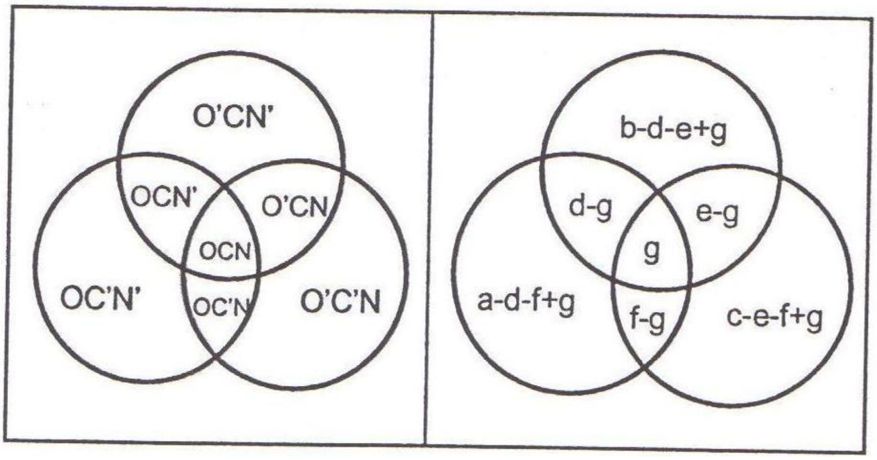

Figure 2.4: Concurrent Delay Representation
(Source: Mbabazi, Hegazy, and Saccomanno, 2005)

Table 2.3 concludes the different perspectives on concurrent delays from previous studies. Concurrent delay analysis brings about many issues, since both owners and contractors view concurrent delays as a strong defense tool against each other. For example, owners use them to preserve their interest in order to get liquidated damages, however contractors use them to neutralize their inexcusable delays and avoid damage entitlement. Courts, practitioners, researchers are generally inconsistent in the subjects of definition and apportionment of concurrent delays.

All kinds of practitioners, especially contractors, contract administrators, and claims consultants have divergent opinions on concurrent delays. (Nguyen, 2007) As shown in the Table 2.3, general views regard concurrent delays as being similar to excusable delays. That means contractors are entitled only time extension.

Table 2.3: Divergent and inconsistent perspectives on concurrent delays
(Source: Nguyen, 2007)

No	Literature	Concurrent Delays		
		Excusable& Inexcusable	Excusable& Compensable	Compensable & Inexcusable
1	Ponce de Leon (1987)	Excusable	Compensable	Excusable
2	Reams (1989); Battikha and Alkass (1994)	Excusable	Excusable	Not Available
3	Arditi and Robinson (1995); Al-Saggaf (1998)	Inexcusable	Excusable	Not Available
4	Rubin (1983); Galloway and Nielsen (1990); Wiezel (1992); Alkass *et al.* (1995); Schumacher (1995); Galloway *et al.* (1997); Kartam (1999); Stumpf (2000); Reynolds and Revay (2001); Niesse (2004)	Excusable	Excusable	Excusable
5	Construction (1993); Baram (2000); Construction (2002)	Inexcusable	Excusable	Inexcusable
6	Kraiem and Diekmann (1987); James (1991); Kutil and Ness (1997); Finke (1999); Ness (2000); Bubshait and Cunningham (2004)	Excusable	Excusable	Excusable or Apportioning
7	Hughes and Ulwelling (1992); Wickwire *et al.* (2003)	Excusable	Excusable	Apportioning

2.4.3 Schedule Delay Analysis

In the study of Ndekugri, Braimah, Gameson (2008), delay analysis (DA) is defined as "the task of investigating the events that led to project delay for the purpose of determining the financial responsibilities of the contracting parties arising from the delay". The authors further point out that the techniques which have been developed for analyzing construction delays until today are referred to as "delay analysis methodologies" (DAM).

2.4.3.1 Tools to Quantify Delay Impacts

Schedule analysis is used in order to identify delays and to measure the net impacts of delays on a project. Basic tools which are used in the schedule analysis are known as bar chart schedules and critical path method schedules.

a) Bar Charts

Callahan *et al.* (1992) defines bar charts as "a collection of activities listed in a vertical column with time represented on a horizontal scale". Bar charts show duration, start and finish times of project activities in chronological order. Henry L. Gantt developed bar charts during World War I. This tool is widely preferred since it is simple, easy to prepare and has an easily understandable format.

However, bar charts have many limitations. Wickwire, Driscoll, Hurlbut, and Hillman (2003) give a detailed list of disadvantages of this tool:

- Size limits a bar chart in what it can graphically present
- Bar charts do not show the interrelationships or interdependencies of one bar to another
- Bar charts do not show the available float or contingency time, nor can they show the delay impact of one bar on another
- Bar charts are not capable of accurately distributing or controlling manpower and project costs.
- Adding more detail to the bar chart makes it harder to read, understand, and maintain.

Consequently, bar charts cannot show the logical relationships among activities. When there are continuous relationships between many activities, a bar chart becomes difficult to prepare schedule correctly (Callahan *et al.* 1992).

b) Critical Path Method

The E.I. Du Pont de Nemours Company in conjunction with UNIVAC Applications Research Center of Remington Rand developed the Critical Path Methods between the years of 1956 and 1958. In 1961, CPM technique was first used in construction projects. However, this tool was not used widely in the late 1960s (Callahan *et al*., 1992).

In project management, the Critical Path Method (CPM) is a planning, scheduling and controlling tool and using this tool properly facilitates the completion of projects timely. Wickwire *et al.* (2003) describe CPM as “a graphic representation of the planned sequence of activities that shows the interrelationships and interdependencies of the elements composing a project.” At first, CPM was introduced as a planning tool; however, later additional function of CPM appeared as proving delay claims. This function is the result of the ability of CPM as showing the picture of the project and changes.

2.4.3.2 Schedule Delay Analysis Techniques

As Nguyen, and Ibbs (2008) stated, there is a variety of schedule delay analysis techniques in construction industry. Many articles have researched these common techniques and some of them also have proposed new methodologies to the construction industry. The different methods of schedule delay analysis will be mentioned as some other techniques in the following part. However, in this part common current methods of schedule delay analysis will have been explained in detail. In the study of Nguyen (2007), the term reliability defines the result of a forensic schedule analysis that correctly presents and shows the facts. According to the research, main techniques presented herein are as follows:

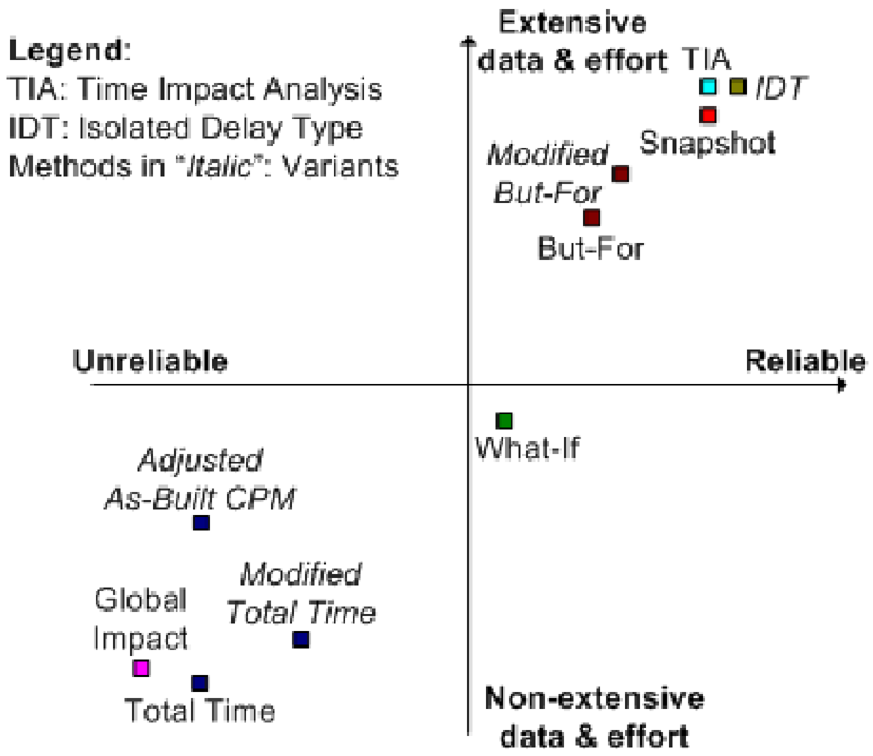

Figure 2.5: Mapping of Forensic Schedule Analysis Techniques
(Source: Nguyen, 2007)

In the research of Arditi and Pattanakitchamroon (2008), a chronological analysis was built up to see the ratios of the usage of common schedule delay methods in a diagram as showed in Figure 2.6. This diagram includes the years of 1989 up to 2005. From the diagram it is understood that time impact analysis method is most preferred since it has become easier due to developed computer technologies; on the other hand impact as-planned analysis method has not become popular currently because this method is not accepted in courts as reliable any more.

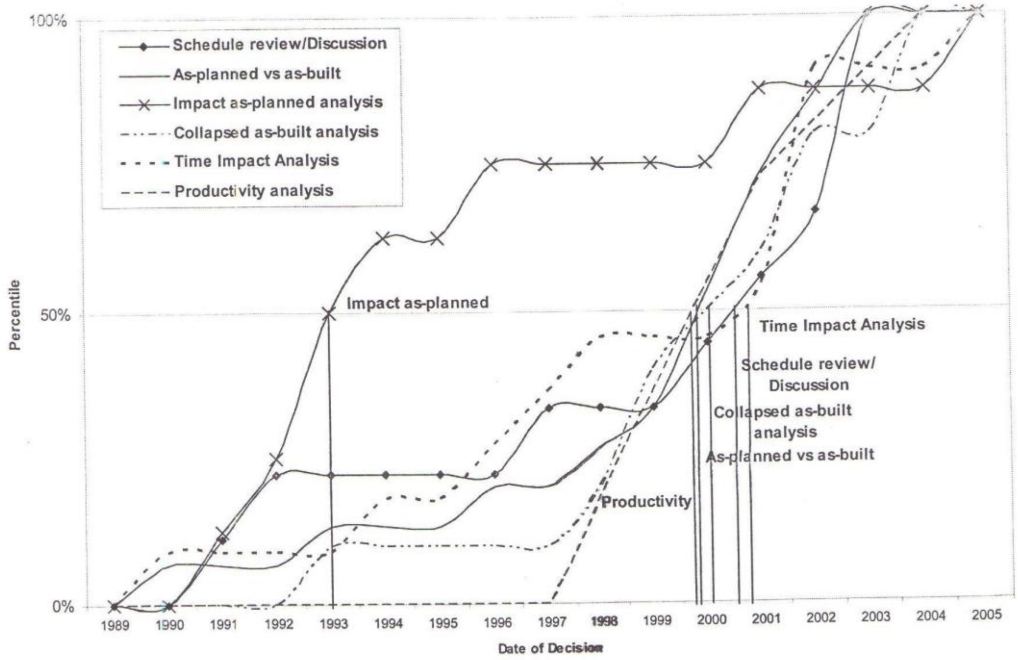

Figure 2.6: Chronological Analysis of Schedule Analysis Techniques
(Source: Arditi and Pattanakitchamroon, 2008)

Table 2.4 concludes the common delay analysis methodologies (DAMs) classified from the literature and their different names. Following methodologies are the most commented upon in literature; they are also given in detail in the following pages.

- As-planned versus as-built,
- Impacted as-planned,
- Collapsed as-built,
- Window analysis, and
- Time impact analysis.

Table 2.4: Names of existing delay analysis methodologies (DAMs)
(Source: Ndekugri, Braimah, Gameson, 2008)

Common Name	Literature Review	Alternative names used by different authors
Non-Cpm Based Techniques		
S-curve Global impact technique	Rubin *et al.* 1999 Leary and Bramble 1988; Alkass *et al.* 1995, 1996; Pinnell 1998	Dollar-to-time relationship (Trauner 1990)
Net impact	Leary and Bramble 1988; Alkass *et al.* 1995, 1996;	Bar chart analysis (Zack 2001; Lucas 2002) As-built bar chart (Bordoli and Baldwin 1998)
Cpm Based Techniques		
As-planned versus as-built	Stumpf 2000; Lucas 2002; Lovejoy 2004; Pickavance 2005	Adjusted as-built CPM (Leary and Bramble 1988; Alkass *et al.* 1996) Total time (Zack 2001; Wickwire and Groff 2004) Impactedas-builtCPM(Pinnell 1998)
As-planned but for Impacted as-planned	Alkass *et al.*1996; Pinnell 1998 Trauner 1990; Pinnell 1998; Lucas 2002; Lovejoy 2004; Pickavance 2005	What if (Schumacher 1995) Baseline adding impacts (Bordoli and Baldwin 1998) As-planned-plus delay analysis (Zack 2001; Chehayeb *et al.* 1995) As-plannedCPM (Pinnell1998)
Collapsed as-built	Pinnell 1998; Stumpf 2000; Wickwire and Groff 2004; Lovejoy 2004	But for (Schumacher 1995; Zack 2001; Lucas 2002) As-built but-for (Pickavance 2005) As-built subtracting impacts (Bordoli and Baldwin 1998) As-built-minus analysis (Chehayeb *et al.* 1995) As-built less delay analysis (Zack 2001)
Window analysis	Galloway and Nielsen 1990; Bordoli and Baldwin 1998; Finke 1999; Lovejoy 2004; Pickavance 2005	Contemporaneous period analysis (Schumacher 1995; Lucas 2002; Zack 2001) Snapshot (Alkass *et al.* 1995, 1996) Periodic update analysis (Chehayeb *et al.* 1995) Watershed (Pickavance 2005)
Time impact analysis	Leary and Bramble 1988; Alkass *et al.*1996; Pickavance 2005	End of every delay analysis (Chehayeb *et al.* 1995) Chronological and cumulative approach (Wickwire and Groff 2004)

a) As-planned versus as-built (Total time) method

Basically, the main concept is that the as-planned versus as-built method compares two schedules, which is why it is also called "the total time method or net impact method". In this method the assumption is that one party (contractor) causes no delays and other party (owner) causes all delays. In this manner, the method displays the net impact of all claimed delays on project's finish date (Nguyen, 2007). Figure 2.7 illustrates the as-planned versus as-built method where the as-planned schedule takes 10 days and as-built schedule takes 15 days. The difference between the two is 5 days which is total amount of delays recoverable. In other words, the difference between the two is regarded as delay to which a contractor is entitled to an extension of time as a means of an excusable delay activity.

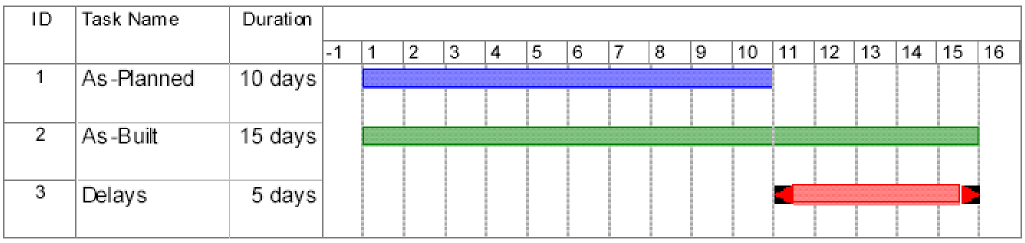

Figure 2.7: Diagram of As-Planned versus As-Built Method
(Source: Nguyen, 2007)

According to Ndekugri *et al.* (2008), the main advantage of this method is that it is inexpensive, simple and easy to use or understand, on the other hand its disadvantages are failure to consider changes in the critical path and incapability of managing complex construction delays.

b) Impacted as-planned (What-if) method

The other names of this method are "what-if" or "adjusted-baseline" method. According to Trauner *et al.* (2009), in this method the analyst specifies the as-planned schedule, and inserts into this schedule the changes which caused project delays. These changes are the only determined delays recorded during construction process which may have affected the project duration. The period between the completion date presented on the as-planned programme and the one on the impacted as-planned programme is regarded as delay to which a contractor is entitled to an extension of time as a means of an excusable delay activity.

Trauner *et al.* (2009) point out the major weaknesses of this method as follows: firstly the impacted schedule does not show the project activities as they occurred, secondly the decision of placing which changes or impacts into the schedule is greatly subjective, and finally, and also most significantly, it does not reflect the dynamic nature of construction project and the critical path. The authors also add that some analysts like this approach because of being simple and clean, however, this method is greatly inaccurate. According to the authors by using the first schedule, this method freezes the critical path at the beginning of the project, thus the real changes in the critical path will not be identified. Nonetheless, Nguyen (2007) claims that the *what-if* method is more reliable than the *total time* method since this method distinguishes between the types of delays.

c) Collapsed as-built (But-for) method

Another method of analysis is the *collapsed as-built* method, also called "the *subtractive as-built* or *but-for* method". In this method, the analyst studies all contemporaneous project documentation and prepares a detailed as-built schedule instead of an as-planned schedule as mentioned in the what-if method. The analyst subtracts or removes activities which affected the project from the as-built schedule (Trauner *et al.* 2009). The authors point out that if subtracting activities from the as-built schedule has an impact on the new schedule's end date, then the difference in time between the as-built and the collapsed as-built end dates is thought to be the delay caused by the subtracted or removed activities. In the study of Trauner *et al*. (2009) two different variations of this method are explained such as "*unit subtractive as-built* and *gross subtractive as-built*" methods.

Finally, according to the authors, this method has many serious problems and their three primary weaknesses are explained as follows:

1. "It requires the analyst to construct a CPM network diagram based on as-built information.
2. It is extremely subjective and highly amenable to manipulation.
3. With very little effort, the analyst can create an as-built schedule that supports a predisposed conclusion."

d) Window analysis (Contemporaneous period analysis) method

Window analysis method is also called the *contemporaneous period analysis* and *snapshot* method. In contrast to previous methods which analyze construction delays by taking into consideration the whole project, window analysis method analyzes delays within certain time periods individually (Nguyen, 2007). This technique is based on CPM scheduling. In this method, the basic concept is that the total project duration of CPM schedule is divided into digestible time periods or windows (e.g., monthly) and the delays that occurred in each windows of time are analyzed successively by focusing on the critical paths (Hegazy and Zhang, 2005). The authors indicate that the selection of boundaries of window sizes is specified with major project milestones, significant modifications in the critical path, occurrence of major delay events and dates for the issue of schedule revisions. These factors identify the number of windows and boundaries of these windows for the entire project.

The study of Kaoa and Yangb (2009) compares windows-based delay analysis methods to determine their advantages and limitations. The differences in terms of the perspectives of use prerequisite, functional capability, analytical process and accuracy of analysis results are reviewed in terms of a simulated case.

Windows-based delay analysis methods are grouped in the study of Kaoa and Yangb as follows:

1. Windows analysis
2. Modified windows analysis
3. Delay analysis method using delay section
4. Daily windows delay analysis

Figure 2.8 shows an example summary of the results in the window schedule analysis.

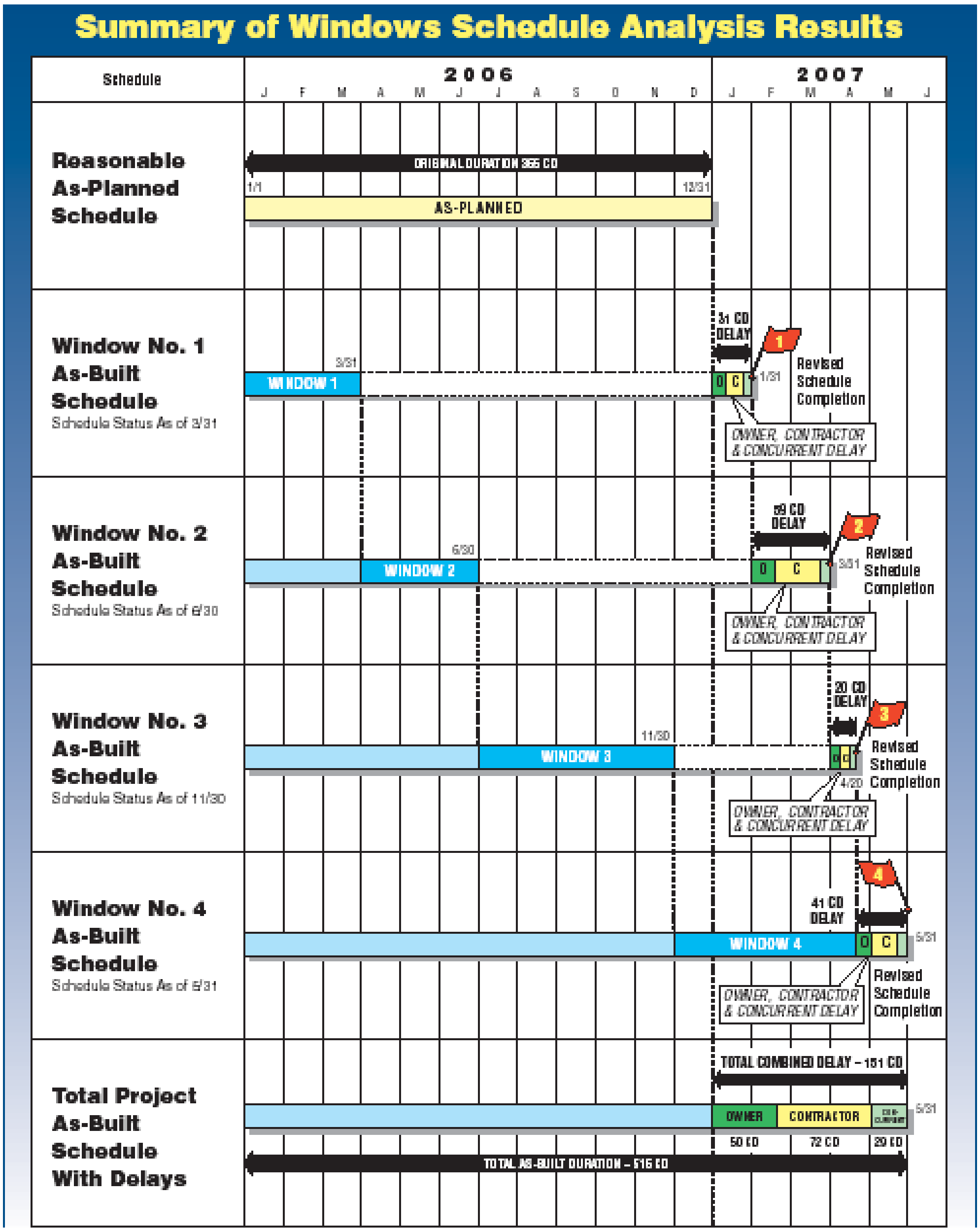

Figure 2.8: Summary of Windows Schedule Analysis Results
(Source: http://www.long-intl.com/brochures/WindowsSchedAnal.pdf, accessed 10/08/2010)

In the research of Hegazy and Zhang (2005, p506), the major drawbacks of traditional windows analysis are summarized below:

> "First drawback: While the as-built is the key to accurate delay analysis, it is widely recognized that it is manually done after the fact (after the project ends) and not as the events evolve, due to the difficulty in site-data recording. Accordingly, the as-

built schedule may be subjected to errors and omissions that hinder accurate delay analysis.

Second drawback: With the window span being in the form of weeks or months, the focus is on the critical path(s) that exists at the end of the window time. Thus, the technique does not consider the fluctuation that occurs in the critical path(s) as events evolve on site.

Third drawback: As a consequence of the above point, the technique loses sensitivity to the time at which the owner/contractor cause project delays within the window. Also, it loses sensitivity to the events of speeding or slowdowns within the window.

Fourth drawback: The delay representation of existing software systems makes the application and automation of the windows technique a difficult task."

On the other hand, the authors evaluate the above drawbacks as the desired objectives of their proposed method which is called "the daily windows delay analysis". According to the authors, the proposed method views the fluctuation day-by-day in critical path and so reaches correct and repeatable results to allocate project delays between the parties involved. The authors claim that this proposed method is a simple and practical alternative with its automated and computerized nature compared to a traditional window analysis which demands extensive effort. In another study of Hegazy and Menesi (2008), the authors proposed a different variation of delay analysis called "delay analysis under multiple baseline updates". This model which is based on a daily window size considers multiple baseline updates in order to accurately apportion delays and accelerations among project parties.

Opposite to Hegazy and Zhang (2005), Ndekugri, Braimah, and Gameson (2008) argue that the main strength of window analysis method is its capacity to take care of the dynamic nature of critical path scheduling. According to the authors, this method is used successively for each of the windows to specify the impacts of all other delays on project completion. Nguyen (2007) also claims that many researchers, experts, courts as well as boards generally approve window analysis method as the most suitable choice.

e) Time impact analysis (Modified as-built) method

Nguyen (2007) indicates that the time impact analysis method (TIA) is one of the most reliable techniques presently. Alkass, Mazerolle, and Harris (1996) state that this method is a variation of the window analysis technique, also in this method, the analyst focuses on a specific delay or delay activity, whereas in the window analysis the analyst focuses on time periods (also known as window or snapshot).

This method analyzes the impacts of delays chronologically, starting with the first delay, by incorporating each delay (sometimes using a fragnet- or subnet-works) into an updated CPM schedule. The analyst determines the amount of project delay resulted from each of the delaying activity successively by calculating the difference between the project completion date of the schedule after the addition of each delay and that prior to the addition (Ndekugri, Braimah, and Gameson, 2008).

Alkass *et al.* (1996) note that this method is incapable of analyzing potential concurrent delays. The effect of concurrent delays is not immediately dealt with in this method since delaying events are analyzed separately. According to Ndekugri, Braimah, and Gameson (2008), another drawback of the method is that it is time consuming and costly to operate, especially in situations with many delaying activities.

Despite some of the above mentioned drawbacks, the Society of Construction Law (2002) recommends this method. Time Impact Analysis is the most appropriate method for specifying the amount of time extension that the contractor should have been given at the time that an excusable risk appeared.

However, in order to apply this method successfully, the daily records and diaries should be noted very meticulously and accurately. Otherwise, the analysis will not give correct results.

2.4.4 Other Techniques of Schedule Delay Analysis

The study of Nguyen, *et al.* (2008) presented a new schedule delay analysis technique named as "FLORA which could control the dynamics of float, logic, and resource allocation in the analyses". The authors further indicate that this method examines both the direct impact of delay and also its secondary effect. On the other hand, Alkass *et al.* (1996) conducted a study to discuss different delay analysis techniques which are currently being used in the construction industry. The authors also presented a new delay analysis method called the Isolated Delay Type (IDT). According to the authors, this new technique can be used as a standalone module for delay analysis or can be integrated within a computer system for delay analysis and construction claims preparation called "Computerized Delay Claims Analysis (CDCA)". In another field observation, Kim, Y., Kim, K., and Shin, (2005) made a study of delay analysis methods and introduced a new method called the "delay analysis method using delay section" (DAMUDS) in order to eliminate inadequate accounting of concurrent delay and time-shortened activities.

In the research of Oliveros, and Fayek (2005), the fuzzy logic model which combines daily site reporting of activity progress and delays with a schedule updating and forecasting system for project monitoring and control is introduced. Another research of Lee, Ryu, Yu, and Kim (2005) proposed a method for analyzing construction schedule delay in terms of lost productivity. They emphasize the necessity of a logical method for analyzing delays occurred by lost productivity in order to measure the delay time correctly. In the study of Shi, Cheung, and Arditi (2001), a different method which is not established on critical path analyses is proposed for computing activity delays. The authors define this technique as "Construction Delay Computation Method" and add that this method may be combined with any delay analysis system in order to advance the process of delay analysis.

Kartam (1999) has presented a generic methodology for analyzing and resolving delay claims which has been developed and successfully used by the author. The developed methodology has brought into question of while several techniques for analyzing delay claims there are, how much adequate these techniques.

In conclusion, there are many schedule analysis techniques: some of them are really simple to understand and apply, while some are perhaps more difficult and more complicated to analyze delay activities. Some of them are old, while some of them are quite recent. Even so, each of the technique has its own advantages and disadvantages. In analyzing the delay activities of the schedule, the analysis method should be selected according to the appropriateness of the technique. However, determinants in selection of the technique depend on the availability of possible as-built information such as: project daily reports and diaries, meeting minutes, pay requests/estimates, inspection reports by the designer or owner, official correspondences, memos in the files, construction photographs taken at the site, and etc. The skill level of the analyst, relevant contract clauses, the nature of the schedule delays and the available time are the other determinants for choosing a delay analysis method.

2.4.5 Main Principles for Analyzing Schedule Delays

According to Trauner *et al.* (2009), some important principles should be adopted in order to analyze schedule delays. A simple example will be examined to understand the basic principles and to measure the completion duration of the project. To start the analysis, the original as-planned schedule of the construction project should be available (Table 2.5). Then, an as-built schedule to determine the changes on the project will be created (Table 2.6).

Table 2.5: As-Planned Schedule (Source: Trauner *et al.* 2009)

No	Name of the Activity	Duration (each column is 10 days)	0--10	10-20	20-30	30-40	40-50	50-60
1	Activity A	10 days						
2	Activity B	10 days						
3	Activity C	10 days						
4	Activity D	5 days						

Table 2.6: As-Built Schedule (Source: Trauner *et al.* 2009)

No	Name of the Activity	Duration (each column is 10 days)	0--10	10-20	20-30	30-40	40-50	50-60
1	Activity A	**20 days**						
2	Activity B	10 days						
3	Activity C	10 days						
4	Activity D	5 days						

While analyzing delays, chronological order should be followed from the beginning of the project. Each delay should be identified and the schedule should be updated accordingly. In this example, firstly Activity A will be analyzed and the delay will be identified. As-planned schedule will be compared with As-built for the Activity A in Table 2.7. It is seen that Activity A started on time but was delayed for 10 days. So, it is concluded that the duration of Activity A is extended from 10 days to 20 days and new duration became 20 days.

Table 2.7: 10 Day Extended Duration of Activity A (Source: Trauner *et al.* 2009)

No	**Name of the Activity**	**Duration (each column is 10 days)**	**0--10**	**10-20**	**20-30**	**30-40**	**40-50**	**50-60**
1	Activity A	10 days			10 day Extended Duration			
1	Activity A	**20 days**						
2	Activity B	10 days						
2	Activity B	10 days						
3	Activity C	10 days						
3	Activity C	10 days						
4	Activity D	5 days						
4	Activity D	5 days						

Next, it is required to update our schedule in order to see the effect of Activity A to the remaining construction activities. The planned start of Activity B is moved later because it depends on the finish of Activity A. Now, the as-planned schedule for the actual performance of Activity A is updated. Activity B should be analyzed to see the effects on completion of the project. It is seen in Table 2.8 that Activity B started 5 days later than it should have because of a late start.

Table 2.8: 5 Day Late Start of Activity B (Source: Trauner *et al.* 2009)

No	**Name of the Activity**	**Duration (each column is 10 days)**	**0--10**	**10-20**	**20-30**	**30-40**	**40-50**	**50-60**
1	Activity A	10 days						
1	Activity A	**20 days**						
2	Activity B	10 days						
2	Activity B	10 days	5day Late Start					
3	Activity C	10 days						
3	Activity C	10 days						
4	Activity D	5 days						
4	Activity D	5 days						

For each activity, this process should be repeated and the schedule should be updated. Again, the planned start of Activity C is moved later since it depends on the finish of Activity B. Now, Activity C of the as-built schedule will be analyzed based on the two previous activities. As seen in Table 2.9, Activity C is delayed for 10 days due to some interruptions. It is understood that in two periods, the work was not performed on Activity C. So, the activity finished 10 days later.

Table 2.9: 10 Day Delay Due to Interruptions to Activity C
(Source: Trauner *et al.* 2009)

No	**Name of the Activity**	**Duration (each column is 10 days)**	**0--10**	**10-20**	**20-30**	**30-40**	**40-50**	**50-60**
1	Activity A	10 days						
1	Activity A	**20 days**						
2	Activity B	10 days						
2	Activity B	10 days						
							10 Day Delay	
3	Activity C	10 days						
3	Activity C	10 days						
4	Activity D	5 days						
4	Activity D	5 days						

Finally, the remaining activities and their impacts on the duration of the project will be examined. In Table 2.10, it is commented that the last activity caused no delay to the project. Therefore, there is no difference in the as-planned and as-built schedules of the activity D.

Table 2.10: No Delay to Activity D (Source: Trauner *et al.* 2009)

No	Name of the Activity	Duration (each column is 10 days)	0--10	10-20	20-30	30-40	40-50	50-60
1	Activity A	10 days						
1	Activity A	**20 days**						
2	Activity B	10 days						
2	Activity B	10 days						
3	Activity C	10 days						
3	Activity C	10 days						
4	Activity D	5 days	Activity D has no delay					
4	Activity D	5 days						

Consequently, in the comparison of As-Planned Schedule and As-Built Schedule as in Table 2.11, total duration is extended from day 35 to day 60. There has been occurred 25 day delay. All delays are summarized in Table 2.12. This kind of approach that is comparison of as-planned schedule to as-built schedule should be the basis in most of the analysis methods. The as-built information is very useful for the analyst in determining delays and their impacts.

Table 2.11: As-Planned vs As-Built Schedule (Source: Trauner *et al.* 2009)

No	Name of the Activity	Duration (each column is 10 days)	0--10	10-20	20-30	30-40	40-50	50-60
1	Activity A	10 days						
1	Activity A	**20 days**						
2	Activity B	10 days						
2	Activity B	10 days						
3	Activity C	10 days						
3	Activity C	10 days						
							25 day delay	
4	Activity D	5 days						
4	Activity D	5 days						

Table 2.12: Summary of Delays (Source: Trauner *et al.* 2009)

No	Name of the Activity	Duration (each column is 10 days)	0--10	10-20	20-30	30-40	40-50	50-60
1	Activity A	10 days			10 Day Extended Duration			
1	Activity A	**20 days**						
2	Activity B	10 days						
2	Activity B	10 days	5day Late Start					
							10 Day Delay	
3	Activity C	10 days						
3	Activity C	10 days						
4	Activity D	5 days		Activity D has no delay				
4	Activity D	5 days						

2.4.6 Float and Criticality in Project Schedules

Trauner *et al.* (2009) points out that the term "float" appeared when the Critical Path Method was introduced. The authors describe float as "the amount of time an activity can be delayed before it begins to delay the project". If the available float of an activity is used up, then the activity will be critical that means any other delay on the activity may extend the project duration. Callahan *et al.* (1992) note that float is measured by detracting the early finish time from the late finish time or detracting the early start time from the late start time. The early start and finish times mean the earliest time that an activity can start or finish depending on the activity durations in the project schedule and logical relationships between the activities. According to the authors, the float is a measure of schedule flexibility and an indicator of the ability of a given activity to have its performance time extended without affecting the project duration.

Float and criticality of an activity have an important relationship in the Critical Path Method. When float of the activity equals to zero, the activity is on the critical path; and activities which are on the critical path are called critical activities. Any kind of project has at least one critical path in its schedule. The concept that while some activities are critical (their total float is zero) some other activities have float is very useful in appropriately analyzing the impacts of delaying events as a management tool in project schedules.

2.4.7 Selection of Delay Analysis Methodology

The analysis method should be selected according to the appropriateness of the technique. Determinants in selection of the delay analysis technique depend on the available data on the as-built project such as: daily reports and diaries, minutes of the meetings, requests for payments, inspection reports by the designer or owner, official correspondence between the parties, office memos on record, photographs taken at the site, the level of skill of the analyst, relevant contract clauses, the nature of the schedule delays, *etc*, as stated in the previous paragraph.

The analysis methods can be classified in many different categories, but classification of methods according to working process is more useful in selection of the methodology. Impacted As-planned (IAP) and Time Impact Analysis (TIA) methods which are based on adding impacts into the as-planned schedules are used both in forward looking and retrospective analysis applications. On the other hand, Collapsed as-built method based on subtracting impacts from the as-built schedules can be used only in retrospective analysis applications. Again, in the windows analysis method as-built schedule is needed, and the as-built schedule may be applied to errors and omissions that obstruct accurate delay analysis. Also, the method of As-planned versus as-built which is based on comparison of an as-planned and as-built schedule analytically is used only in retrospective analysis applications. Therefore, TIA and IAP methods remain since forward looking analysis application will be conducted in this study.

In this stage, the decision of selecting TIA or IAP method will be determined. TIA method is more reliable and more acceptable than IAP method. As it is understood from the research of Arditi and Pattanakitchamroon (2008), TIA method is most preferred presently because it has become easier due to developed computer technologies; however IAP analysis method has not become popular currently because this method is not accepted in courts as reliable any more. The Society of Construction Law Delay and Disruption Protocol recommend TIA method at the same time. Therefore, TIA seems to be one of the best techniques for applying in this study.

CHAPTER 3

MATERIAL AND METHODOLOGY

The material and the research methodology of the study are presented in this chapter. The survey material includes the case study of completion construction works of a covered swimming pool building in Ankara. This part gives general information about the project. The methodology part presents the evaluation processes of the material.

3.1 Material

This study was conducted for analyzing construction schedule delays in order to recommend steps to eliminate or minimize their negative effects on construction completion duration and to apportion responsibility of delays amongst all project participants. A delay analysis was carried out on an under-construction project of a covered swimming pool building in Ankara, which had suffered many delays during its construction. Information on the case study project is presented in more detail in the following paragraphs.

This work consisted of the completion of unfinished construction works that had been abandoned by the previous contractor. The reason for choosing this project was that all the related data and materials like *as-planned schedule* of the project, project reports and diaries, official correspondences, project change orders, time extension requests, the construction contract and all other related bid documents could be easily obtained from the related construction and consulting companies. Also, this project suffered many delays caused by the owner and the contractor, as well as by the project architects and the project consultant. Consequently, the as-planned schedule of the project was revised many times. Details on the identity of the project participants and the project are not given in this thesis for ethical reasons.

In the context of this project, a FIDIC based contract was signed between the contractor and the owner. The owner had assigned a consulting company to oversee the project and deal with the contractor. The scope of work consisted of the completion of the unfinished covered swimming pool building as per the activities determined in the as-planned schedule, in compliance with the technical specifications of the contract. This as-planned schedule was attached to the FIDIC based contract. The working diagram of the case study project is presented in Figure 3.1.

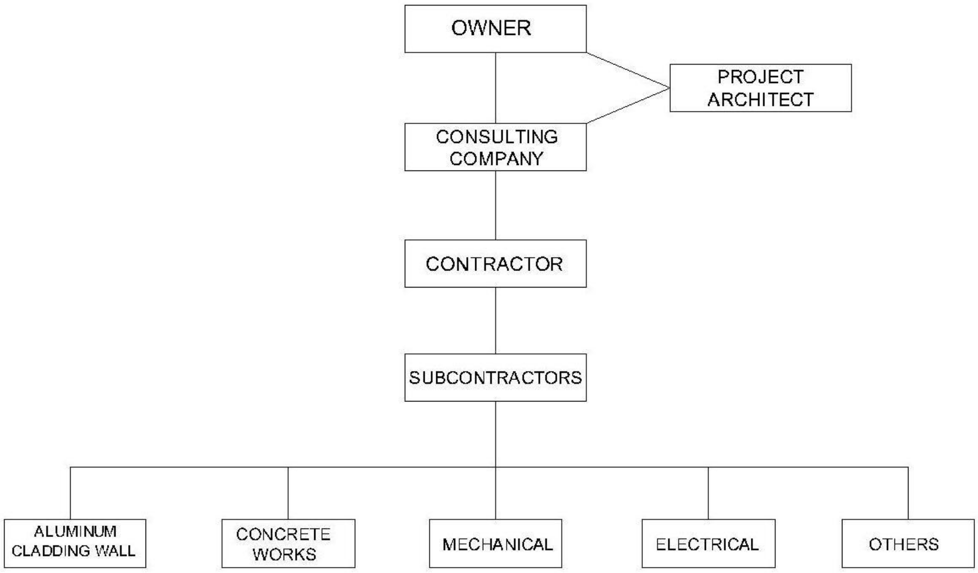

Figure 3.1: Working Diagram of the Case Study Project

The completion of construction works of the case study project consisted of two main stages: construction of the building’s structure and the finishing works. The original as-planned schedule was prepared according to this division of work items. According to this schedule, the construction works were to be carried out in 4 months from 9 October 2009 to 16 February 2010; and the finishing works were to be carried out in 8 months from 16 February 2010 to 16 October 2010. However, some disputes, delays and failures occurred which prevented adherence to the as-planned schedule.

3.2. Methodology

The Time Impact Analysis method (TIA) was selected to analyze the construction delays in the work-schedule of the case-study construction project in order to determine the delays and apportion the responsibility of such delays amongst all parties. The aim was to identify construction delays, to quantify their net impacts on the project completion date and to allocate responsibility to all parties. Accurate allocation of liability is very important in schedule delay analyses in order to prevent delay claims amongst project parties. From the literature survey it was seen that the TIA would be the most appropriate technique to be used in this study. Therefore, for the successful application of this method, the daily records and diaries had been noted meticulously during the construction process.

This study was conducted in three stages; which are explained in detail in the following sections.

- Collection of Information and Data;
- Determination of Causes, Types and Liability of Delays; and
- Conducting the Schedule Delay Analysis with TIA.

3.2.1 Collection of Information and Data

First of all, the construction site and the related companies were visited. Next, information on the specific problems and the delayed events of the covered swimming pool building were gathered through informal interviews carried out with the site supervisor; the project manager; the controller of the payments and bills; as well as the architects of the construction and consulting companies.

Secondly, the related data such as official correspondence between the contractor and the consultant, time extension requests of the contractor, project change orders of the owner during the construction period, old photographs of the construction works and as-planned schedule of the case study project were collected from the related department of the construction and consulting companies and analyzed carefully in order to have comprehensive knowledge about the construction process of the project. These data were compiled in tabulated form.

Finally, in order to understand time extension conditions and to identify types of construction schedule delays, the related clauses in the contract were studied to see if there were any special clauses in addition to the FIDIC clauses.

3.2.2 Determination of Causes, Types and Liability of Delays

The application of the selected method started with the research and identification of delays. The accuracy of the schedule delay analysis depends on determining project delays and causes of such delays clearly. The causes of delays were determined by analyzing the official correspondence between consultant and contractor, time extension requests of the contractor, payment bills and project change orders by the owner during the construction period. These causes were studied to understand which party was responsible for their occurrences. The causes of delays and the liable parties for such delays were compiled in a table form. Finally, the delay types according to their compensability were determined and presented alongside.

In this case study project, there were a total of 13 instances of delayed events including both critical and non-critical delays. 5 of them occurred in critical activities while 8 of these delays occurred in noncritical activities. In the context of this case study selection of delays was done according to the critical path method of the project as presented in Figure 3.2 and, therefore, in the delay analysis delays in non-critical activities were not included.

The delays in critical activities which were included in the Time Impact Analysis method are as follows:

1. Late start of handing over of construction site
2. Getting work permits late from municipality
3. Problems in concreting the ground floor
4. Unforeseeable weather conditions in concreting activities
5. Problems in masonry works

The delays in non-critical activities which were not included in the Time Impact Analysis method are as follows:

6. Delays in choice of material and, consequently, the subcontractor for the fenestration,
7. Delays in choice of material and, consequently, the subcontractor for paving tiles of the pool area,
8. Delays in the approval for gas connection by the gas company,
9. Uneven settling of floor area in one of the rooms, which had to be re-concreted,
10. Access route to the site had to be changed,
11. Extra work load in steel roof, (Incomplete works like welding, painting,

assembly and also repair work such as cleaning rusted steel surfaces. Also testing for integrity of the welded-joints of steel sections in the roof had to be repeated, resulting in delay in steel works.)

12. Delays in the approval of aluminum cladding wall subcontractor because of slow decision-making mechanism of the consulting company,
13. Change in system details of generator room according to field orders by the owner.

The reason these delays were not included in the analysis was because they did not extend the total construction period. For instance, the choice of material and the related subcontractor for the fenestration and for paving tiles of the pool area which delayed their installation did not cause delays in any other activities. In the same way problems in the steel roof, delays in approval of aluminum cladding wall subcontractor or change in system details of generator room caused some delays in the completion of these activities however the project duration did not change.

COVERED SWIMMING POOL PROJECT

Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
COVERED SWIMMING POOL PROJECT		370	09-Oct-09	16-Oct-10	0
ENVIRONMENTAL LANDSCAPE WORKS		0			0
WORKS AFTER CONSTRUCTION		49	29-Aug-10	16-Oct-10	0
A2010	Testing of electrical system	30	29-Aug-10	27-Sep-10	0
A2020	Provisional Acceptance	7	18-Sep-10	24-Sep-10	0
A2030	Finishing of incomplete works	21	25-Sep-10	15-Oct-10	0
A2040	End of the project	1	16-Oct-10	16-Oct-10	0
WORKS BEFORE CONSTRUCTION		45	09-Oct-09	22-Nov-09	0
A1000	Signing contract	1	09-Oct-09	09-Oct-09	0
A1010	Handing over of construction site	1	10-Oct-09	10-Oct-09	0
A1020	Mobilization work	21	01-Nov-09	21-Nov-09	0
A1040	Getting work permits (municipality)	21	11-Oct-09	31-Oct-09	0
A1050	Getting consultant permits to work in construction site	1	22-Nov-09	22-Nov-09	0
ELECTRICAL WORKS		11	19-Aug-10	29-Aug-10	0
Context of Finishing works		11	19-Aug-10	29-Aug-10	0
A1700	Installation of lighting armatures and switches	11	19-Aug-10	29-Aug-10	0
Context of Construction works		0			0
MECHANICAL WORKS		0			0
Context of Finishing works		0			0
Context of Construction works		0			0
ARCHITECTURAL FINISHING WORKS		182	17-Feb-10	18-Aug-10	0
Basement Floor Finishing Works		35	17-Feb-10	23-Mar-10	0
A1210	Block masonry works	35	17-Feb-10	23-Mar-10	0
Ground Floor Finishing Works		35	24-Mar-10	27-Apr-10	0
A1340	Block masonry works	35	24-Mar-10	27-Apr-10	0
First Floor Finishing Works		112	28-Apr-10	18-Aug-10	0
A1370	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	28	16-Jun-10	14-Jul-10	0
A1380	Screed with mesh reinforcement	15	12-May-10	26-May-10	0
A1420	Ceiling and suspended ceiling works	35	15-Jul-10	18-Aug-10	0
A1440	Block masonry works	14	28-Apr-10	11-May-10	0
A1450	Flooring (Ceramic coating, parquet, etc.)	35	27-May-10	30-Jun-10	0
Other Finishing Works		0			0
CONSTRUCTION WORKS		84	23-Nov-09	16-Feb-10	0
Pouring Concrete		84	23-Nov-09	16-Feb-10	0
A1060	Basement Floor (Insulation, lean concrete and reinforced concrete wo	28	23-Nov-09	20-Dec-09	0
A1070	Ground Floor	56	05-Dec-09	31-Jan-10	0
A1080	First Floor	37	20-Dec-09	27-Jan-10	0
A1150	Cladding concrete	20	28-Jan-10	16-Feb-10	0
Steel Works		0			0
Infrastructure Works		0			0

Figure 3.2: Critical Path Method of the Case Study Project

3.2.3 Conducting the Schedule Delay Analysis with TIA

As stated before, the Time Impact Analysis (TIA) method was selected for the application of schedule delay analysis on the case study. The as-planned schedule, which had been added to the contract documents, was obtained in order to start the delay analysis. After identification of construction delays and allocation of liabilities to parties, the delay analysis method was applied. In this study PRIMAVERA® software was used since the as-planned schedule of the project was originally prepared in this computer programme. Although the costs, resources and durations of the activities were calculated in the as-planned schedule of the project, in the context of this research only durations were analyzed.

The as-planned schedule of the case study project is given in Appendix B. Original completion duration of the project was determined in the as-planned schedule as 370 days. In this step of the methodology, the impacts of the delays on the critical activities were seen in terms of project completion duration. Accordingly, the delayed events were entered into the as-planned schedule chronologically to ascertain the changes and delays in the progress of the construction. The delayed events in the critical activities were selected to be analyzed in TIA method since these delays extended the project duration. The selected delayed activities were also marked on the Critical Path Method of the project in Figure 3.2.

The first delayed activity which was late handing over of construction site was entered into the as-planned schedule and a "1st Revised Schedule" was prepared and the new completion duration of the project was determined as 386 days. This "1st Revised Schedule" was taken as the baseline for the next delayed activity of getting work permits late from municipality and this delayed activity was entered to make the "2nd Revised Schedule". Thus "2nd Revised Schedule" was formed and new project completion duration was obtained as 392. These revisions and calculations were repeated for the remaining 3 delayed events, consequently new revised schedules and new project completion durations were obtained. After adding the last delayed event, the final revised schedule was generated in the end.

CHAPTER 4

RESULTS AND DISCUSSION

Impacts of construction schedule delays on the duration of the case study project were analyzed by the help of Time Impact Analysis method. The results of application of the selected method and the discussions are given in this section under respective headings, presented with figures and tables.

4.1 Determination of Delays

In application of the TIA method, the accuracy of records which were used in the delay analysis was very important. To provide reliability of schedule delay analysis, inaccurate and unreliable records should not be used during the analysis process. Project changes, changing site conditions, official correspondences between project participants, time extension requests of the contractor were approved under the control of parties. Therefore, these records did not require any reliability control.

In this study, only approved records were collected and analyzed, as well interviews with the project parties were conducted at the construction site. After these steps, it was noticed that there had been many problems during the whole construction process inevitably resulting in delays in the as-planned schedule. The results of this delay analysis are presented in the following sections.

1) Handing over of construction site

In this project, handing over of construction site (A1010) was a critical activity which affected subsequent activities in the schedule because of its total float being zero. According to the as-planned schedule A1010 activity should have been finished on 10 October, however the owner had some problems at that time because of organizational deficiencies. And this activity was finished on 26 October. Unless the handing over of construction site was finished, the following activities could not be started. There occurred 16-days delay in the as-planned schedule caused by the owner.

2) Work Permits from Municipality

In this project, getting work permits from municipality (A1040) was again a critical activity which affected subsequent activities in the schedule because of its total float being zero. The work permits should have been taken until 16 November in regard to the revised 1st schedule; however the activity could not be finished until 8 December. Although the contractor performed his own tasks on time, there occurred delay caused by project architects as well as the provincial municipality.

During the application process for getting work permits, project architect presented related drawings to the municipality very late. On the other hand, the main responsibility lay with the provincial municipality in this delayed event, since the municipality misinformed the project architect about necessary documents at the beginning of the application. Therefore, this delayed event was a result of external factors.

3) Problems in Concreting the Ground Floor

Activity of concreting the ground floor (A1070) was again on the critical path as seen in Figure 3.2. Because of the delays on the previous activities, this activity was moved later as the all other activities had been postponed. This activity should have been finished on 23 February according to the revised 2nd schedule; however this activity was finished on 4 March. Some technical disputes and material procurement delays caused by the contractor occurred in this activity. Problems in organizing concrete subcontractors and concrete plant and delays in material procurement were main causes of these delays.

4) Unforeseeable Weather Conditions

Unforeseeable weather conditions delayed formwork removal in the concreting activities (A1080) in the first floor. Because the weather was unusually cold rather than expected, the consulting company wanted to keep concrete in the formwork for longer period of time. This activity should have been finished on 28 February according to the revised 3rd schedule; however this activity was finished on 4 March. Since this activity was critical, the project completion duration extended. Unforeseeable weather conditions were the main causes of this delayed event and regarded as external factors.

5) Problems in Masonry

There were some problems in the activity of block masonry works (A1440). For these activities, architectural, mechanical and electrical drawings were not superposed appropriately. Because of the defective work of the mechanical and electrical subcontractors in terms of superposing system drawings, there occurred some delays in the block masonry works. This activity should have been finished on 16 June according to the revised 4th schedule; however this activity was finished on 7 July. This delay was caused by the subcontractors, but the contractor is the responsible party for all failures and delays caused by subcontractors.

Consequently, the delays were researched from related records conscientiously and causes of delays were identified. According to obtained information, the result of this research is presented in Table 4.1 as a summary of delay identification.

Table 4.1: Summary of Delay Identification

No	Delay Description	Impacted Activity Name	Impacted Activity Code (IAC)
1	Late start of handing over of construction site	Handing Over of Construction Site	A1010
2	Getting work permits late from municipality	Getting Work Permits	A1040
3	Problems in concreting the ground floor	Concreting the Ground Floor	A1070
4	Unforeseeable weather conditions	Concreting the First Floor	A1080
5	Problems in masonry works	Block Masonry Works	A1440

4.2 Allocation of Liability to Parties and Determining Types of Delays

From related records, the causes of delays were researched and determined in the first step. These are also listed in the second column of Table 4.2 below. Then, types of delay factors were determined and given in the fourth column of the below table. Next, liabilities for delays were allocated between project participants and this can be seen in the fifth column with their ID Code given in the sixth column of the below Table. After allocation of liabilities to parties, types of delays according to their compensability were determined and the results are presented in the seventh column of the Table 4.2.

Table 4.2: Summary of Allocation of Liability to Parties and Delay Types

No	Causes of Delay	IAC	Type of Delay Factors	Liable Party	Delay ID Code	Types of Delay
1	Late start of handing over of construction site	A1010	Delay (Access to site)	Owner Related	OR1	Excusable Compensable
2	Getting work permits late from municipality	A1040	3 rd Party Actions (Local Permits)	External Factor (Provincial Municipality, Project Architect)	EF1	Excusable Compensable
3	Problems in concreting the ground floor	A1070	Delay (Procurement) Technical Disputes	Contractor Related	CR1	Non-excusable
4	Unforeseeable weather conditions	A1080	Unanticipated Events	External Factor (Force Majeure)	EF2	Excusable Non-compensable
5	Problems in masonry works	A1440	Failure (Subcontractor default, defective work)	Contractor Related	CR2	Non-excusable

IAC: Impacted Activity Code
OR: Owner Related
EF: External Factor
CR: Contractor Related

Types of delays according to their compensability are presented in Table 4.2. A matrix showing the compensability of construction delays was formed and is presented below in Table 4.3. In this matrix, the distribution of the construction delays according to the degree of compensability can be seen.

Table 4.3: Matrix of Construction Delays According to the Compensability

	Compensable	**Non-compensable**
Excusable	OR1 EF1	EF2
Non-excusable	Not applicable	CR1 CR2

4.3 Schedule Delay Analysis with TIA

As explained in section 3.2.3, the delayed activities were entered one by one and the schedule was updated to determine the project finish date. The results of the revisions of the schedules are presented in Table 4.4. The As-planned Schedule and other Revised Schedules are given in Appendix B.

In the schedule delay analysis of the case study it was seen that the project duration was changed when the activities on the critical path were delayed. Therefore, delays which affect the project completion are called critical delays and delays which do not affect the project completion are considered as non-critical delays, as noted in the literature review. For instance, the late start of handing over of construction site by owner and problems in concreting the ground floor caused by contractor extended the project duration because these delayed events were on the critical path or in other words these activities (A1010, A1070) had zero float as seen in the critical path method of the project (Figure 3.2).

Table 4.4: Results of Primavera Software Application

No	Schedule Name	Causes of Delay	Delay ID Code	IAC (Critical Activities)	Date of Revision	Project Finish Date	Completion Duration	Project Delay
1	As-planned	-----	-----	----	-----	16.10.2010	370	----
2	Revised Schedule 1	Late start of handing over of construction site	OR1	A1010	27.10.2009	01.11.2010	386	16 day
3	Revised Schedule 2	Getting work permits late from municipality	EF1	A1040	10.12.2009	07.11.2010	392	6 day
4	Revised Schedule 3	Problems in concreting the ground floor	CR1	A1070	08.01.2010	17.11.2010	402	10 day
5	Revised Schedule 4	Unforeseeable weather conditions	EF2	A1080	16.02.2010	21.11.2010	406	4 day
6	Revised Schedule 5	Problems in masonry works	CR2	A1440	01.05.2010	12.12.2010	427	21 day

IAC: Impacted Activity Code
OR: Owner Related
EF: External Factor
CR: Contractor Related

While the project duration was extended because of construction schedule delays in the critical activities, inevitably cost and resources of the project were impacted from these delayed events. However, these impacted issues were not evaluated in this delay analysis.

4.4 Concluding Remarks

Results of allocation of project delays among the parties are presented in Table 4.5. As it can be seen from this table, the owner caused delays extended the project by 16 day; while contractor caused delays were 31 day in totality. Also, there had been 10 day delays caused by external factors such as unforeseeable weather conditions, provincial municipality and project architects.

Table 4.5: Allocation of Project Delays to Parties

No	Liable Party	Delay ID Code	Amount of Delay
1	Owner	OR1	16
		Subtotal	16 day
2	Contractor	CR1 CR2	10 21
		Subtotal	31 day
3	External Factor	EF1 EF2	6 4
		Subtotal	10 day
		Total Delay	57 day

Consequently, the project finish date was postponed from 16 October 2010 to 12 December 2010; i.e. the project was delayed by 57 days due to these five construction delays. This means that the project duration was extended by 15.4 % or in other words more than 1/6 of the estimated construction period.

These delays can further be categorized as 22-days excusable compensable delays, 31-days non-excusable delays and 4-days excusable non-compensable delays; which can be seen in Table 4.6.

Table 4.6: Summary of Project Delays According to Compensability

No	Type of Delay	Delay ID Code	Amount of Delay
1	Excusable Compensable	OR1	16
		EF1	6
		Subtotal	22 day
2	Excusable Non-compensable	EF2	4
		Subtotal	4 day
3	Non-excusable	CR1	10
		CR2	21
		Subtotal	31 day
		Total Delay	57 day

Consequently, fines should have been paid by the contractor according to the related clauses of the contract because of 31-days non-excusable delays. On the other hand, the contractor should have been given a time extension of 26-days due to 22-days excusable compensable delays and 4-days excusable non-compensable delays which were beyond the control of the contractor.

The delayed events of this case study which extended the project duration were caused due to organizational deficiencies of the owner, the bureaucracy of the provincial municipality, the lack of detail drawings during the municipality application, the lack of experience of the contractor, problems in material procurement, unforeseeable weather conditions and shortages of qualified employees of the subcontractors. It was observed that of these all except one correspond to the important causes of delays as reported by Arditi *et al.* (1985) in public projects of Turkish construction industry (see Chapter 2 of this thesis).

CHAPTER 5

CONCLUSION

Construction schedule delays in a project can cause major problems for contractors and owners, resulting in costly disputes, controversial issues and adverse relationships between all the project participants. As Arditi *et al.* (1985) point out, the most important causes of delays in public projects of Turkey are shortage of resources, financial difficulties and organizational deficiencies of public agencies and contracting companies, delays in design work, large quantities of extra work and frequent change orders.

In the case of the project analyzed in this study, the causes of the delayed events can be listed as follows:

1. Organizational deficiencies of the owner in handing over of construction site,
2. The bureaucracy of the provincial municipality, the lack of detail drawings during the municipality application,
3. The lack of experience of the contractor in organizing concrete subcontractors, problems in material procurement,
4. Unforeseeable weather conditions,
5. Shortages of qualified employees of the subcontractors,
6. Delays in choice of material and the subcontractor for the fenestration,
7. Delays in choice of material and the subcontractor for paving tiles of the pool area,
8. Delays in the approval for gas connection by the gas company,

9. Uneven settling of floor area in one of the rooms, which had to be re-concreted,
10. Change in access route to the site,
11. Extra work load in steel roof,
12. Delays in the approval of aluminum cladding wall subcontractor,
13. Change in system details of generator room.

These were 13 delays caused due to both critical and non-critical activities. Of these all except one correspond to the causes of delays mentioned by Arditi *et al.* (1985) in the previous sections. The fourth one was due to force majeure and therefore beyond the control of all parties.

According to the TIA schedule delay analysis the delays due to the critical activities extended the project duration by 57 days in totality i.e. by 15.4 % of the estimated construction period. On the other hand, the delays due to the noncritical activities did not impact the total duration.

The reason for selecting the Time Impact Analysis (TIA) method was that it can display the progress of construction works step by step with the help of PRIMAVERA® software. The main advantage of this method is that the situation of construction on the updated dates could be pictured clearly. It is important for the delay analysis to be able to reflect the actual process of the construction in order to reach an accurate analysis of construction schedule delays. The delayed events are entered into the as-planned schedule respectively to see the changes on the project. Therefore, this analysis method is the most realistic. On the other hand, the most important constraint of TIA method is that the available records, related data and as-planned schedule should be accurate in order to obtain accurate and clear results; otherwise, the analysis will be incorrect. Another drawback of the method is that the analysis of concurrent delays is difficult in terms of understanding the net portion of the liability. Despite these drawbacks, this selected method is the most reliable as recommended by many researchers and the best technique for determining amount of time extension caused by construction schedule delays.

Based on this study, some general recommendations are presented here, which could also have been useful in minimizing or avoiding the impacts of the construction delays in the project analyzed.

- The design of the project should be finalized with all details before tendering the work so as to avoid change orders by the owners.
- Owner should allocate sufficient time and adequate finances for the design stage of the project.
- The selection of the contractor should be done through a pre-qualification of the firms.
- The owners should mobilize all resources and get the necessary permissions before signing the contract.
- The contract should include clauses of incentive for early completion.
- The schedule should be prepared and agreed over by both the contractors and the consulting companies.
- The contractor should employ qualified work teams and provide in-house worker training in order to improve managerial and technical skills.
- The contractor should also have a project manager in his team to check the progress of work and ensure timely delivery of materials.
- The last but most important issue is to establish a healthy communication between all parties in order to solve problems in a timely manner.

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APPENDIX A

TABLE A 1: LIST OF CAUSES OF DELAY FROM LITERATURE

(Source: Abd El-Razek, Bassioni, Mobarak, 2008)

Group	**Delay causes from literature**	**Interviews outcome**	**Delay causes resulting from interviews**
Financing	Financing by contractor during construction	Selected	Financing by contractor during construction
	Delays in contractor's progress payment by owner	Selected	Delays in contractor's payment by owner
	Partial payments during construction	Selected	Partial payments during construction
Manpower	Shortage of labor	Selected	Shortage of labor
	Labor skill	Selected	Poor labor productivity
	Nationality of laborers	Deleted	
	Labor injuries	Deleted	
	Labor disputes and strikes	Deleted	
	Labor and management relations	Deleted	

TABLE A 1: CONTINUED

Changes	Design changes by owner or his agent during construction	Selected	Design changes by owner or his agent during construction
	Design errors made by designers (due to unfamiliarity with local conditions and environment)	Selected	Design errors made by designers
	Foundation conditions encountered in the field	Selected	Unexpected foundation conditions encountered in the field
	Mistakes in soil investigation	Selected	Mistakes in soil investigation
	Errors committed during field construction at job site	Selected	Errors committed due to lack of experience
	Water table conditions on site	Already represented	
	Geological problems on site	Already represented	
Contractual relationships	The relationship between different subcontractors' schedules in the execution of the project	Selected	The relationship between different subcontractor's schedules
	The conflict between contractor and consultant	Selected	The conflict in point of view between contractor and consultant
	Slowness of the owner decision making process	Selected	Slowness of the owner decision making process
	Poor organization of the contractor or consultant	Selected	Poor organization of the contractor or consultant

TABLE A 1: CONTINUED

	Difficulty of coordination between various parties (contractor, subcontractor, owner, consultant) working on the project	Selected	Difficulty of coordination between various parties (contractor, subcontractor, owner, consultant) working on the project
	Nonutilization of professional construction/contractual management	Selected	Nonutilization of professional construction/contractual management
	Controlling subcontractors by general contractors in the execution of work	Selected	Controlling subcontractors main contractor in the execution of work
	Uncooperative owners	Already represented	
	Insufficient communication between the owner and designer in design phase	Already represented	
	Legal disputes between various parties in the construction project	Already represented	
	Poor contract management	Already represented	
	Nonadherence to contract conditions	Already represented	
	Mistakes and discrepacies in contract documents	Already represented	
	Project delivery systems used (design-build, general contracting, turnkey…etc.)	Deleted	
	The joint ownership of the projects	Deleted	

TABLE A 1: CONTINUED

	The unavailability of financial incentives for contractor to finish ahead of schedule	Deleted	
	Negotiations and obtaining of contracts	Deleted	
	Contract modifications	Deleted	
	Completeness of project information	Deleted	
Environment	Hot weather effect on construction activities	Merged	Weather effect
	Rain effect on construction activities	Merged	
	Flood	Merged	
	Hurricane	Merged	
	Wind damage	Merged	
	Fire	Deleted	
	Insufficient available utilities on site	Deleted	
	Social and cultural factors	Deleted	
Equipment	Shortage in equipments	Selected	Shortage in equipment
	Unskilled operators	Selected	Unskilled operators
	Equipment productivity	Selected	Poor equipment productivity
	Equipment failure	Already represented	
	Slow delivery of equipment	Already represented	
	Lack of high-technology equipment	Deleted	

TABLE A 1: CONTINUED

Rules& regulations	Obtaining permits from municipality	Selected	Obtaining permits from municipality
	Excessive bureaucracy in project owner operation	Selected	Excessive bureaucracy in project owner operation
	Building permits approval process	Deleted	
	Changes in laws and regulations	Deleted	
	Safety rules	Deleted	
	OSHA regulations	Deleted	
	Building regulations in coastal regions	Deleted	
	Coastal construction control line permit	Deleted	
	Florida administrative code	Deleted	
	National flood insurance program	Deleted	
	Obtaining permits for laborers	Deleted	
	Building codes used in the design of the projects	Already represented	
Materials	Shortage in construction materials	Selected	Shortage in construction materials
	Materials changes in types and specifications during construction	Selected	Changes in materials types and specifications during construction
	Slow delivery of materials	Selected	Slow delivery of materials
	Damage of materials in storage	Deleted	
	Imported materials and plant items	Deleted	

TABLE A 1: CONTINUED

Scheduling& control	Lack of database in estimating activity duration and resources	Selected	Lack of database in estimating activity duration and resources
	Inspection and testing procedures used in the project	Selected	Inspection and testing procedures used in the project
	Application of quality control based on foreign specification	Selected	Application of quality control based on foreign specification
	Accidents during construction	Selected	Accidents during construction
	Lack of training personnel& management support to model the construction operation	Already represented	
	Judgment and experience of the involved people in estimating time and resources	Already represented	
	Inadequate early planning of the project	Already represented	
	Poor subcontractor performance	Already represented	
	Often change of subcontractors	Already represented	
	Preparation and approval of shop drawings	Merged	Preparation of shop drawings and material samples

TABLE A 1: CONTINUED

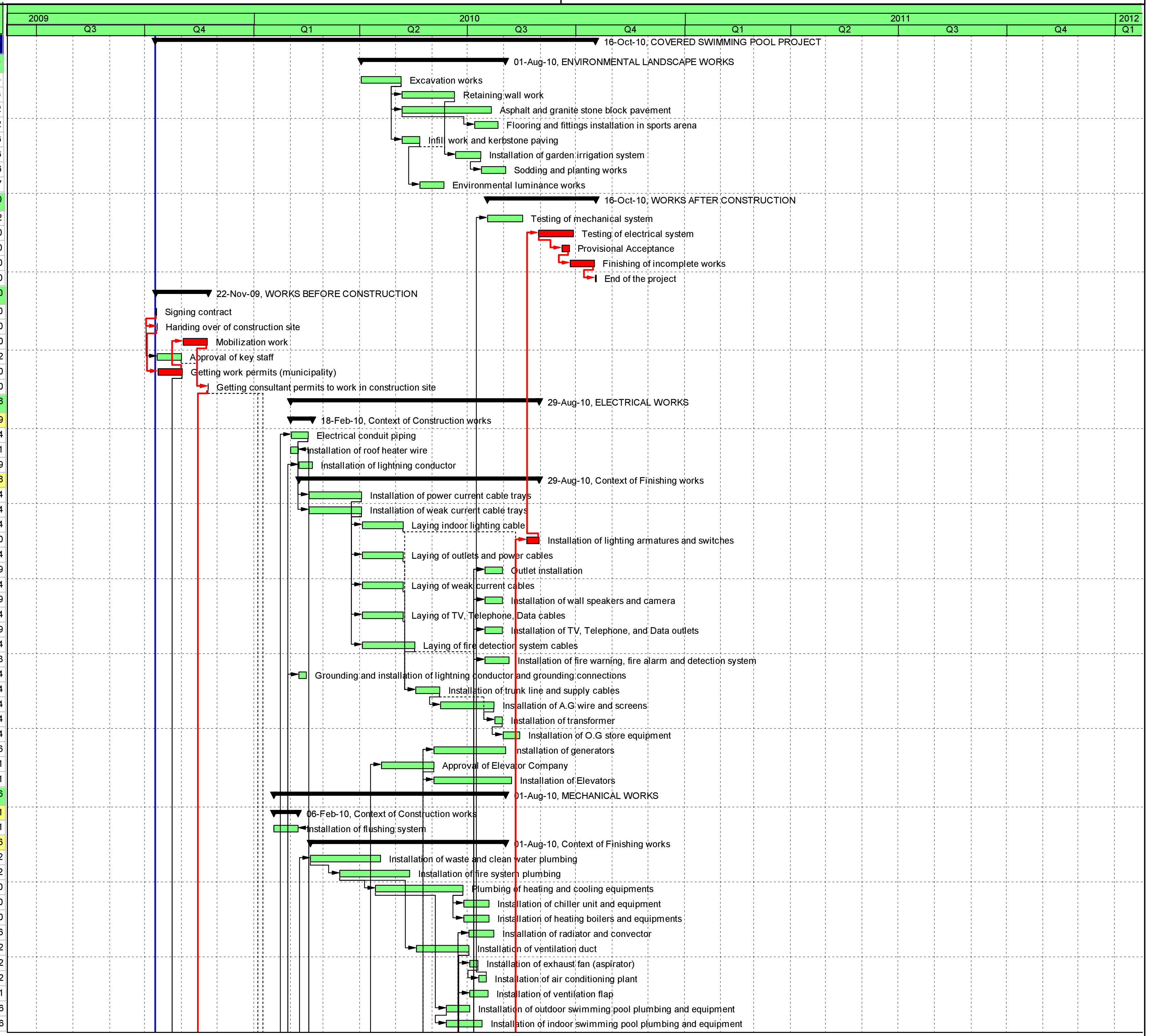
	Waiting for sample material approval	Merged	Waiting for approval of shop drawings and material samples
	Preparation of scheduling networks and revisions by consultant while construction is in progress	Deleted	
	Traffic control regulation practiced in the site of the project	Deleted	
	Damage to structure	Deleted	
	Staffing problems	Deleted	
	Transportation delays	Already represented	
	Inadequate review	Deleted	
	Different site conditions	Deleted	
	Construction methods	Deleted	
	Timeliness of project information	Already represented	
	Time spent to find appropriate subcontractors for each task	Deleted	

APPENDIX B

PRIMAVERA SCHEDULES

COVERED SWIMMING POOL PROJECT | As-Planned Schedule - 09.10.2009 | 08-Jan-11 13:17

Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
COVERED SWIMMING POOL PROJECT		370	09-Oct-09	16-Oct-10	0
ENVIRONMENTAL LANDSCAPE WORKS		122	01-Apr-10	01-Aug-10	76
A1870	Excavation works	35	01-Apr-10*	05-May-10	76
A1930	Retaining wall work	45	06-May-10	19-Jun-10	76
A1940	Asphalt and granite stone block pavement	75	06-May-10	20-Jul-10	82
A1950	Flooring and fittings installation in sports arena	21	06-Jul-10	26-Jul-10	82
A1960	Infill work and kerbstone paving	15	06-May-10	20-May-10	106
A1970	Installation of garden irrigation system	21	20-Jun-10	11-Jul-10	76
A1980	Sodding and planting works	21	12-Jul-10	01-Aug-10	76
A1990	Environmental luminance works	21	21-May-10	10-Jun-10	127
WORKS AFTER CONSTRUCTION		92	17-Jul-10	16-Oct-10	0
A2000	Testing of mechanical system	30	17-Jul-10	15-Aug-10	62
A2010	Testing of electrical system	30	29-Aug-10	27-Sep-10	0
A2020	Provisional Acceptance	7	18-Sep-10	24-Sep-10	0
A2030	Finishing of incomplete works	21	25-Sep-10	15-Oct-10	0
A2040	End of the project	1	16-Oct-10	16-Oct-10	0
WORKS BEFORE CONSTRUCTION		45	09-Oct-09	22-Nov-09	0
A1000	Signing contract	1	09-Oct-09	09-Oct-09	0
A1010	Handing over of construction site	1	10-Oct-09	10-Oct-09	0
A1020	Mobilization work	21	01-Nov-09	21-Nov-09	0
A1030	Approval of key staff	21	10-Oct-09	30-Oct-09	22
A1040	Getting work permits (municipality)	21	11-Oct-09	31-Oct-09	0
A1050	Getting consultant permits to work in construction site	1	22-Nov-09	22-Nov-09	0
ELECTRICAL WORKS		210	31-Jan-10	29-Aug-10	48
Context of Construction works		19	31-Jan-10	18-Feb-10	239
A1170	Electrical conduit piping	15	01-Feb-10	15-Feb-10	64
A1180	Installation of roof heater wire	7	31-Jan-10	06-Feb-10	251
A1190	Installation of lightning conductor	12	07-Feb-10	18-Feb-10	239
Context of Finishing works		203	07-Feb-10	29-Aug-10	48
A1670	Installation of power current cable trays	45	16-Feb-10	01-Apr-10	74
A1680	Installation of weak current cable trays	45	16-Feb-10	01-Apr-10	64
A1690	Laying indoor lighting cable	35	02-Apr-10	06-May-10	74
A1700	Installation of lighting armatures and switches	11	19-Aug-10	29-Aug-10	0
A1710	Laying of outlets and power cables	35	02-Apr-10	06-May-10	74
A1720	Outlet installation	15	15-Jul-10	29-Jul-10	79
A1730	Laying of weak current cables	35	02-Apr-10	06-May-10	74
A1740	Installation of wall speakers and camera	15	15-Jul-10	29-Jul-10	79
A1750	Laying of TV, Telephone, Data cables	35	02-Apr-10	06-May-10	74
A1760	Installation of TV, Telephone, and Data outlets	15	15-Jul-10	29-Jul-10	79
A1770	Laying of fire detection system cables	45	02-Apr-10	16-May-10	64
A1780	Installation of fire warning, fire alarm and detection system	21	15-Jul-10	04-Aug-10	73
A1790	Grounding and installation of lightning conductor and grounding conn	7	07-Feb-10	13-Feb-10	244
A1800	Installation of trunk line and supply cables	21	17-May-10	06-Jun-10	64
A1810	Installation of A.G wire and screens	45	07-Jun-10	22-Jul-10	64
A1820	Installation of transformer	7	23-Jul-10	29-Jul-10	64
A1830	Installation of O.G store equipment	15	30-Jul-10	13-Aug-10	64
A1840	Installation of generators	60	02-Jun-10	01-Aug-10	76
A1850	Approval of Elevator Company	45	18-Apr-10	01-Jun-10	71
A1860	Installation of Elevators	65	02-Jun-10	06-Aug-10	71
MECHANICAL WORKS		196	17-Jan-10	01-Aug-10	76
Context of Construction works		21	17-Jan-10	06-Feb-10	251
A1160	Installation of flushing system	21	17-Jan-10	06-Feb-10	251
Context of Finishing works		165	17-Feb-10	01-Aug-10	76
A1540	Installation of waste and clean water plumbing	60	17-Feb-10	17-Apr-10	62
A1550	Installation of fire system plumbing	60	14-Mar-10	12-May-10	62
A1560	Plumbing of heating and cooling equipments	75	13-Apr-10	26-Jun-10	90
A1570	Installation of chiller unit and equipment	21	27-Jun-10	18-Jul-10	90
A1580	Installation of heating boilers and equipments	21	27-Jun-10	18-Jul-10	90
A1590	Installation of radiator and convector	21	01-Jul-10	22-Jul-10	86
A1600	Installation of ventilation duct	45	18-May-10	01-Jul-10	62
A1610	Installation of exhaust fan (aspirator)	7	02-Jul-10	09-Jul-10	62
A1620	Installation of air conditioning plant	7	10-Jul-10	16-Jul-10	62
A1630	Installation of ventilation flap	15	02-Jul-10	17-Jul-10	91
A1640	Installation of outdoor swimming pool plumbing and equipment	21	12-Jun-10	02-Jul-10	96
A1650	Installation of indoor swimming pool plumbing and equipment	30	12-Jun-10	12-Jul-10	96



Actual Work | Critical Remaining Work | Summary
Remaining Work | % Complete

TASK filter: All Activities

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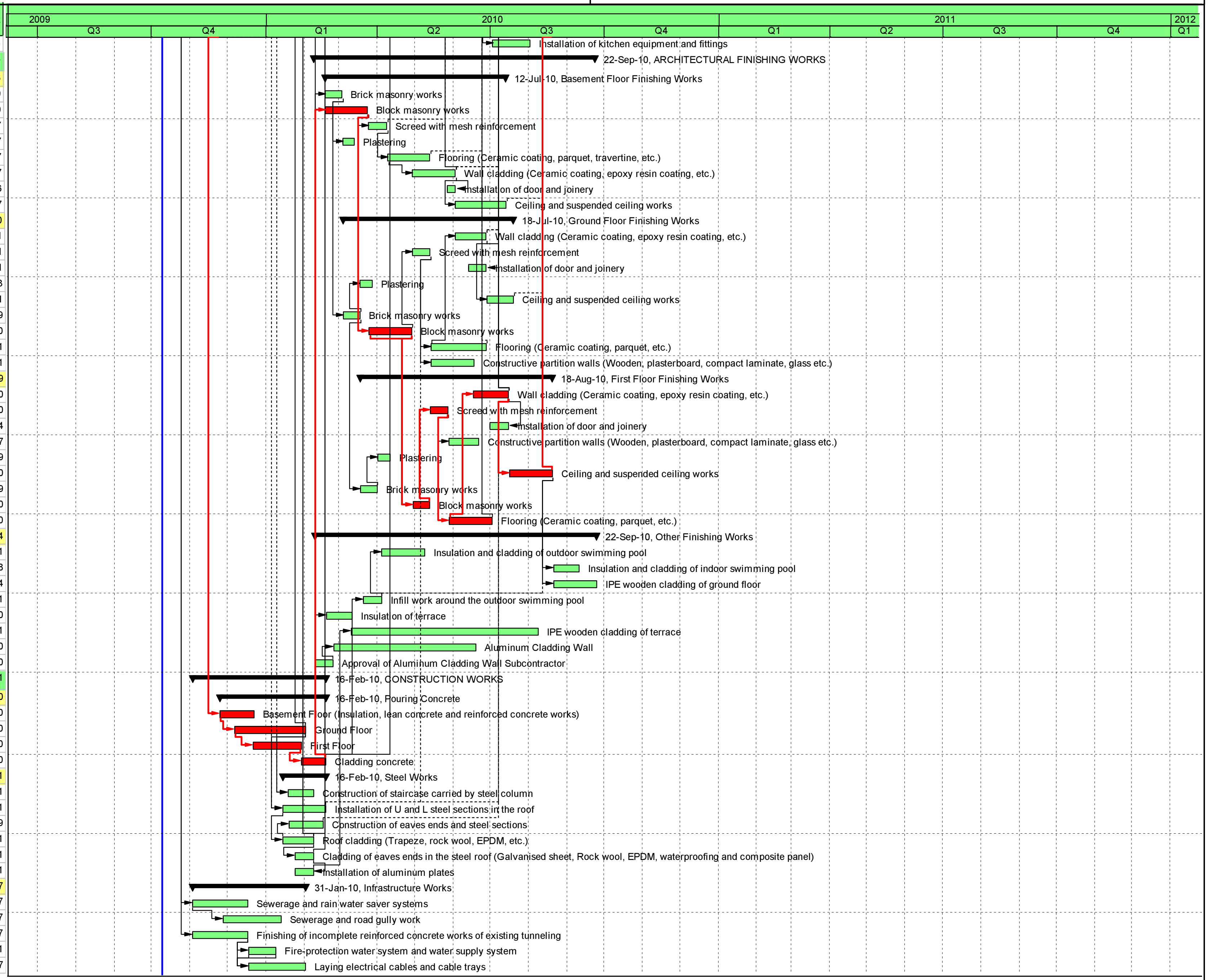
COVERED SWIMMING POOL PROJECT | As-Planned Schedule - 09.10.2009 | 08-Jan-11 13:17

Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
A1660	Installation of kitchen equipment and fittings	30	02-Jul-10	01-Aug-10	76
ARCHITECTURAL FINISHING WORKS		226	08-Feb-10	22-Sep-10	24
Basement Floor Finishing Works		145	17-Feb-10	12-Jul-10	96
A1200	Brick masonry works	14	17-Feb-10	02-Mar-10	189
A1210	Block masonry works	35	17-Feb-10	23-Mar-10	0
A1220	Screed with mesh reinforcement	15	24-Mar-10	07-Apr-10	37
A1230	Plastering	10	03-Mar-10	12-Mar-10	217
A1240	Flooring (Ceramic coating, parquet, travertine, etc.)	35	08-Apr-10	12-May-10	37
A1250	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	35	28-Apr-10	01-Jun-10	37
A1260	Installation of door and joinery	7	26-May-10	01-Jun-10	136
A1270	Ceiling and suspended ceiling works	40	02-Jun-10	12-Jul-10	37
Ground Floor Finishing Works		137	03-Mar-10	18-Jul-10	90
A1280	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	25	02-Jun-10	26-Jun-10	31
A1290	Screed with mesh reinforcement	15	28-Apr-10	12-May-10	31
A1300	Installation of door and joinery	15	12-Jun-10	26-Jun-10	111
A1310	Plastering	10	17-Mar-10	26-Mar-10	203
A1320	Ceiling and suspended ceiling works	21	27-Jun-10	18-Jul-10	31
A1330	Brick masonry works	14	03-Mar-10	16-Mar-10	189
A1340	Block masonry works	35	24-Mar-10	27-Apr-10	0
A1350	Flooring (Ceramic coating, parquet, etc.)	45	13-May-10	26-Jun-10	31
A1360	Constructive partition walls (Wooden, plasterboard, compact laminate	35	13-May-10	16-Jun-10	121
First Floor Finishing Works		154	17-Mar-10	18-Aug-10	59
A1370	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	28	16-Jun-10	14-Jul-10	0
A1380	Screed with mesh reinforcement	15	12-May-10	26-May-10	0
A1390	Installation of door and joinery	15	29-Jun-10	14-Jul-10	94
A1400	Constructive partition walls (Wooden, plasterboard, compact laminate	25	27-May-10	20-Jun-10	117
A1410	Plastering	10	31-Mar-10	09-Apr-10	189
A1420	Ceiling and suspended ceiling works	35	15-Jul-10	18-Aug-10	0
A1430	Brick masonry works	14	17-Mar-10	30-Mar-10	189
A1440	Block masonry works	14	28-Apr-10	11-May-10	0
A1450	Flooring (Ceramic coating, parquet, etc.)	35	27-May-10	30-Jun-10	0
Other Finishing Works		226	08-Feb-10	22-Sep-10	24
A1460	Insulation and cladding of outdoor swimming pool	35	03-Apr-10	07-May-10	161
A1470	Insulation and cladding of indoor swimming pool	21	19-Aug-10	08-Sep-10	38
A1480	IPE wooden cladding of ground floor	35	19-Aug-10	22-Sep-10	24
A1490	Infill work around the outdoor swimming pool	15	19-Mar-10	02-Apr-10	161
A1500	Insulation of terrace	21	17-Feb-10	09-Mar-10	220
A1510	IPE wooden cladding of terrace	150	09-Mar-10	06-Aug-10	71
A1520	Aluminum Cladding Wall	115	23-Feb-10	17-Jun-10	120
A1530	Approval of Aluminum Cladding Wall Subcontractor	15	08-Feb-10*	22-Feb-10	120
CONSTRUCTION WORKS		106	01-Nov-09	16-Feb-10	241
Pouring Concrete		84	23-Nov-09	16-Feb-10	0
A1060	Basement Floor (Insulation, lean concrete and reinforced concrete wc	28	23-Nov-09	20-Dec-09	0
A1070	Ground Floor	56	05-Dec-09	31-Jan-10	0
A1080	First Floor	37	20-Dec-09	27-Jan-10	0
A1150	Cladding concrete	20	28-Jan-10	16-Feb-10	0
Steel Works		35	13-Jan-10	16-Feb-10	241
A1090	Construction of staircase carried by steel column	21	17-Jan-10	06-Feb-10	251
A1100	Installation of U and L steel sections in the roof	35	13-Jan-10	16-Feb-10	71
A1110	Construction of eaves ends and steel sections	28	18-Jan-10	14-Feb-10	149
A1120	Roof cladding (Trapeze, rock wool, EPDM, etc.)	25	13-Jan-10	06-Feb-10	71
A1130	Cladding of eaves ends in the steel roof (Galvanised sheet, Rock woo	15	23-Jan-10	06-Feb-10	71
A1140	Installation of aluminum plates	15	23-Jan-10	06-Feb-10	71
Infrastructure Works		90	01-Nov-09	31-Jan-10	257
A1880	Sewerage and rain water saver systems	45	01-Nov-09	15-Dec-09	277
A1890	Sewerage and road gully work	45	26-Nov-09	11-Jan-10	277
A1900	Finishing of incomplete reinforced concrete works of existing tunneling	45	01-Nov-09	15-Dec-09	257
A1910	Fire-protection water system and water supply system	21	16-Dec-09	07-Jan-10	281
A1920	Laying electrical cables and cable trays	45	16-Dec-09	31-Jan-10	257



Actual Work | Critical Remaining Work | Summary
Remaining Work | % Complete

TASK filter: All Activities

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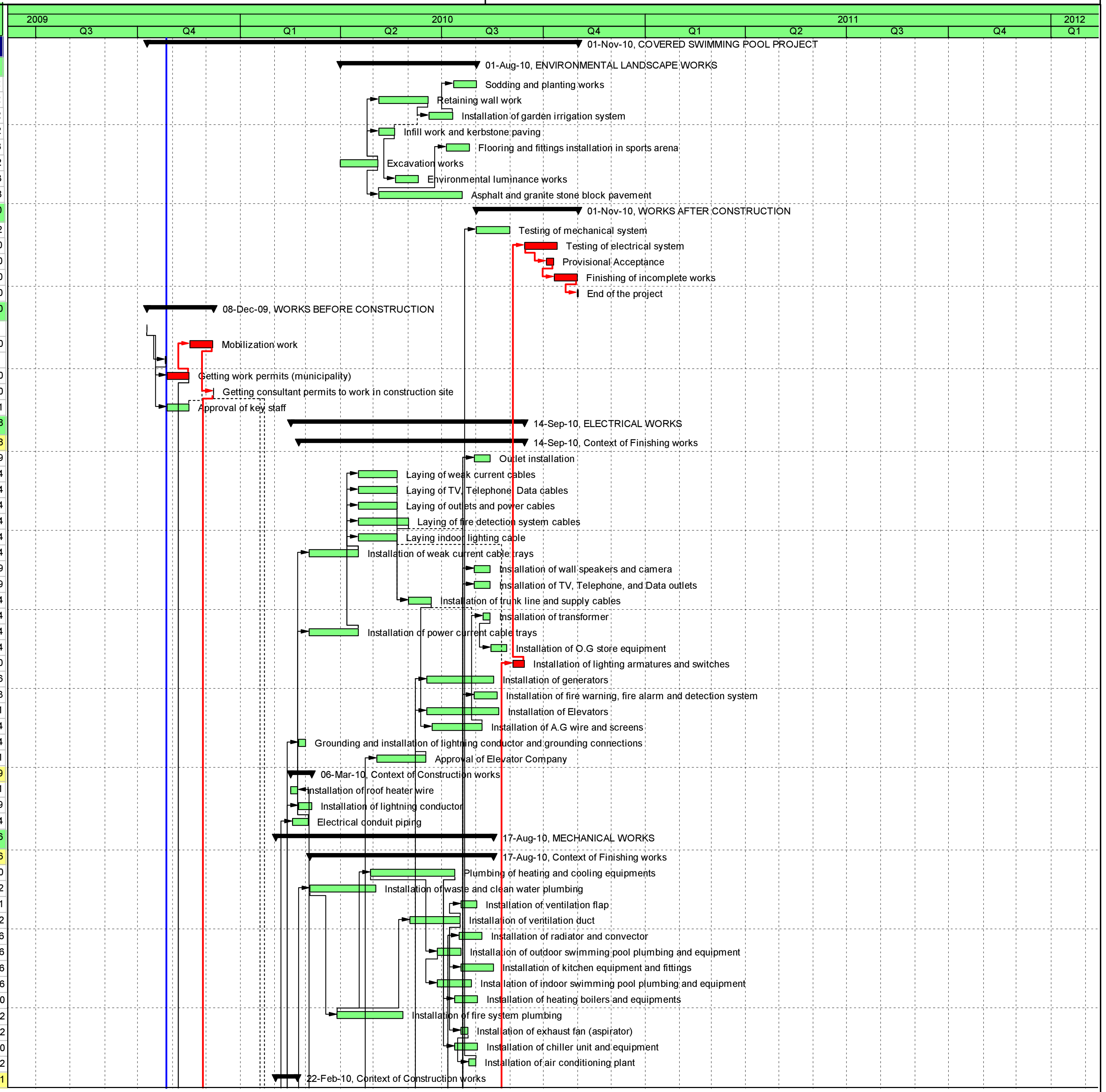
Activity ID	Activity Name	Original Duration	Schedule % Complete	Activity % Complete	Start	Finish	Total Float
COVERED SWIMMING POOL PROJECT		386	0%		09-Oct-09 A	01-Nov-10	0
ENVIRONMENTAL LANDSCAPE WORKS		122	0%		01-Apr-10	01-Aug-10	92
A1980	Sodding and planting works	21	0%	0%	12-Jul-10	01-Aug-10	92
A1930	Retaining wall work	45	0%	0%	06-May-10	19-Jun-10	92
A1970	Installation of garden irrigation system	21	0%	0%	20-Jun-10	11-Jul-10	92
A1960	Infill work and kerbstone paving	15	0%	0%	06-May-10	20-May-10	122
A1950	Flooring and fittings installation in sports arena	21	0%	0%	06-Jul-10	26-Jul-10	98
A1870	Excavation works	35	0%	0%	01-Apr-10*	05-May-10	92
A1990	Environmental luminance works	21	0%	0%	21-May-10	10-Jun-10	143
A1940	Asphalt and granite stone block pavement	75	0%	0%	06-May-10	20-Jul-10	98
WORKS AFTER CONSTRUCTION		92	0%		02-Aug-10	01-Nov-10	0
A2000	Testing of mechanical system	30	0%	0%	02-Aug-10	31-Aug-10	62
A2010	Testing of electrical system	30	0%	0%	14-Sep-10	13-Oct-10	0
A2020	Provisional Acceptance	7	0%	0%	04-Oct-10	10-Oct-10	0
A2030	Finishing of incomplete works	21	0%	0%	11-Oct-10	31-Oct-10	0
A2040	End of the project	1	0%	0%	01-Nov-10	01-Nov-10	0
WORKS BEFORE CONSTRUCTION		61	0%		09-Oct-09 A	08-Dec-09	0
A1000	Signing contract	1	100%	100%	09-Oct-09 A	09-Oct-09 A	
A1020	Mobilization work	21	0%	0%	17-Nov-09	07-Dec-09	0
A1010	Handing over of construction site	1	100%	100%	26-Oct-09 A	26-Oct-09 A	
A1040	Getting work permits (municipality)	21	0%	0%	27-Oct-09	16-Nov-09	0
A1050	Getting consultant permits to work in construction site	1	0%	0%	08-Dec-09	08-Dec-09	0
A1030	Approval of key staff	21	0%	0%	27-Oct-09	16-Nov-09	21
ELECTRICAL WORKS		210	0%		16-Feb-10	14-Sep-10	48
Context of Finishing works		203	0%		23-Feb-10	14-Sep-10	48
A1720	Outlet installation	15	0%	0%	31-Jul-10	14-Aug-10	79
A1730	Laying of weak current cables	35	0%	0%	18-Apr-10	22-May-10	74
A1750	Laying of TV, Telephone, Data cables	35	0%	0%	18-Apr-10	22-May-10	74
A1710	Laying of outlets and power cables	35	0%	0%	18-Apr-10	22-May-10	74
A1770	Laying of fire detection system cables	45	0%	0%	18-Apr-10	01-Jun-10	64
A1690	Laying indoor lighting cable	35	0%	0%	18-Apr-10	22-May-10	74
A1680	Installation of weak current cable trays	45	0%	0%	04-Mar-10	17-Apr-10	64
A1740	Installation of wall speakers and camera	15	0%	0%	31-Jul-10	14-Aug-10	79
A1760	Installation of TV, Telephone, and Data outlets	15	0%	0%	31-Jul-10	14-Aug-10	79
A1800	Installation of trunk line and supply cables	21	0%	0%	02-Jun-10	22-Jun-10	64
A1820	Installation of transformer	7	0%	0%	08-Aug-10	14-Aug-10	64
A1670	Installation of power current cable trays	45	0%	0%	04-Mar-10	17-Apr-10	74
A1830	Installation of O.G store equipment	15	0%	0%	15-Aug-10	29-Aug-10	64
A1700	Installation of lighting armatures and switches	11	0%	0%	04-Sep-10	14-Sep-10	0
A1840	Installation of generators	60	0%	0%	18-Jun-10	17-Aug-10	76
A1780	Installation of fire warning, fire alarm and detection system	21	0%	0%	31-Jul-10	20-Aug-10	73
A1860	Installation of Elevators	65	0%	0%	18-Jun-10	22-Aug-10	71
A1810	Installation of A.G wire and screens	45	0%	0%	23-Jun-10	07-Aug-10	64
A1790	Grounding and installation of lightning conductor and grounding conn	7	0%	0%	23-Feb-10	01-Mar-10	244
A1850	Approval of Elevator Company	45	0%	0%	04-May-10	17-Jun-10	71
Context of Construction works		19	0%		16-Feb-10	06-Mar-10	239
A1180	Installation of roof heater wire	7	0%	0%	16-Feb-10	22-Feb-10	251
A1190	Installation of lightning conductor	12	0%	0%	23-Feb-10	06-Mar-10	239
A1170	Electrical conduit piping	15	0%	0%	17-Feb-10	03-Mar-10	64
MECHANICAL WORKS		196	0%		02-Feb-10	17-Aug-10	76
Context of Finishing works		165	0%		05-Mar-10	17-Aug-10	76
A1560	Plumbing of heating and cooling equipments	75	0%	0%	29-Apr-10	13-Jul-10	90
A1540	Installation of waste and clean water plumbing	60	0%	0%	05-Mar-10	03-May-10	62
A1630	Installation of ventilation flap	15	0%	0%	19-Jul-10	02-Aug-10	91
A1600	Installation of ventilation duct	45	0%	0%	03-Jun-10	18-Jul-10	62
A1590	Installation of radiator and convector	21	0%	0%	18-Jul-10	07-Aug-10	86
A1640	Installation of outdoor swimming pool plumbing and equipment	21	0%	0%	28-Jun-10	19-Jul-10	96
A1660	Installation of kitchen equipment and fittings	30	0%	0%	19-Jul-10	17-Aug-10	76
A1650	Installation of indoor swimming pool plumbing and equipment	30	0%	0%	28-Jun-10	28-Jul-10	96
A1580	Installation of heating boilers and equipments	21	0%	0%	14-Jul-10	03-Aug-10	90
A1550	Installation of fire system plumbing	60	0%	0%	30-Mar-10	28-May-10	62
A1610	Installation of exhaust fan (aspirator)	7	0%	0%	19-Jul-10	25-Jul-10	62
A1570	Installation of chiller unit and equipment	21	0%	0%	14-Jul-10	03-Aug-10	90
A1620	Installation of air conditioning plant	7	0%	0%	26-Jul-10	01-Aug-10	62
Context of Construction works		21	0%		02-Feb-10	22-Feb-10	251



Actual Work | Critical Remaining Work | Summary
Remaining Work | % Complete

TASK filter: All Activities

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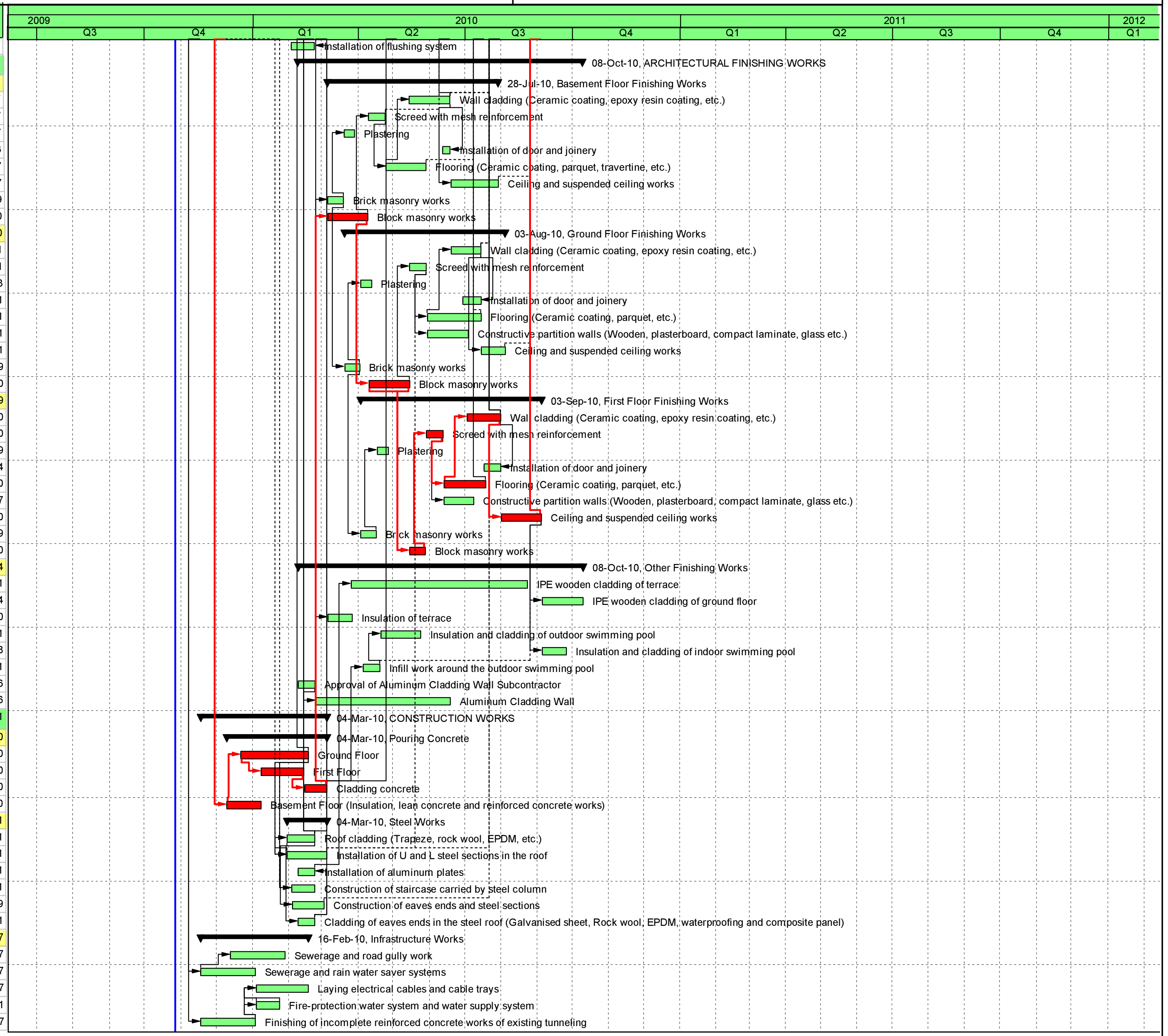
Activity ID	Activity Name	Original Duration	Schedule % Complete	Activity % Complete	Start	Finish	Total Float
A1160	Installation of flushing system	21	0%	0%	02-Feb-10	22-Feb-10	251
ARCHITECTURAL FINISHING WORKS		242	0%		08-Feb-10	08-Oct-10	24
Basement Floor Finishing Works		145	0%		05-Mar-10	28-Jul-10	96
A1250	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	35	0%	0%	14-May-10	17-Jun-10	37
A1220	Screed with mesh reinforcement	15	0%	0%	09-Apr-10	23-Apr-10	37
A1230	Plastering	10	0%	0%	19-Mar-10	28-Mar-10	217
A1260	Installation of door and joinery	7	0%	0%	11-Jun-10	17-Jun-10	136
A1240	Flooring (Ceramic coating, parquet, travertine, etc.)	35	0%	0%	24-Apr-10	28-May-10	37
A1270	Ceiling and suspended ceiling works	40	0%	0%	18-Jun-10	28-Jul-10	37
A1200	Brick masonry works	14	0%	0%	05-Mar-10	18-Mar-10	189
A1210	Block masonry works	35	0%	0%	05-Mar-10	08-Apr-10	0
Ground Floor Finishing Works		137	0%		19-Mar-10	03-Aug-10	90
A1280	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	25	0%	0%	18-Jun-10	13-Jul-10	31
A1290	Screed with mesh reinforcement	15	0%	0%	14-May-10	28-May-10	31
A1310	Plastering	10	0%	0%	02-Apr-10	11-Apr-10	203
A1300	Installation of door and joinery	15	0%	0%	28-Jun-10	13-Jul-10	111
A1350	Flooring (Ceramic coating, parquet, etc.)	45	0%	0%	29-May-10	13-Jul-10	31
A1360	Constructive partition walls (Wooden, plasterboard, compact laminat	35	0%	0%	29-May-10	02-Jul-10	121
A1320	Ceiling and suspended ceiling works	21	0%	0%	14-Jul-10	03-Aug-10	31
A1330	Brick masonry works	14	0%	0%	19-Mar-10	01-Apr-10	189
A1340	Block masonry works	35	0%	0%	09-Apr-10	13-May-10	0
First Floor Finishing Works		154	0%		02-Apr-10	03-Sep-10	59
A1370	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	28	0%	0%	02-Jul-10	30-Jul-10	0
A1380	Screed with mesh reinforcement	15	0%	0%	28-May-10	11-Jun-10	0
A1410	Plastering	10	0%	0%	16-Apr-10	25-Apr-10	189
A1390	Installation of door and joinery	15	0%	0%	16-Jul-10	30-Jul-10	94
A1450	Flooring (Ceramic coating, parquet, etc.)	35	0%	0%	12-Jun-10	17-Jul-10	0
A1400	Constructive partition walls (Wooden, plasterboard, compact laminat	25	0%	0%	12-Jun-10	07-Jul-10	117
A1420	Ceiling and suspended ceiling works	35	0%	0%	31-Jul-10	03-Sep-10	0
A1430	Brick masonry works	14	0%	0%	02-Apr-10	15-Apr-10	189
A1440	Block masonry works	14	0%	0%	14-May-10	27-May-10	0
Other Finishing Works		242	0%		08-Feb-10	08-Oct-10	24
A1510	IPE wooden cladding of terrace	150	0%	0%	25-Mar-10	22-Aug-10	71
A1480	IPE wooden cladding of ground floor	35	0%	0%	04-Sep-10	08-Oct-10	24
A1500	Insulation of terrace	21	0%	0%	05-Mar-10	25-Mar-10	220
A1460	Insulation and cladding of outdoor swimming pool	35	0%	0%	19-Apr-10	23-May-10	161
A1470	Insulation and cladding of indoor swimming pool	21	0%	0%	04-Sep-10	24-Sep-10	38
A1490	Infill work around the outdoor swimming pool	15	0%	0%	04-Apr-10	18-Apr-10	161
A1530	Approval of Aluminum Cladding Wall Subcontractor	15	0%	0%	08-Feb-10*	22-Feb-10	136
A1520	Aluminum Cladding Wall	115	0%	0%	23-Feb-10	17-Jun-10	136
CONSTRUCTION WORKS		106	0%		17-Nov-09	04-Mar-10	241
Pouring Concrete		84	0%		09-Dec-09	04-Mar-10	0
A1070	Ground Floor	56	0%	0%	21-Dec-09	16-Feb-10	0
A1080	First Floor	37	0%	0%	07-Jan-10	12-Feb-10	0
A1150	Cladding concrete	20	0%	0%	13-Feb-10	04-Mar-10	0
A1060	Basement Floor (Insulation, lean concrete and reinforced concrete wc	28	0%	0%	09-Dec-09	07-Jan-10	0
Steel Works		35	0%		29-Jan-10	04-Mar-10	241
A1120	Roof cladding (Trapeze, rock wool, EPDM, etc.)	25	0%	0%	29-Jan-10	22-Feb-10	71
A1100	Installation of U and L steel sections in the roof	35	0%	0%	29-Jan-10	04-Mar-10	71
A1140	Installation of aluminum plates	15	0%	0%	08-Feb-10	22-Feb-10	71
A1090	Construction of staircase carried by steel column	21	0%	0%	02-Feb-10	22-Feb-10	251
A1110	Construction of eaves ends and steel sections	28	0%	0%	03-Feb-10	02-Mar-10	149
A1130	Cladding of eaves ends in the steel roof (Galvanised sheet, Rock woo	15	0%	0%	08-Feb-10	22-Feb-10	71
Infrastructure Works		90	0%		17-Nov-09	16-Feb-10	257
A1890	Sewerage and road gully work	45	0%	0%	12-Dec-09	27-Jan-10	277
A1880	Sewerage and rain water saver systems	45	0%	0%	17-Nov-09	02-Jan-10	277
A1920	Laying electrical cables and cable trays	45	0%	0%	03-Jan-10	16-Feb-10	257
A1910	Fire-protection water system and water supply system	21	0%	0%	03-Jan-10	23-Jan-10	281
A1900	Finishing of incomplete reinforced concrete works of existing tunneling	45	0%	0%	17-Nov-09	02-Jan-10	257



Actual Work	Critical Remaining Work	Summary
Remaining Work	% Complete	

TASK filter: All Activities

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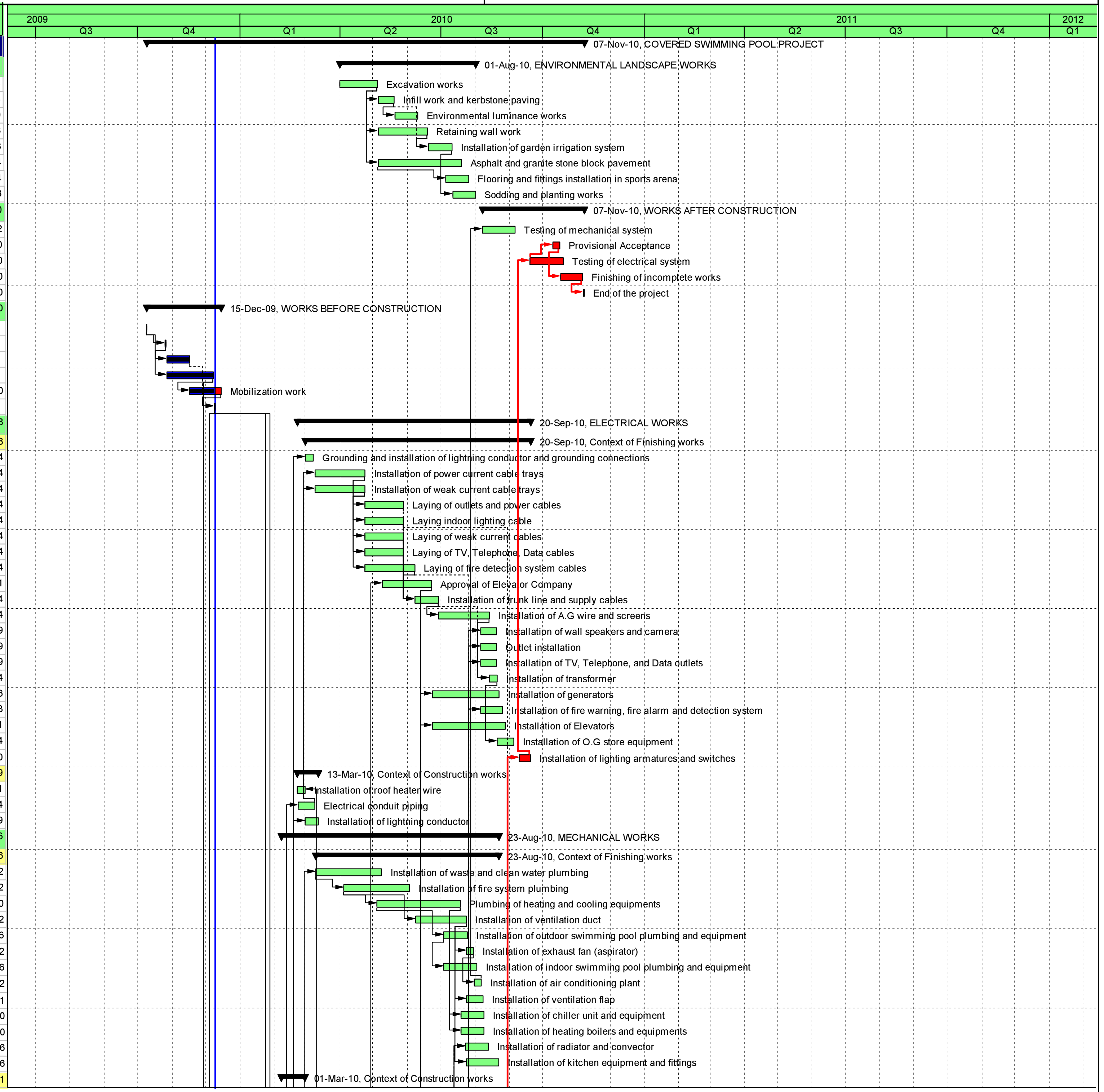
COVERED SWIMMING POOL PROJECT	Revised Schedule 2 - 10.12.2009.	08-Jan-11 14:46

Activity ID	Activity Name	Original Duration	Schedule % Complete	Activity % Complete	Start	Finish	Total Float
COVERED SWIMMING POOL PROJECT		392	0%		09-Oct-09 A	07-Nov-10	0
ENVIRONMENTAL LANDSCAPE WORKS		122	0%		01-Apr-10	01-Aug-10	98
A1870	Excavation works	35	0%	0%	01-Apr-10*	05-May-10	98
A1960	Infill work and kerbstone paving	15	0%	0%	06-May-10	20-May-10	128
A1990	Environmental luminance works	21	0%	0%	21-May-10	10-Jun-10	149
A1930	Retaining wall work	45	0%	0%	06-May-10	19-Jun-10	98
A1970	Installation of garden irrigation system	21	0%	0%	20-Jun-10	11-Jul-10	98
A1940	Asphalt and granite stone block pavement	75	0%	0%	06-May-10	20-Jul-10	104
A1950	Flooring and fittings installation in sports arena	21	0%	0%	06-Jul-10	26-Jul-10	104
A1980	Sodding and planting works	21	0%	0%	12-Jul-10	01-Aug-10	98
WORKS AFTER CONSTRUCTION		92	0%		08-Aug-10	07-Nov-10	0
A2000	Testing of mechanical system	30	0%	0%	08-Aug-10	06-Sep-10	62
A2020	Provisional Acceptance	7	0%	0%	10-Oct-10	16-Oct-10	0
A2010	Testing of electrical system	30	0%	0%	20-Sep-10	19-Oct-10	0
A2030	Finishing of incomplete works	21	0%	0%	17-Oct-10	06-Nov-10	0
A2040	End of the project	1	0%	0%	07-Nov-10	07-Nov-10	0
WORKS BEFORE CONSTRUCTION		62	0%		09-Oct-09 A	15-Dec-09	0
A1000	Signing contract	1	100%	100%	09-Oct-09 A	09-Oct-09 A	
A1010	Handing over of construction site	1	100%	100%	26-Oct-09 A	26-Oct-09 A	
A1030	Approval of key staff	21	100%	100%	27-Oct-09 A	17-Nov-09 A	
A1040	Getting work permits (municipality)	21	100%	100%	27-Oct-09 A	08-Dec-09 A	
A1020	Mobilization work	21	100%	75%	17-Nov-09 A	15-Dec-09	0
A1050	Getting consultant permits to work in construction site	1	100%	100%	09-Dec-09 A	09-Dec-09 A	
ELECTRICAL WORKS		210	0%		22-Feb-10	20-Sep-10	48
Context of Finishing works		203	0%		01-Mar-10	20-Sep-10	48
A1790	Grounding and installation of lightning conductor and grounding conn	7	0%	0%	01-Mar-10	08-Mar-10	244
A1670	Installation of power current cable trays	45	0%	0%	10-Mar-10	24-Apr-10	74
A1680	Installation of weak current cable trays	45	0%	0%	10-Mar-10	24-Apr-10	64
A1710	Laying of outlets and power cables	35	0%	0%	24-Apr-10	29-May-10	74
A1690	Laying indoor lighting cable	35	0%	0%	24-Apr-10	29-May-10	74
A1730	Laying of weak current cables	35	0%	0%	24-Apr-10	29-May-10	74
A1750	Laying of TV, Telephone, Data cables	35	0%	0%	24-Apr-10	29-May-10	74
A1770	Laying of fire detection system cables	45	0%	0%	24-Apr-10	08-Jun-10	64
A1850	Approval of Elevator Company	45	0%	0%	10-May-10	23-Jun-10	71
A1800	Installation of trunk line and supply cables	21	0%	0%	08-Jun-10	29-Jun-10	64
A1810	Installation of A.G wire and screens	45	0%	0%	29-Jun-10	14-Aug-10	64
A1740	Installation of wall speakers and camera	15	0%	0%	06-Aug-10	20-Aug-10	79
A1720	Outlet installation	15	0%	0%	06-Aug-10	20-Aug-10	79
A1760	Installation of TV, Telephone, and Data outlets	15	0%	0%	06-Aug-10	20-Aug-10	79
A1820	Installation of transformer	7	0%	0%	14-Aug-10	21-Aug-10	64
A1840	Installation of generators	60	0%	0%	24-Jun-10	23-Aug-10	76
A1780	Installation of fire warning, fire alarm and detection system	21	0%	0%	06-Aug-10	26-Aug-10	73
A1860	Installation of Elevators	65	0%	0%	24-Jun-10	28-Aug-10	71
A1830	Installation of O.G store equipment	15	0%	0%	21-Aug-10	05-Sep-10	64
A1700	Installation of lighting armatures and switches	11	0%	0%	10-Sep-10	20-Sep-10	0
Context of Construction works		19	0%		22-Feb-10	13-Mar-10	239
A1180	Installation of roof heater wire	7	0%	0%	22-Feb-10	01-Mar-10	251
A1170	Electrical conduit piping	15	0%	0%	23-Feb-10	10-Mar-10	64
A1190	Installation of lightning conductor	12	0%	0%	01-Mar-10	13-Mar-10	239
MECHANICAL WORKS		196	0%		08-Feb-10	23-Aug-10	76
Context of Finishing works		165	0%		11-Mar-10	23-Aug-10	76
A1540	Installation of waste and clean water plumbing	60	0%	0%	11-Mar-10	09-May-10	62
A1550	Installation of fire system plumbing	60	0%	0%	05-Apr-10	03-Jun-10	62
A1560	Plumbing of heating and cooling equipments	75	0%	0%	05-May-10	19-Jul-10	90
A1600	Installation of ventilation duct	45	0%	0%	09-Jun-10	24-Jul-10	62
A1640	Installation of outdoor swimming pool plumbing and equipment	21	0%	0%	04-Jul-10	25-Jul-10	96
A1610	Installation of exhaust fan (aspirator)	7	0%	0%	25-Jul-10	31-Jul-10	62
A1650	Installation of indoor swimming pool plumbing and equipment	30	0%	0%	04-Jul-10	03-Aug-10	96
A1620	Installation of air conditioning plant	7	0%	0%	01-Aug-10	07-Aug-10	62
A1630	Installation of ventilation flap	15	0%	0%	25-Jul-10	08-Aug-10	91
A1570	Installation of chiller unit and equipment	21	0%	0%	20-Jul-10	09-Aug-10	90
A1580	Installation of heating boilers and equipments	21	0%	0%	20-Jul-10	09-Aug-10	90
A1590	Installation of radiator and convector	21	0%	0%	24-Jul-10	13-Aug-10	86
A1660	Installation of kitchen equipment and fittings	30	0%	0%	25-Jul-10	23-Aug-10	76
Context of Construction works		21	0%		08-Feb-10	01-Mar-10	251



Actual Work | Critical Remaining Work | Summary
Remaining Work | % Complete

TASK filter: All Activities

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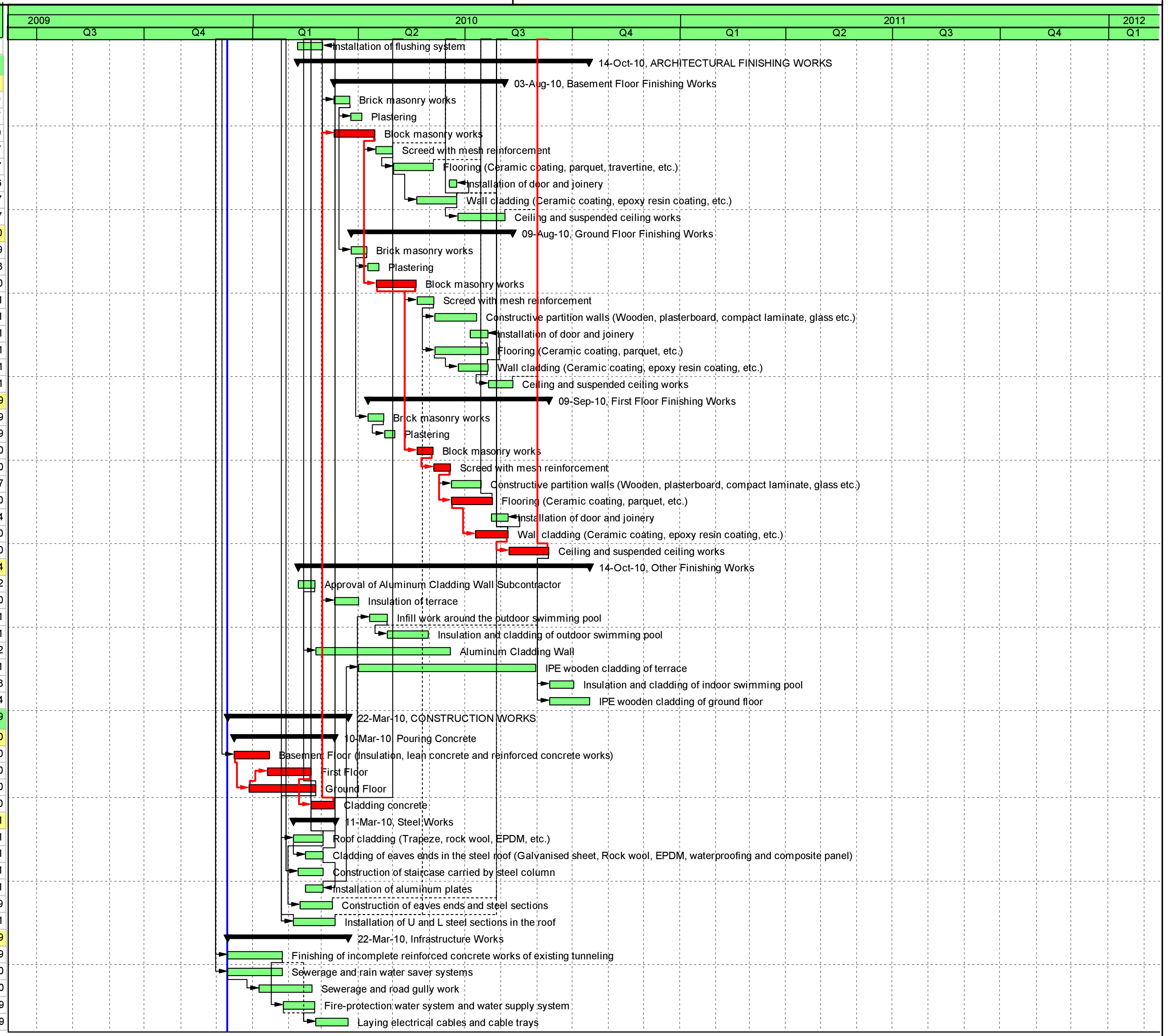
COVERED SWIMMING POOL PROJECT	Revised Schedule 2 - 10.12.2009.	08-Jan-11 14:46

Activity ID	Activity Name	Original Duration	Schedule % Complete	Activity % Complete	Start	Finish	Total Float
A1160	Installation of flushing system	21	0%	0%	08-Feb-10	01-Mar-10	251
ARCHITECTURAL FINISHING WORKS		248	0%		08-Feb-10	14-Oct-10	24
Basement Floor Finishing Works		145	0%		11-Mar-10	03-Aug-10	96
A1200	Brick masonry works	14	0%	0%	11-Mar-10	24-Mar-10	189
A1230	Plastering	10	0%	0%	25-Mar-10	03-Apr-10	217
A1210	Block masonry works	35	0%	0%	11-Mar-10	14-Apr-10	0
A1220	Screed with mesh reinforcement	15	0%	0%	15-Apr-10	29-Apr-10	37
A1240	Flooring (Ceramic coating, parquet, travertine, etc.)	35	0%	0%	30-Apr-10	03-Jun-10	37
A1260	Installation of door and joinery	7	0%	0%	17-Jun-10	23-Jun-10	136
A1250	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	35	0%	0%	20-May-10	23-Jun-10	37
A1270	Ceiling and suspended ceiling works	40	0%	0%	24-Jun-10	03-Aug-10	37
Ground Floor Finishing Works		137	0%		25-Mar-10	09-Aug-10	90
A1330	Brick masonry works	14	0%	0%	25-Mar-10	07-Apr-10	189
A1310	Plastering	10	0%	0%	08-Apr-10	17-Apr-10	203
A1340	Block masonry works	35	0%	0%	15-Apr-10	19-May-10	0
A1290	Screed with mesh reinforcement	15	0%	0%	20-May-10	03-Jun-10	31
A1360	Constructive partition walls (Wooden, plasterboard, compact laminate	35	0%	0%	04-Jun-10	09-Jul-10	121
A1300	Installation of door and joinery	15	0%	0%	04-Jul-10	19-Jul-10	111
A1350	Flooring (Ceramic coating, parquet, etc.)	45	0%	0%	04-Jun-10	19-Jul-10	31
A1280	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	25	0%	0%	24-Jun-10	19-Jul-10	31
A1320	Ceiling and suspended ceiling works	21	0%	0%	20-Jul-10	09-Aug-10	31
First Floor Finishing Works		154	0%		08-Apr-10	09-Sep-10	59
A1430	Brick masonry works	14	0%	0%	08-Apr-10	21-Apr-10	189
A1410	Plastering	10	0%	0%	22-Apr-10	01-May-10	189
A1440	Block masonry works	14	0%	0%	20-May-10	02-Jun-10	0
A1380	Screed with mesh reinforcement	15	0%	0%	03-Jun-10	17-Jun-10	0
A1400	Constructive partition walls (Wooden, plasterboard, compact laminate	25	0%	0%	18-Jun-10	13-Jul-10	117
A1450	Flooring (Ceramic coating, parquet, etc.)	35	0%	0%	18-Jun-10	23-Jul-10	0
A1390	Installation of door and joinery	15	0%	0%	22-Jul-10	05-Aug-10	94
A1370	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	28	0%	0%	09-Jul-10	05-Aug-10	0
A1420	Ceiling and suspended ceiling works	35	0%	0%	06-Aug-10	09-Sep-10	0
Other Finishing Works		248	0%		08-Feb-10	14-Oct-10	24
A1530	Approval of Aluminum Cladding Wall Subcontractor	15	0%	0%	08-Feb-10*	22-Feb-10	142
A1500	Insulation of terrace	21	0%	0%	11-Mar-10	31-Mar-10	220
A1490	Infill work around the outdoor swimming pool	15	0%	0%	10-Apr-10	24-Apr-10	161
A1460	Insulation and cladding of outdoor swimming pool	35	0%	0%	25-Apr-10	29-May-10	161
A1520	Aluminum Cladding Wall	115	0%	0%	23-Feb-10	17-Jun-10	142
A1510	IPE wooden cladding of terrace	150	0%	0%	31-Mar-10	29-Aug-10	71
A1470	Insulation and cladding of indoor swimming pool	21	0%	0%	10-Sep-10	30-Sep-10	38
A1480	IPE wooden cladding of ground floor	35	0%	0%	10-Sep-10	14-Oct-10	24
CONSTRUCTION WORKS		101	0%		10-Dec-09 A	22-Mar-10	229
Pouring Concrete		84	0%		15-Dec-09 A	10-Mar-10	0
A1060	Basement Floor (Insulation, lean concrete and reinforced concrete wc	29	0%	0%	15-Dec-09 A	14-Jan-10	0
A1080	First Floor	37	0%	0%	13-Jan-10	19-Feb-10	0
A1070	Ground Floor	56	0%	0%	28-Dec-09	23-Feb-10	0
A1150	Cladding concrete	20	0%	0%	19-Feb-10	10-Mar-10	0
Steel Works		35	0%		04-Feb-10	11-Mar-10	241
A1120	Roof cladding (Trapeze, rock wool, EPDM, etc.)	25	0%	0%	04-Feb-10	01-Mar-10	71
A1130	Cladding of eaves ends in the steel roof (Galvanised sheet, Rock woo	15	0%	0%	14-Feb-10	01-Mar-10	71
A1090	Construction of staircase carried by steel column	21	0%	0%	08-Feb-10	01-Mar-10	251
A1140	Installation of aluminum plates	15	0%	0%	14-Feb-10	01-Mar-10	71
A1110	Construction of eaves ends and steel sections	28	0%	0%	09-Feb-10	09-Mar-10	149
A1100	Installation of U and L steel sections in the roof	35	0%	0%	04-Feb-10	11-Mar-10	71
Infrastructure Works		101	0%		10-Dec-09	22-Mar-10	229
A1900	Finishing of incomplete reinforced concrete works of existing tunneling	45	0%	0%	10-Dec-09	25-Jan-10	229
A1880	Sewerage and rain water saver systems	45	0%	0%	10-Dec-09	25-Jan-10	260
A1890	Sewerage and road gully work	45	0%	0%	06-Jan-10	19-Feb-10	260
A1910	Fire-protection water system and water supply system	28	0%	0%	26-Jan-10	22-Feb-10	229
A1920	Laying electrical cables and cable trays	28	0%	0%	23-Feb-10	22-Mar-10	229



Actual Work	Critical Remaining Work	Summary	Page 2 of 2
Remaining Work	% Complete		TASK filter: All Activities

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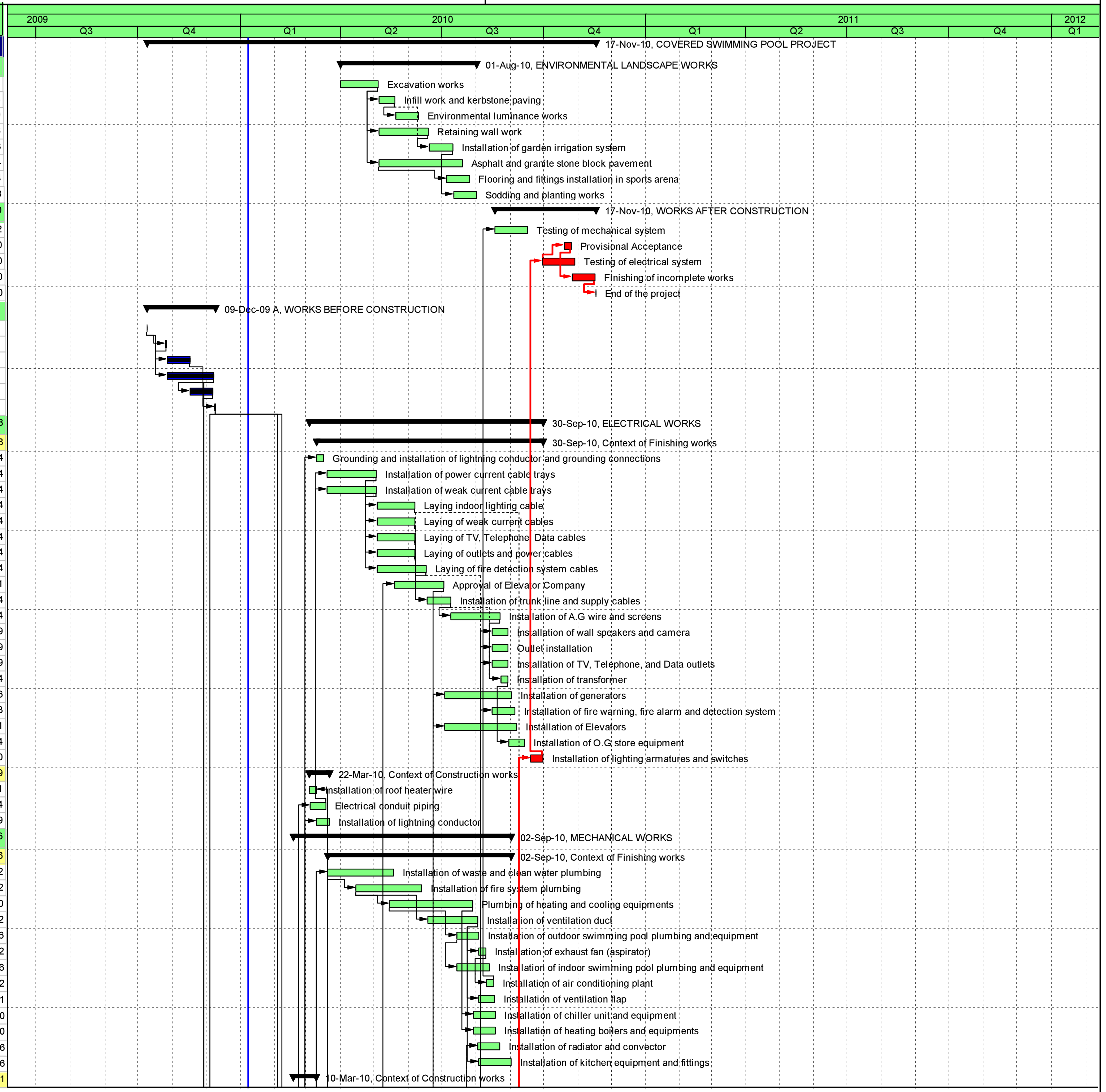
Activity ID	Activity Name	Original Duration	Schedule % Complete	Activity % Complete	Start	Finish	Total Float
	COVERED SWIMMING POOL PROJECT	402	0%		09-Oct-09 A	17-Nov-10	0
	ENVIRONMENTAL LANDSCAPE WORKS	122	0%		01-Apr-10	01-Aug-10	108
A1870	Excavation works	35	0%	0%	01-Apr-10*	05-May-10	108
A1960	Infill work and kerbstone paving	15	0%	0%	06-May-10	20-May-10	138
A1990	Environmental luminance works	21	0%	0%	21-May-10	10-Jun-10	159
A1930	Retaining wall work	45	0%	0%	06-May-10	19-Jun-10	108
A1970	Installation of garden irrigation system	21	0%	0%	20-Jun-10	11-Jul-10	108
A1940	Asphalt and granite stone block pavement	75	0%	0%	06-May-10	20-Jul-10	114
A1950	Flooring and fittings installation in sports arena	21	0%	0%	06-Jul-10	26-Jul-10	114
A1980	Sodding and planting works	21	0%	0%	12-Jul-10	01-Aug-10	108
	WORKS AFTER CONSTRUCTION	92	0%		18-Aug-10	17-Nov-10	0
A2000	Testing of mechanical system	30	0%	0%	18-Aug-10	16-Sep-10	62
A2020	Provisional Acceptance	7	0%	0%	20-Oct-10	26-Oct-10	0
A2010	Testing of electrical system	30	0%	0%	30-Sep-10	29-Oct-10	0
A2030	Finishing of incomplete works	21	0%	0%	27-Oct-10	16-Nov-10	0
A2040	End of the project	1	0%	0%	17-Nov-10	17-Nov-10	0
	WORKS BEFORE CONSTRUCTION	62	0%		09-Oct-09 A	09-Dec-09 A	
A1000	Signing contract	1	100%	100%	09-Oct-09 A	09-Oct-09 A	
A1010	Handing over of construction site	1	100%	100%	26-Oct-09 A	26-Oct-09 A	
A1030	Approval of key staff	21	100%	100%	27-Oct-09 A	17-Nov-09 A	
A1040	Getting work permits (municipality)	21	100%	100%	27-Oct-09 A	08-Dec-09 A	
A1020	Mobilization work	21	100%	100%	17-Nov-09 A	07-Dec-09 A	
A1050	Getting consultant permits to work in construction site	1	100%	100%	09-Dec-09 A	09-Dec-09 A	
	ELECTRICAL WORKS	210	0%		04-Mar-10	30-Sep-10	48
	Context of Finishing works	203	0%		11-Mar-10	30-Sep-10	48
A1790	Grounding and installation of lightning conductor and grounding conn	7	0%	0%	11-Mar-10	17-Mar-10	244
A1670	Installation of power current cable trays	45	0%	0%	20-Mar-10	03-May-10	74
A1680	Installation of weak current cable trays	45	0%	0%	20-Mar-10	03-May-10	64
A1690	Laying indoor lighting cable	35	0%	0%	04-May-10	07-Jun-10	74
A1730	Laying of weak current cables	35	0%	0%	04-May-10	07-Jun-10	74
A1750	Laying of TV, Telephone, Data cables	35	0%	0%	04-May-10	07-Jun-10	74
A1710	Laying of outlets and power cables	35	0%	0%	04-May-10	07-Jun-10	74
A1770	Laying of fire detection system cables	45	0%	0%	04-May-10	17-Jun-10	64
A1850	Approval of Elevator Company	45	0%	0%	20-May-10	03-Jul-10	71
A1800	Installation of trunk line and supply cables	21	0%	0%	18-Jun-10	09-Jul-10	64
A1810	Installation of A.G wire and screens	45	0%	0%	10-Jul-10	23-Aug-10	64
A1740	Installation of wall speakers and camera	15	0%	0%	16-Aug-10	30-Aug-10	79
A1720	Outlet installation	15	0%	0%	16-Aug-10	30-Aug-10	79
A1760	Installation of TV, Telephone, and Data outlets	15	0%	0%	16-Aug-10	30-Aug-10	79
A1820	Installation of transformer	7	0%	0%	24-Aug-10	30-Aug-10	64
A1840	Installation of generators	60	0%	0%	04-Jul-10	02-Sep-10	76
A1780	Installation of fire warning, fire alarm and detection system	21	0%	0%	16-Aug-10	05-Sep-10	73
A1860	Installation of Elevators	65	0%	0%	04-Jul-10	07-Sep-10	71
A1830	Installation of O.G store equipment	15	0%	0%	31-Aug-10	14-Sep-10	64
A1700	Installation of lighting armatures and switches	11	0%	0%	20-Sep-10	30-Sep-10	0
	Context of Construction works	19	0%		04-Mar-10	22-Mar-10	239
A1180	Installation of roof heater wire	7	0%	0%	04-Mar-10	10-Mar-10	251
A1170	Electrical conduit piping	15	0%	0%	05-Mar-10	19-Mar-10	64
A1190	Installation of lightning conductor	12	0%	0%	11-Mar-10	22-Mar-10	239
	MECHANICAL WORKS	196	0%		18-Feb-10	02-Sep-10	76
	Context of Finishing works	165	0%		21-Mar-10	02-Sep-10	76
A1540	Installation of waste and clean water plumbing	60	0%	0%	21-Mar-10	19-May-10	62
A1550	Installation of fire system plumbing	60	0%	0%	15-Apr-10	13-Jun-10	62
A1560	Plumbing of heating and cooling equipments	75	0%	0%	15-May-10	29-Jul-10	90
A1600	Installation of ventilation duct	45	0%	0%	19-Jun-10	03-Aug-10	62
A1640	Installation of outdoor swimming pool plumbing and equipment	21	0%	0%	15-Jul-10	04-Aug-10	96
A1610	Installation of exhaust fan (aspirator)	7	0%	0%	04-Aug-10	10-Aug-10	62
A1650	Installation of indoor swimming pool plumbing and equipment	30	0%	0%	15-Jul-10	13-Aug-10	96
A1620	Installation of air conditioning plant	7	0%	0%	11-Aug-10	17-Aug-10	62
A1630	Installation of ventilation flap	15	0%	0%	04-Aug-10	18-Aug-10	91
A1570	Installation of chiller unit and equipment	21	0%	0%	30-Jul-10	19-Aug-10	90
A1580	Installation of heating boilers and equipments	21	0%	0%	30-Jul-10	19-Aug-10	90
A1590	Installation of radiator and convector	21	0%	0%	03-Aug-10	23-Aug-10	86
A1660	Installation of kitchen equipment and fittings	30	0%	0%	04-Aug-10	02-Sep-10	76
	Context of Construction works	21	0%		18-Feb-10	10-Mar-10	251



Actual Work | Critical Remaining Work | Summary
Remaining Work | % Complete

TASK filter: All Activities

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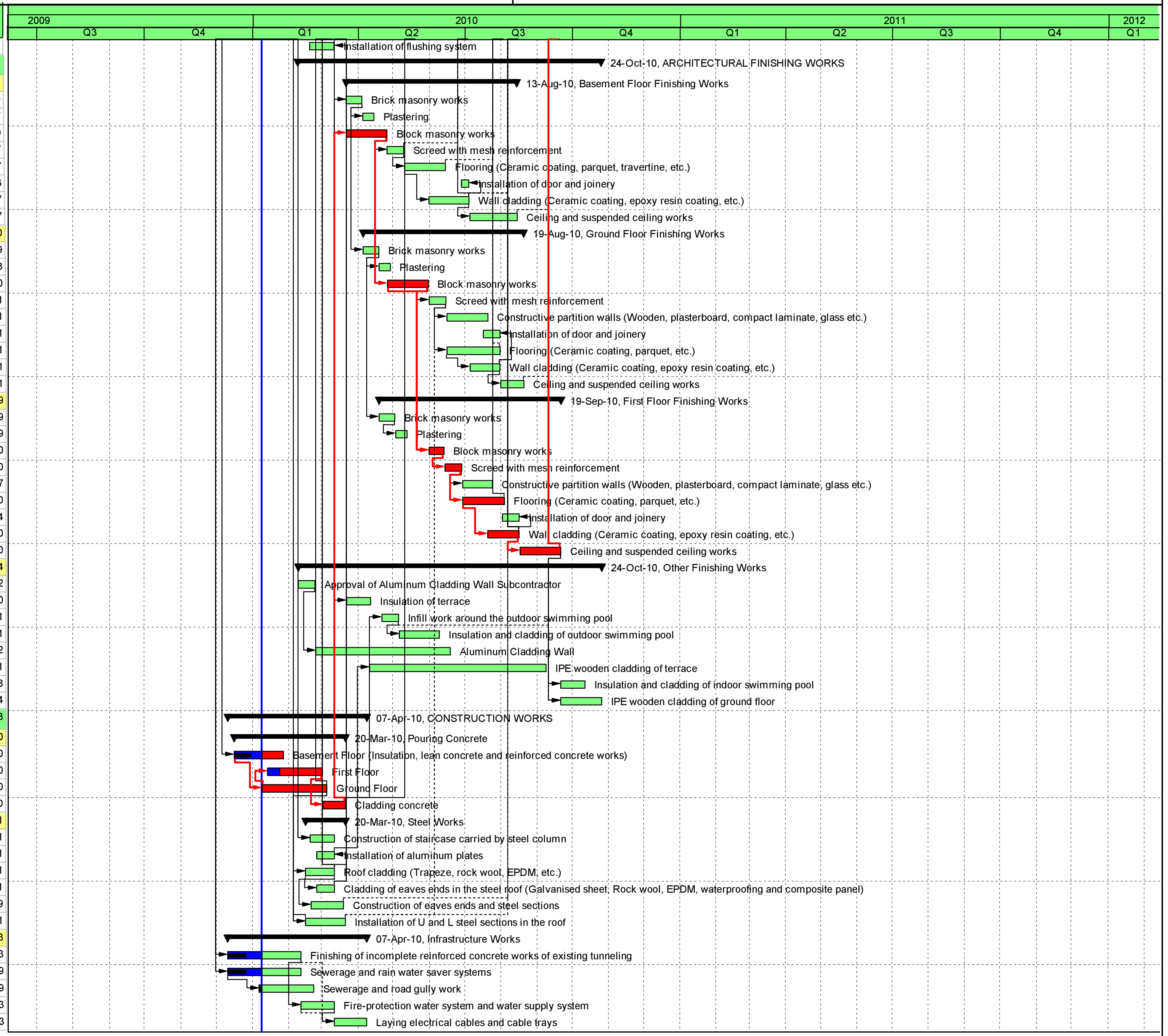
Activity ID	Activity Name	Original Duration	Schedule % Complete	Activity % Complete	Start	Finish	Total Float
A1160	Installation of flushing system	21	0%	0%	18-Feb-10	10-Mar-10	251
ARCHITECTURAL FINISHING WORKS		258	0%		08-Feb-10	24-Oct-10	24
Basement Floor Finishing Works		145	0%		21-Mar-10	13-Aug-10	96
A1200	Brick masonry works	14	0%	0%	21-Mar-10	03-Apr-10	189
A1230	Plastering	10	0%	0%	04-Apr-10	13-Apr-10	217
A1210	Block masonry works	35	0%	0%	21-Mar-10	24-Apr-10	0
A1220	Screed with mesh reinforcement	15	0%	0%	25-Apr-10	09-May-10	37
A1240	Flooring (Ceramic coating, parquet, travertine, etc.)	35	0%	0%	10-May-10	13-Jun-10	37
A1260	Installation of door and joinery	7	0%	0%	27-Jun-10	03-Jul-10	136
A1250	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	35	0%	0%	30-May-10	03-Jul-10	37
A1270	Ceiling and suspended ceiling works	40	0%	0%	04-Jul-10	13-Aug-10	37
Ground Floor Finishing Works		137	0%		04-Apr-10	19-Aug-10	90
A1330	Brick masonry works	14	0%	0%	04-Apr-10	17-Apr-10	189
A1310	Plastering	10	0%	0%	18-Apr-10	27-Apr-10	203
A1340	Block masonry works	35	0%	0%	25-Apr-10	29-May-10	0
A1290	Screed with mesh reinforcement	15	0%	0%	30-May-10	13-Jun-10	31
A1360	Constructive partition walls (Wooden, plasterboard, compact laminate	35	0%	0%	14-Jun-10	19-Jul-10	121
A1300	Installation of door and joinery	15	0%	0%	15-Jul-10	29-Jul-10	111
A1350	Flooring (Ceramic coating, parquet, etc.)	45	0%	0%	14-Jun-10	29-Jul-10	31
A1280	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	25	0%	0%	04-Jul-10	29-Jul-10	31
A1320	Ceiling and suspended ceiling works	21	0%	0%	30-Jul-10	19-Aug-10	31
First Floor Finishing Works		154	0%		18-Apr-10	19-Sep-10	59
A1430	Brick masonry works	14	0%	0%	18-Apr-10	01-May-10	189
A1410	Plastering	10	0%	0%	02-May-10	11-May-10	189
A1440	Block masonry works	14	0%	0%	30-May-10	12-Jun-10	0
A1380	Screed with mesh reinforcement	15	0%	0%	13-Jun-10	27-Jun-10	0
A1400	Constructive partition walls (Wooden, plasterboard, compact laminate	25	0%	0%	28-Jun-10	23-Jul-10	117
A1450	Flooring (Ceramic coating, parquet, etc.)	35	0%	0%	28-Jun-10	02-Aug-10	0
A1390	Installation of door and joinery	15	0%	0%	01-Aug-10	15-Aug-10	94
A1370	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	28	0%	0%	19-Jul-10	15-Aug-10	0
A1420	Ceiling and suspended ceiling works	35	0%	0%	16-Aug-10	19-Sep-10	0
Other Finishing Works		258	0%		08-Feb-10	24-Oct-10	24
A1530	Approval of Aluminum Cladding Wall Subcontractor	15	0%	0%	08-Feb-10*	22-Feb-10	152
A1500	Insulation of terrace	21	0%	0%	21-Mar-10	10-Apr-10	220
A1490	Infill work around the outdoor swimming pool	15	0%	0%	20-Apr-10	04-May-10	161
A1460	Insulation and cladding of outdoor swimming pool	35	0%	0%	05-May-10	08-Jun-10	161
A1520	Aluminum Cladding Wall	115	0%	0%	23-Feb-10	17-Jun-10	152
A1510	IPE wooden cladding of terrace	150	0%	0%	10-Apr-10	07-Sep-10	71
A1470	Insulation and cladding of indoor swimming pool	21	0%	0%	20-Sep-10	10-Oct-10	38
A1480	IPE wooden cladding of ground floor	35	0%	0%	20-Sep-10	24-Oct-10	24
CONSTRUCTION WORKS		117	0%		10-Dec-09 A	07-Apr-10	223
Pouring Concrete		94	0%		15-Dec-09 A	20-Mar-10	0
A1060	Basement Floor (Insulation, lean concrete and reinforced concrete wc	28	77.68%	35%	15-Dec-09 A	26-Jan-10	0
A1080	First Floor	37	0%	0%	13-Jan-10 A	28-Feb-10	0
A1070	Ground Floor	56	0%	0%	08-Jan-10	04-Mar-10	0
A1150	Cladding concrete	20	0%	0%	01-Mar-10	20-Mar-10	0
Steel Works		35	0%		14-Feb-10	20-Mar-10	241
A1090	Construction of staircase carried by steel column	21	0%	0%	18-Feb-10	10-Mar-10	251
A1140	Installation of aluminum plates	15	0%	0%	24-Feb-10	10-Mar-10	71
A1120	Roof cladding (Trapeze, rock wool, EPDM, etc.)	25	0%	0%	14-Feb-10	10-Mar-10	71
A1130	Cladding of eaves ends in the steel roof (Galvanised sheet, Rock woo	15	0%	0%	24-Feb-10	10-Mar-10	71
A1110	Construction of eaves ends and steel sections	28	0%	0%	19-Feb-10	18-Mar-10	149
A1100	Installation of U and L steel sections in the roof	35	0%	0%	14-Feb-10	20-Mar-10	71
Infrastructure Works		117	0%		10-Dec-09 A	07-Apr-10	223
A1900	Finishing of incomplete reinforced concrete works of existing tunneling	45	60%	25%	10-Dec-09 A	10-Feb-10	223
A1880	Sewerage and rain water saver systems	45	60%	25%	10-Dec-09 A	10-Feb-10	269
A1890	Sewerage and road gully work	45	4.44%	2%	06-Jan-10 A	21-Feb-10	269
A1910	Fire-protection water system and water supply system	28	0%	0%	10-Feb-10	10-Mar-10	223
A1920	Laying electrical cables and cable trays	28	0%	0%	10-Mar-10	07-Apr-10	223



Actual Work | Critical Remaining Work | Summary
Remaining Work | % Complete

TASK filter: All Activities

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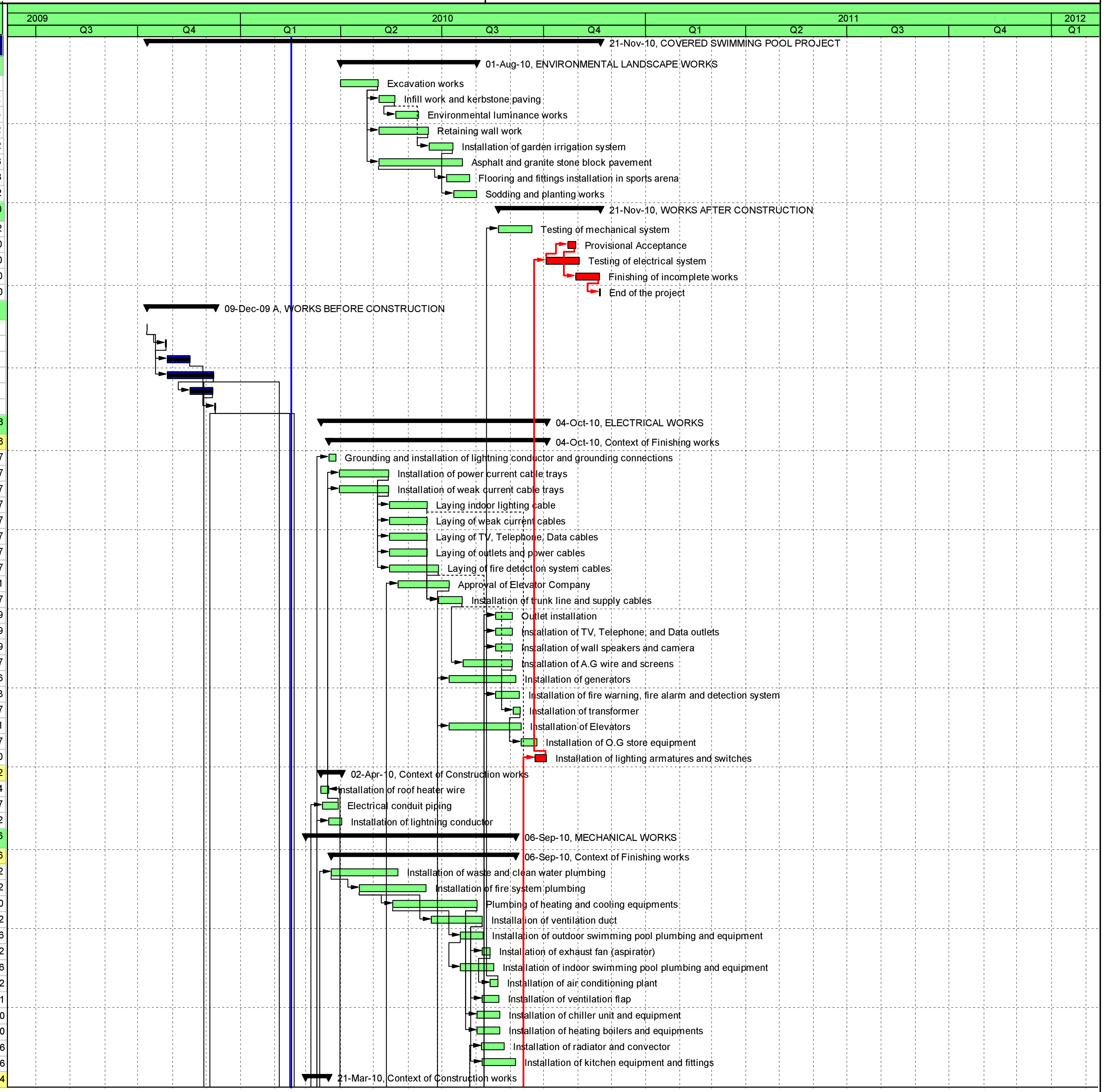
Activity ID	Activity Name	Original Duration	Schedule % Complete	Activity % Complete	Start	Finish	Total Float
COVERED SWIMMING POOL PROJECT		406	0%		09-Oct-09 A	21-Nov-10	0
ENVIRONMENTAL LANDSCAPE WORKS		122	0%		01-Apr-10	01-Aug-10	112
A1870	Excavation works	35	0%	0%	01-Apr-10*	05-May-10	112
A1960	Infill work and kerbstone paving	15	0%	0%	06-May-10	20-May-10	142
A1990	Environmental luminance works	21	0%	0%	21-May-10	10-Jun-10	163
A1930	Retaining wall work	45	0%	0%	06-May-10	19-Jun-10	112
A1970	Installation of garden irrigation system	21	0%	0%	20-Jun-10	11-Jul-10	112
A1940	Asphalt and granite stone block pavement	75	0%	0%	06-May-10	20-Jul-10	118
A1950	Flooring and fittings installation in sports arena	21	0%	0%	06-Jul-10	26-Jul-10	118
A1980	Sodding and planting works	21	0%	0%	12-Jul-10	01-Aug-10	112
WORKS AFTER CONSTRUCTION		92	0%		21-Aug-10	21-Nov-10	0
A2000	Testing of mechanical system	30	0%	0%	21-Aug-10	20-Sep-10	62
A2020	Provisional Acceptance	7	0%	0%	23-Oct-10	30-Oct-10	0
A2010	Testing of electrical system	30	0%	0%	03-Oct-10	02-Nov-10	0
A2030	Finishing of incomplete works	21	0%	0%	30-Oct-10	20-Nov-10	0
A2040	End of the project	1	0%	0%	20-Nov-10	21-Nov-10	0
WORKS BEFORE CONSTRUCTION		62	0%		09-Oct-09 A	09-Dec-09 A	
A1000	Signing contract	1	100%	100%	09-Oct-09 A	09-Oct-09 A	
A1010	Handing over of construction site	1	100%	100%	26-Oct-09 A	26-Oct-09 A	
A1030	Approval of key staff	21	100%	100%	27-Oct-09 A	17-Nov-09 A	
A1040	Getting work permits (municipality)	21	100%	100%	27-Oct-09 A	17-Nov-09 A	
A1020	Mobilization work	21	100%	100%	17-Nov-09 A	07-Dec-09 A	
A1050	Getting consultant permits to work in construction site	1	100%	100%	09-Dec-09 A	09-Dec-09 A	
ELECTRICAL WORKS		203	0%		15-Mar-10	04-Oct-10	48
Context of Finishing works		196	0%		22-Mar-10	04-Oct-10	48
A1790	Grounding and installation of lightning conductor and grounding conn	7	0%	0%	22-Mar-10	28-Mar-10	237
A1670	Installation of power current cable trays	45	0%	0%	31-Mar-10	14-May-10	67
A1680	Installation of weak current cable trays	45	0%	0%	31-Mar-10	14-May-10	57
A1690	Laying indoor lighting cable	35	0%	0%	15-May-10	18-Jun-10	67
A1730	Laying of weak current cables	35	0%	0%	15-May-10	18-Jun-10	67
A1750	Laying of TV, Telephone, Data cables	35	0%	0%	15-May-10	18-Jun-10	67
A1710	Laying of outlets and power cables	35	0%	0%	15-May-10	18-Jun-10	67
A1770	Laying of fire detection system cables	45	0%	0%	15-May-10	28-Jun-10	57
A1850	Approval of Elevator Company	45	0%	0%	23-May-10	08-Jul-10	71
A1800	Installation of trunk line and supply cables	21	0%	0%	29-Jun-10	20-Jul-10	57
A1720	Outlet installation	15	0%	0%	19-Aug-10	03-Sep-10	79
A1760	Installation of TV, Telephone, and Data outlets	15	0%	0%	19-Aug-10	03-Sep-10	79
A1740	Installation of wall speakers and camera	15	0%	0%	19-Aug-10	03-Sep-10	79
A1810	Installation of A.G wire and screens	45	0%	0%	21-Jul-10	03-Sep-10	57
A1840	Installation of generators	60	0%	0%	08-Jul-10	06-Sep-10	76
A1780	Installation of fire warning, fire alarm and detection system	21	0%	0%	19-Aug-10	09-Sep-10	73
A1820	Installation of transformer	7	0%	0%	04-Sep-10	10-Sep-10	57
A1860	Installation of Elevators	65	0%	0%	08-Jul-10	11-Sep-10	71
A1830	Installation of O.G store equipment	15	0%	0%	11-Sep-10	25-Sep-10	57
A1700	Installation of lighting armatures and switches	11	0%	0%	23-Sep-10	04-Oct-10	0
Context of Construction works		19	0%		15-Mar-10	02-Apr-10	232
A1180	Installation of roof heater wire	7	0%	0%	15-Mar-10	21-Mar-10	244
A1170	Electrical conduit piping	15	0%	0%	16-Mar-10	30-Mar-10	57
A1190	Installation of lightning conductor	12	0%	0%	22-Mar-10	02-Apr-10	232
MECHANICAL WORKS		189	0%		01-Mar-10	06-Sep-10	76
Context of Finishing works		165	0%		24-Mar-10	06-Sep-10	76
A1540	Installation of waste and clean water plumbing	60	0%	0%	24-Mar-10	23-May-10	62
A1550	Installation of fire system plumbing	60	0%	0%	18-Apr-10	17-Jun-10	62
A1560	Plumbing of heating and cooling equipments	75	0%	0%	18-May-10	02-Aug-10	90
A1600	Installation of ventilation duct	45	0%	0%	22-Jun-10	07-Aug-10	62
A1640	Installation of outdoor swimming pool plumbing and equipment	21	0%	0%	18-Jul-10	08-Aug-10	96
A1610	Installation of exhaust fan (aspirator)	7	0%	0%	07-Aug-10	14-Aug-10	62
A1650	Installation of indoor swimming pool plumbing and equipment	30	0%	0%	18-Jul-10	17-Aug-10	96
A1620	Installation of air conditioning plant	7	0%	0%	14-Aug-10	21-Aug-10	62
A1630	Installation of ventilation flap	15	0%	0%	07-Aug-10	22-Aug-10	91
A1570	Installation of chiller unit and equipment	21	0%	0%	02-Aug-10	23-Aug-10	90
A1580	Installation of heating boilers and equipments	21	0%	0%	02-Aug-10	23-Aug-10	90
A1590	Installation of radiator and convector	21	0%	0%	06-Aug-10	27-Aug-10	86
A1660	Installation of kitchen equipment and fittings	30	0%	0%	07-Aug-10	06-Sep-10	76
Context of Construction works		21	0%		01-Mar-10	21-Mar-10	244



Actual Work | Critical Remaining Work | Summary
Remaining Work | % Complete

TASK filter: All Activities

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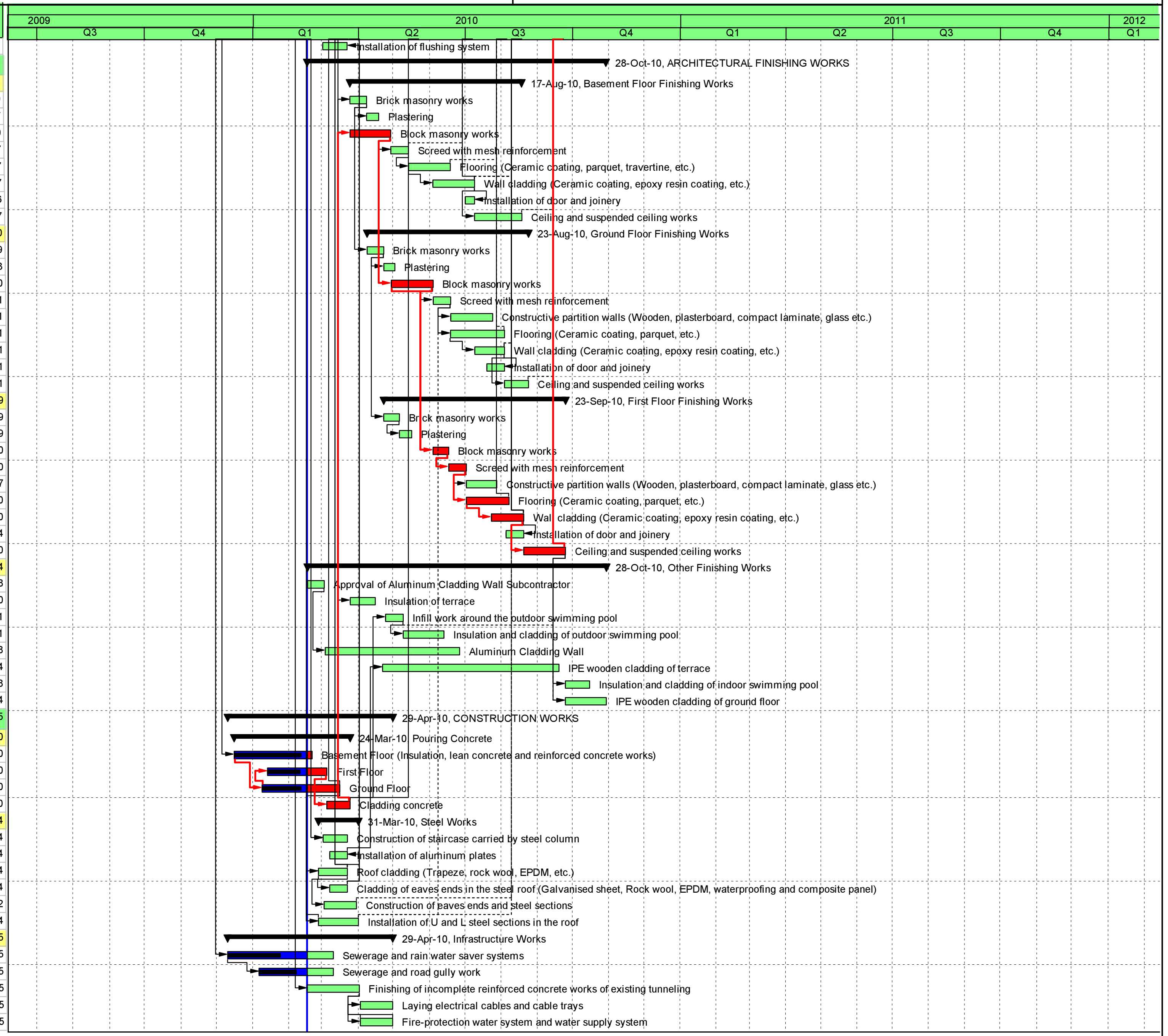
COVERED SWIMMING POOL PROJECT	Revised Schedule 4 - 16.02.2010	08-Jan-11 15:19

Activity ID	Activity Name	Original Duration	Schedule % Complete	Activity % Complete	Start	Finish	Total Float
A1160	Installation of flushing system	21	0%	0%	01-Mar-10	21-Mar-10	244
ARCHITECTURAL FINISHING WORKS		254	0%		16-Feb-10	28-Oct-10	24
Basement Floor Finishing Works		145	0%		24-Mar-10	17-Aug-10	96
A1200	Brick masonry works	14	0%	0%	24-Mar-10	07-Apr-10	189
A1230	Plastering	10	0%	0%	07-Apr-10	17-Apr-10	217
A1210	Block masonry works	35	0%	0%	24-Mar-10	28-Apr-10	0
A1220	Screed with mesh reinforcement	15	0%	0%	28-Apr-10	13-May-10	37
A1240	Flooring (Ceramic coating, parquet, travertine, etc.)	35	0%	0%	13-May-10	17-Jun-10	37
A1250	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	35	0%	0%	02-Jun-10	08-Jul-10	37
A1260	Installation of door and joinery	7	0%	0%	30-Jun-10	08-Jul-10	136
A1270	Ceiling and suspended ceiling works	40	0%	0%	08-Jul-10	17-Aug-10	37
Ground Floor Finishing Works		137	0%		07-Apr-10	23-Aug-10	90
A1330	Brick masonry works	14	0%	0%	07-Apr-10	21-Apr-10	189
A1310	Plastering	10	0%	0%	21-Apr-10	01-May-10	203
A1340	Block masonry works	35	0%	0%	28-Apr-10	02-Jun-10	0
A1290	Screed with mesh reinforcement	15	0%	0%	02-Jun-10	17-Jun-10	31
A1360	Constructive partition walls (Wooden, plasterboard, compact laminate	35	0%	0%	17-Jun-10	23-Jul-10	121
A1350	Flooring (Ceramic coating, parquet, etc.)	45	0%	0%	17-Jun-10	02-Aug-10	31
A1280	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	25	0%	0%	08-Jul-10	02-Aug-10	31
A1300	Installation of door and joinery	15	0%	0%	18-Jul-10	02-Aug-10	111
A1320	Ceiling and suspended ceiling works	21	0%	0%	02-Aug-10	23-Aug-10	31
First Floor Finishing Works		154	0%		21-Apr-10	23-Sep-10	59
A1430	Brick masonry works	14	0%	0%	21-Apr-10	05-May-10	189
A1410	Plastering	10	0%	0%	05-May-10	15-May-10	189
A1440	Block masonry works	14	0%	0%	02-Jun-10	16-Jun-10	0
A1380	Screed with mesh reinforcement	15	0%	0%	16-Jun-10	01-Jul-10	0
A1400	Constructive partition walls (Wooden, plasterboard, compact laminate	25	0%	0%	01-Jul-10	27-Jul-10	117
A1450	Flooring (Ceramic coating, parquet, etc.)	35	0%	0%	01-Jul-10	06-Aug-10	0
A1370	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	28	0%	0%	22-Jul-10	19-Aug-10	0
A1390	Installation of door and joinery	15	0%	0%	04-Aug-10	19-Aug-10	94
A1420	Ceiling and suspended ceiling works	35	0%	0%	19-Aug-10	23-Sep-10	0
Other Finishing Works		254	0%		16-Feb-10	28-Oct-10	24
A1530	Approval of Aluminum Cladding Wall Subcontractor	15	0%	0%	16-Feb-10*	02-Mar-10	148
A1500	Insulation of terrace	21	0%	0%	24-Mar-10	14-Apr-10	220
A1490	Infill work around the outdoor swimming pool	15	0%	0%	23-Apr-10	08-May-10	161
A1460	Insulation and cladding of outdoor swimming pool	35	0%	0%	08-May-10	12-Jun-10	161
A1520	Aluminum Cladding Wall	115	0%	0%	03-Mar-10	25-Jun-10	148
A1510	IPE wooden cladding of terrace	150	0%	0%	21-Apr-10	18-Sep-10	64
A1470	Insulation and cladding of indoor swimming pool	21	0%	0%	23-Sep-10	14-Oct-10	38
A1480	IPE wooden cladding of ground floor	35	0%	0%	23-Sep-10	28-Oct-10	24
CONSTRUCTION WORKS		139	0%		10-Dec-09 A	29-Apr-10	205
Pouring Concrete		97	0%		15-Dec-09 A	24-Mar-10	0
A1060	Basement Floor (Insulation, lean concrete and reinforced concrete wc	28	100%	85%	15-Dec-09 A	20-Feb-10	0
A1080	First Floor	37	91.22%	55%	13-Jan-10 A	04-Mar-10	0
A1070	Ground Floor	56	69.64%	50%	08-Jan-10 A	15-Mar-10	0
A1150	Cladding concrete	20	0%	0%	04-Mar-10 A	24-Mar-10	0
Steel Works		35	0%		25-Feb-10	31-Mar-10	234
A1090	Construction of staircase carried by steel column	21	0%	0%	01-Mar-10	21-Mar-10	244
A1140	Installation of aluminum plates	15	0%	0%	07-Mar-10	21-Mar-10	64
A1120	Roof cladding (Trapeze, rock wool, EPDM, etc.)	25	0%	0%	25-Feb-10	21-Mar-10	64
A1130	Cladding of eaves ends in the steel roof (Galvanised sheet, Rock woo	15	0%	0%	07-Mar-10	21-Mar-10	64
A1110	Construction of eaves ends and steel sections	28	0%	0%	02-Mar-10	29-Mar-10	142
A1100	Installation of U and L steel sections in the roof	35	0%	0%	25-Feb-10	31-Mar-10	64
Infrastructure Works		139	0%		10-Dec-09 A	29-Apr-10	205
A1880	Sewerage and rain water saver systems	45	100%	50%	10-Dec-09 A	10-Mar-10	255
A1890	Sewerage and road gully work	45	91.11%	50%	06-Jan-10 A	10-Mar-10	255
A1900	Finishing of incomplete reinforced concrete works of existing tunneling	45	0%	0%	16-Feb-10	01-Apr-10	205
A1920	Laying electrical cables and cable trays	28	0%	0%	02-Apr-10	29-Apr-10	205
A1910	Fire-protection water system and water supply system	28	0%	0%	02-Apr-10	29-Apr-10	205



Actual Work — Critical Remaining Work — Summary
Remaining Work — % Complete

Page 2 of 2

TASK filter: All Activities

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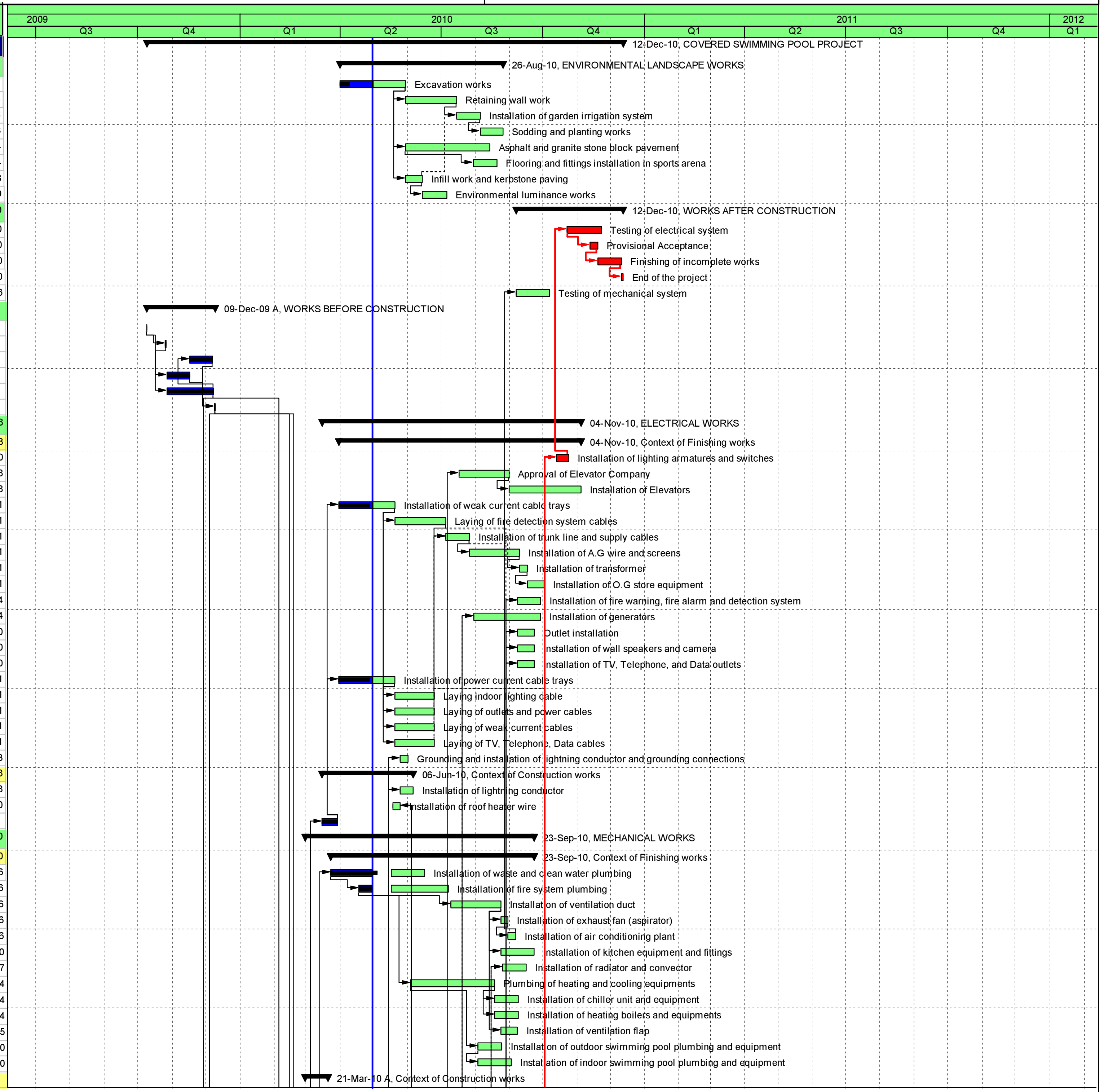
COVERED SWIMMING POOL PROJECT | Revised Schedule 5 - 01.05.2010. | 08-Jan-11 16:23

Activity ID	Activity Name	Original Duration	Schedule % Complete	Activity % Complete	Start	Finish	Total Float
COVERED SWIMMING POOL PROJECT		427	0%		09-Oct-09 A	12-Dec-10	0
ENVIRONMENTAL LANDSCAPE WORKS		147	0%		01-Apr-10 A	26-Aug-10	108
A1870	Excavation works	35	85.71%	15%	01-Apr-10 A	30-May-10	108
A1930	Retaining wall work	45	0%	0%	30-May-10	15-Jul-10	108
A1970	Installation of garden irrigation system	21	0%	0%	15-Jul-10	05-Aug-10	108
A1980	Sodding and planting works	21	0%	0%	05-Aug-10	26-Aug-10	108
A1940	Asphalt and granite stone block pavement	75	0%	0%	30-May-10	14-Aug-10	114
A1950	Flooring and fittings installation in sports arena	21	0%	0%	30-Jul-10	20-Aug-10	114
A1960	Infill work and kerbstone paving	15	0%	0%	30-May-10	14-Jun-10	138
A1990	Environmental luminance works	21	0%	0%	14-Jun-10	06-Jul-10	159
WORKS AFTER CONSTRUCTION		96	0%		07-Sep-10	12-Dec-10	0
A2010	Testing of electrical system	31	0%	0%	23-Oct-10	23-Nov-10	0
A2020	Provisional Acceptance	7	0%	0%	12-Nov-10	19-Nov-10	0
A2030	Finishing of incomplete works	22	0%	0%	19-Nov-10	11-Dec-10	0
A2040	End of the project	1	0%	0%	11-Dec-10	12-Dec-10	0
A2000	Testing of mechanical system	30	0%	0%	07-Sep-10	07-Oct-10	66
WORKS BEFORE CONSTRUCTION		62	0%		09-Oct-09 A	09-Dec-09 A	
A1000	Signing contract	1	100%	100%	09-Oct-09 A	09-Oct-09 A	
A1010	Handing over of construction site	1	100%	100%	26-Oct-09 A	26-Oct-09 A	
A1020	Mobilization work	21	100%	100%	17-Nov-09 A	07-Dec-09 A	
A1030	Approval of key staff	21	100%	100%	27-Oct-09 A	17-Nov-09 A	
A1040	Getting work permits (municipality)	21	100%	100%	27-Oct-09 A	08-Dec-09 A	
A1050	Getting consultant permits to work in construction site	1	100%	100%	09-Dec-09 A	09-Dec-09 A	
ELECTRICAL WORKS		233	0%		16-Mar-10 A	04-Nov-10	38
Context of Finishing works		218	0%		31-Mar-10 A	04-Nov-10	38
A1700	Installation of lighting armatures and switches	11	0%	0%	13-Oct-10	24-Oct-10	0
A1850	Approval of Elevator Company	45	0%	0%	18-Jul-10	31-Aug-10	38
A1860	Installation of Elevators	65	0%	0%	01-Sep-10	04-Nov-10	38
A1680	Installation of weak current cable trays	45	68.89%	55%	31-Mar-10 A	21-May-10	71
A1770	Laying of fire detection system cables	45	0%	0%	21-May-10	06-Jul-10	71
A1800	Installation of trunk line and supply cables	21	0%	0%	06-Jul-10	27-Jul-10	71
A1810	Installation of A.G wire and screens	45	0%	0%	27-Jul-10	10-Sep-10	71
A1820	Installation of transformer	7	0%	0%	10-Sep-10	17-Sep-10	71
A1830	Installation of O.G store equipment	15	0%	0%	17-Sep-10	02-Oct-10	71
A1780	Installation of fire warning, fire alarm and detection system	21	0%	0%	08-Sep-10	29-Sep-10	74
A1840	Installation of generators	60	0%	0%	31-Jul-10	29-Sep-10	74
A1720	Outlet installation	15	0%	0%	08-Sep-10	23-Sep-10	80
A1740	Installation of wall speakers and camera	15	0%	0%	08-Sep-10	23-Sep-10	80
A1760	Installation of TV, Telephone, and Data outlets	15	0%	0%	08-Sep-10	23-Sep-10	80
A1670	Installation of power current cable trays	45	68.89%	55%	31-Mar-10 A	21-May-10	81
A1690	Laying indoor lighting cable	35	0%	0%	21-May-10	25-Jun-10	81
A1710	Laying of outlets and power cables	35	0%	0%	21-May-10	25-Jun-10	81
A1730	Laying of weak current cables	35	0%	0%	21-May-10	25-Jun-10	81
A1750	Laying of TV, Telephone, Data cables	35	0%	0%	21-May-10	25-Jun-10	81
A1790	Grounding and installation of lightning conductor and grounding conn	7	0%	0%	26-May-10	01-Jun-10	193
Context of Construction works		83	0%		16-Mar-10 A	06-Jun-10	188
A1190	Installation of lightning conductor	12	0%	0%	26-May-10	06-Jun-10	188
A1180	Installation of roof heater wire	7	0%	0%	19-May-10	25-May-10	200
A1170	Electrical conduit piping	15	100%	100%	16-Mar-10 A	30-Mar-10 A	
MECHANICAL WORKS		206	0%		01-Mar-10 A	23-Sep-10	80
Context of Finishing works		182	0%		24-Mar-10 A	23-Sep-10	80
A1540	Installation of waste and clean water plumbing	60	62.25%	50%	24-Mar-10 A	16-Jun-10	66
A1550	Installation of fire system plumbing	60	20.58%	15%	18-Apr-10 A	08-Jul-10	66
A1600	Installation of ventilation duct	45	0%	0%	10-Jul-10	24-Aug-10	66
A1610	Installation of exhaust fan (aspirator)	7	0%	0%	24-Aug-10	31-Aug-10	66
A1620	Installation of air conditioning plant	7	0%	0%	31-Aug-10	07-Sep-10	66
A1660	Installation of kitchen equipment and fittings	30	0%	0%	24-Aug-10	23-Sep-10	80
A1590	Installation of radiator and convector	21	0%	0%	26-Aug-10	16-Sep-10	87
A1560	Plumbing of heating and cooling equipments	75	0%	0%	04-Jun-10	19-Aug-10	94
A1570	Installation of chiller unit and equipment	21	0%	0%	19-Aug-10	09-Sep-10	94
A1580	Installation of heating boilers and equipments	21	0%	0%	19-Aug-10	09-Sep-10	94
A1630	Installation of ventilation flap	15	0%	0%	24-Aug-10	08-Sep-10	95
A1640	Installation of outdoor swimming pool plumbing and equipment	21	0%	0%	04-Aug-10	25-Aug-10	100
A1650	Installation of indoor swimming pool plumbing and equipment	30	0%	0%	04-Aug-10	03-Sep-10	100
Context of Construction works		21	0%		01-Mar-10 A	21-Mar-10 A	



Actual Work | Critical Remaining Work | Summary
Remaining Work | % Complete

TASK filter: All Activities

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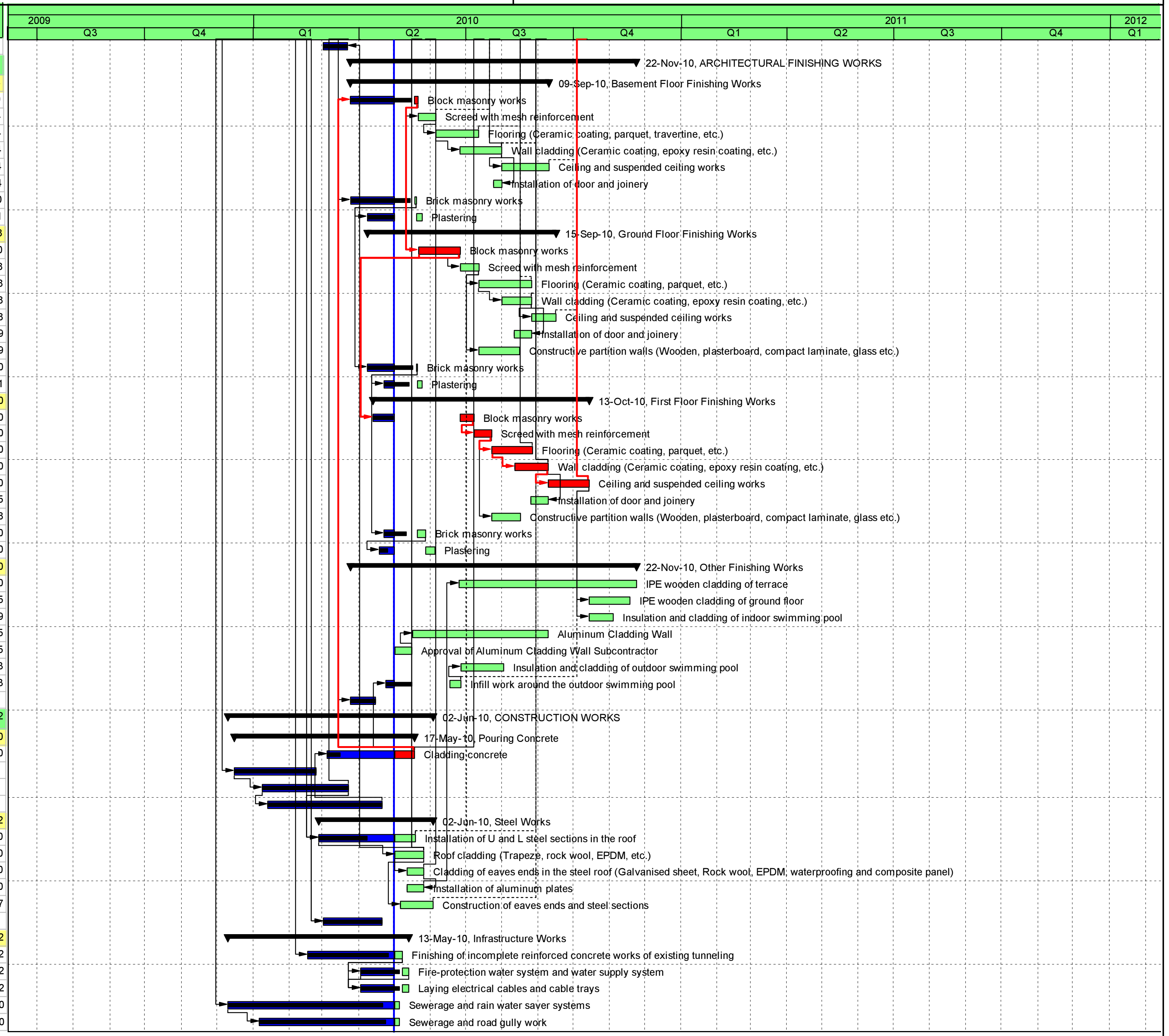
Activity ID	Activity Name	Original Duration	Schedule % Complete	Activity % Complete	Start	Finish	Total Float
A1160	Installation of flushing system	21	100%	100%	01-Mar-10 A	21-Mar-10 A	
ARCHITECTURAL FINISHING WORKS		242	0%		24-Mar-10 A	22-Nov-10	20
Basement Floor Finishing Works		168	0%		24-Mar-10 A	09-Sep-10	94
A1210	Block masonry works	35	100%	90%	24-Mar-10 A	21-May-10	0
A1220	Screed with mesh reinforcement	15	0%	0%	21-May-10	05-Jun-10	34
A1240	Flooring (Ceramic coating, parquet, travertine, etc.)	35	0%	0%	05-Jun-10	11-Jul-10	34
A1250	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	35	0%	0%	25-Jun-10	31-Jul-10	34
A1270	Ceiling and suspended ceiling works	40	0%	0%	31-Jul-10	09-Sep-10	34
A1260	Installation of door and joinery	7	0%	0%	24-Jul-10	31-Jul-10	134
A1200	Brick masonry works	14	100%	90%	24-Mar-10 A	19-May-10	190
A1230	Plastering	10	100%	50%	07-Apr-10 A	24-May-10	201
Ground Floor Finishing Works		160	0%		07-Apr-10 A	15-Sep-10	88
A1340	Block masonry works	35	0%	0%	21-May-10	25-Jun-10	0
A1290	Screed with mesh reinforcement	15	0%	0%	25-Jun-10	11-Jul-10	28
A1350	Flooring (Ceramic coating, parquet, etc.)	45	0%	0%	11-Jul-10	25-Aug-10	28
A1280	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	25	0%	0%	31-Jul-10	25-Aug-10	28
A1320	Ceiling and suspended ceiling works	21	0%	0%	25-Aug-10	15-Sep-10	28
A1300	Installation of door and joinery	15	0%	0%	10-Aug-10	25-Aug-10	109
A1360	Constructive partition walls (Wooden, plasterboard, compact laminat	35	0%	0%	11-Jul-10	15-Aug-10	119
A1330	Brick masonry works	14	100%	90%	07-Apr-10 A	20-May-10	190
A1310	Plastering	10	93.5%	65%	21-Apr-10 A	24-May-10	201
First Floor Finishing Works		184	0%		12-Apr-10 A	13-Oct-10	60
A1440	Block masonry works	14	100%	20%	12-Apr-10 A	07-Jul-10	0
A1380	Screed with mesh reinforcement	15	0%	0%	07-Jul-10	22-Jul-10	0
A1450	Flooring (Ceramic coating, parquet, etc.)	35	0%	0%	22-Jul-10	26-Aug-10	0
A1370	Wall cladding (Ceramic coating, epoxy resin coating, etc.)	28	0%	0%	11-Aug-10	08-Sep-10	0
A1420	Ceiling and suspended ceiling works	35	0%	0%	08-Sep-10	13-Oct-10	0
A1390	Installation of door and joinery	15	0%	0%	24-Aug-10	08-Sep-10	95
A1400	Constructive partition walls (Wooden, plasterboard, compact laminat	25	0%	0%	22-Jul-10	16-Aug-10	118
A1430	Brick masonry works	14	66.79%	55%	21-Apr-10 A	27-May-10	190
A1410	Plastering	10	100%	15%	18-Apr-10 A	04-Jun-10	190
Other Finishing Works		242	0%		24-Mar-10 A	22-Nov-10	20
A1510	IPE wooden cladding of terrace	150	0%	0%	25-Jun-10	22-Nov-10	20
A1480	IPE wooden cladding of ground floor	35	0%	0%	13-Oct-10	17-Nov-10	25
A1470	Insulation and cladding of indoor swimming pool	21	0%	0%	13-Oct-10	03-Nov-10	39
A1520	Aluminum Cladding Wall	115	0%	0%	16-May-10	08-Sep-10	95
A1530	Approval of Aluminum Cladding Wall Subcontractor	15	0%	0%	01-May-10*	15-May-10	95
A1460	Insulation and cladding of outdoor swimming pool	35	0%	0%	26-Jun-10	01-Aug-10	133
A1490	Infill work around the outdoor swimming pool	15	49%	35%	23-Apr-10 A	26-Jun-10	133
A1500	Insulation of terrace	21	100%	100%	24-Mar-10 A	14-Apr-10 A	
CONSTRUCTION WORKS		173	0%		10-Dec-09 A	02-Jun-10	192
Pouring Concrete		97	0%		15-Dec-09 A	17-May-10	0
A1150	Cladding concrete	20	100%	15%	04-Mar-10 A	17-May-10	0
A1060	Basement Floor (Insulation, lean concrete and reinforced concrete wc	28	100%	100%	15-Dec-09 A	23-Feb-10 A	
A1070	Ground Floor	56	100%	100%	08-Jan-10 A	23-Mar-10 A	
A1080	First Floor	37	100%	100%	13-Jan-10 A	20-Apr-10 A	
Steel Works		98	0%		25-Feb-10 A	02-Jun-10	192
A1100	Installation of U and L steel sections in the roof	35	100%	50%	25-Feb-10 A	18-May-10	20
A1120	Roof cladding (Trapeze, rock wool, EPDM, etc.)	25	0%	0%	01-May-10	25-May-10	20
A1130	Cladding of eaves ends in the steel roof (Galvanised sheet, Rock woo	15	0%	0%	11-May-10	25-May-10	20
A1140	Installation of aluminum plates	15	0%	0%	11-May-10	25-May-10	20
A1110	Construction of eaves ends and steel sections	28	0%	0%	06-May-10	02-Jun-10	97
A1090	Construction of staircase carried by steel column	21	100%	100%	01-Mar-10 A	20-Apr-10 A	
Infrastructure Works		139	0%		10-Dec-09 A	13-May-10	212
A1900	Finishing of incomplete reinforced concrete works of existing tunneling	45	100%	85%	16-Feb-10 A	07-May-10	212
A1910	Fire-protection water system and water supply system	28	100%	80%	02-Apr-10 A	13-May-10	212
A1920	Laying electrical cables and cable trays	28	100%	80%	02-Apr-10 A	13-May-10	212
A1880	Sewerage and rain water saver systems	45	100%	90%	10-Dec-09 A	05-May-10	220
A1890	Sewerage and road gully work	45	100%	90%	06-Jan-10 A	05-May-10	220



Actual Work | Critical Remaining Work | Summary
Remaining Work | % Complete

TASK filter: All Activities

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