DELAYS IN CONSTRUCTION PROJECTS IN GREECE: CAUSES, EFFECTS AND PROJECT MANAGEMENT TOOLS

By

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Abstract

Time overruns in construction projects is a global phenomenon and is commonly cited in Greece as well, calling for the implementation of sound and effective project management. Although construction development has presented significant prosperity the last decade, experience has showed that projects are running significantly over schedule raising the question of what the causes of such delays are and to what extent are contractors and other actors of the construction industry aware of certain project management tools and techniques that will facilitate the timely completion of a contract.

The present dissertation examines and analyses the factors causing delays in large- and medium-scale projects in the private sector in Greece. It also aims to gain an insight of the Greek experience regarding project management tools and methods, the professionals' awareness of such tools and their willingness to adopt them. These are achieved through a questionnaire distributed to a number of participants in the construction industry and through interviews held with some of the respondents, with reference to a theoretical background.

Key Words: Project Management, Time Overruns, Project Management Tools and Techniques, Causes of Delays, Delay Effects

Word Count: 10,874

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1. INTRODUCTION

1.1 BACKGROUND

The definition of project management provided by the UK Body of Knowledge (BoK) (Association of Project Management, 1995) is as follows: project management is "the planning, organisation, monitoring and control of all aspects of a project and the motivation of all involved to achieve the project objectives safely and within agreed time, cost and performance criteria".

Many attempts have been made but giving a precise definition is not that simple as project management is an evolving phenomenon. However, it is widely accepted that project management should be brought into the project right from its very early stages (from conception to completion) since, "doing things right the first time -like the early stages of construction- adds nothing to the cost of the product or service. Doing things wrong is what costs money" (Crosby, 1979).

In practice, project management involves planning and controlling of all the activities that constitute the project in an efficient way that will resolve, or even prevent, problems that may result into time or cost overruns, in order to facilitate the achievement of the time-cost-quality goals and client satisfaction.

1.2 IDENTIFICATION OF RESEARCH PROBLEM AND PROBLEM OWNER

"Managing the programme is, for many, the core competence of the discipline of project management" (Winch, 2002). The problem of delays in construction projects is a global phenomenon and is particularly common in Greek projects as well, generating negative effects on the overall project's performance. Cost

overruns, disputes, litigation, reworks or total reconstruction of parts of the project, are only some of the effects that delays throughout the construction progress may have. Efficient and effective management of programme acts as the essential mechanism to address this problem.

It is important that the effects of delays are examined together with the factors that cause them (in terms of identification of those factors, as well as examination of their frequency and severity) in order to gain an understanding of what actions should actors involved in construction process (clients, contractors, consultants) take to avoid such delays.

The inherent complexity and uncertainty of construction projects make the temporal planning and monitoring a rather complicated task. However, the contribution of the project management tools and techniques in addressing this problem is great, as there are several advanced techniques developed to support the planning and control of tasks duration and their interrelationship, resource availability and spatial organisation.

1.3 Research Objectives

This report aims to:

- Point out the means available to the contractor to achieve timely completion, by giving a brief overview of the project management tools and techniques.
- Identify the main factors causing delays in Greek construction projects.
- Discuss the effects of delays on the project performance.
- Gain an insight to the current state of knowledge of Greek professionals, regarding the management tools and techniques, as well as to their willingness to adopt such techniques.

- Evaluate the significance of each delay factor, the frequency by which they are cited in Greek projects and the contribution of the management tools to these factors.

1.4 Report Layout

Chapter 2 provides a theoretical background and literature review on setting the project targets and on how the schedule targets in particular, are to be met. The latter section consists of a part referring to the means available to the client to encourage timely completion, and another part discussing the project management tools and techniques available to the contractor.

Chapter 3 is a brief overview of the Greek construction industry and its contribution to the country's economic development. It also provides the current state of knowledge as far as project management is concerned, in reference to precedent surveys.

In ***Chapter 4***, the causes and types of delay on which the questionnaire will be based are identified and the delay effects are discussed.

In ***Chapter 5*** the survey methodology is described in detail.

Chapter 6 is the presentation and analysis of the survey (questionnaire and interviews) findings in reference to the theoretical background, in an attempt to investigate the Greek experience of time overruns in construction projects.

Finally, ***Chapter 7*** summarizes the conclusions drawn from the research findings.

2. THEORETICAL BACKGROUND AND LITERATURE REVIEW

2.1 SETTING THE PROJECT TARGETS

Client's Objectives and Measurement of Project Success

The management of construction projects commences with the setting of the project targets which comprise the criteria against which project success will be measured. Defining success and failure and deciding on the different critical success measures for each project is inextricably linked to actually defining the project and setting its goals which essentially refer to the client's objectives.

The client's objectives are traditionally defined in respect of *price*, *quality* and *time* (commonly referred to as *Iron Triangle* -figure 2-), the main principle being that the project should be delivered "on time, in budget, to scope" (the PMBOK Guide defines scope as "the sum of products and services to be provided as a project"). The weight different clients give to each of these factors varies, and therefore different factors are likely to be critical to each project. Walker (2002) suggests a typical weighting that clients give to each of these factors (figure 1).

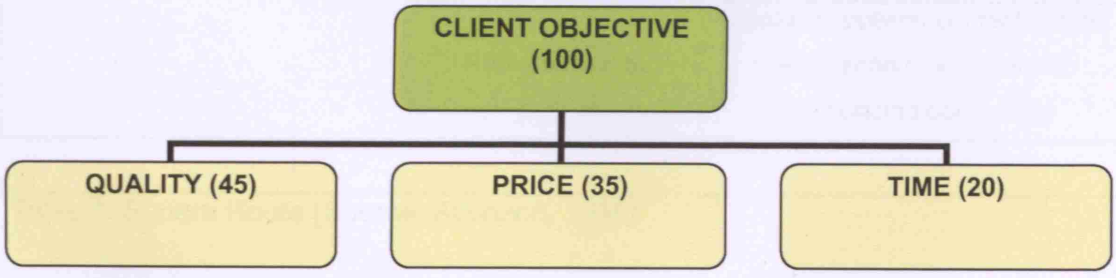

Figure 1. Weighting of factors (Source: Walker, 2002)

However, many writers argue that compliance with time, budget and specifications constraints are not enough to lead to project success. According to Winch (2002) "as there will inevitably have been changes as the project mission was developed in briefing, and then defined, described and executed on site, the key criterion for project success is not that the intended mission is fully achieved, but that the realised asset fully matches the client's needs at the time of realisation".

In an attempt to expand the limited set of success criteria (i.e. cost-time-quality), Roger Atkinson (1999) proposes a new framework, the *Square Route* (Table 1), which is a development of the Iron Triangle and, apart of cost, time and quality, it also includes a number of other criteria mentioned by other writers (Turner (1999), Morris and Hough (1987), Wateridge (1998), de Wit (1988), McCoy (1987), Pinto and Slevin (1988), Saarinen(1990) and Ballantine (1996)).

Iron Triangle	The information System	Direct Benefits (organisation)	Indirect Benefits (stakeholder community)
Cost	Maintainability	Improved efficiency	Satisfied users
Quality	Reliability	Improved effectiveness	Social impact
Time	Validity	Increased profits	Environmental impact
	Information-quality use	Strategic goals	Personal development
		Organisational-learning	Professional learning, contractors profits
		Reduced waste	Capital suppliers, content project team, economic impact to surrounding community

Table 1. Square Route (Source: Atkinson, 1999)

Moreover, further to Morris's and Hough's (1987) view that success criteria include both the traditional tangible ones (cost, time, quality) and some intangible which are most relevant to the different clients, Lim and Mohamed

(1999) distinguish two criteria categories, namely completion criteria (relevant to contract-related items, i.e. time, cost, quality, scope) and satisfaction criteria (related to utility and operation).

All clients seek value for money but each on their own particular terms which are stated in the *client's brief* at the beginning of the project's life cycle. The client's brief is a reasonably detailed statement of what is required by the client, what the project's objectives are and how these are to be met. Latham makes a distinction in his report between the project brief and the design brief, the former being a statement of the client's basic objectives and the latter stating the client's specific requirements.

For the purposes of this report, the concept of the Iron Triangle is recognised as the main principle on which project management is based while the focus will be on temporal management (planning and monitoring) of construction projects.

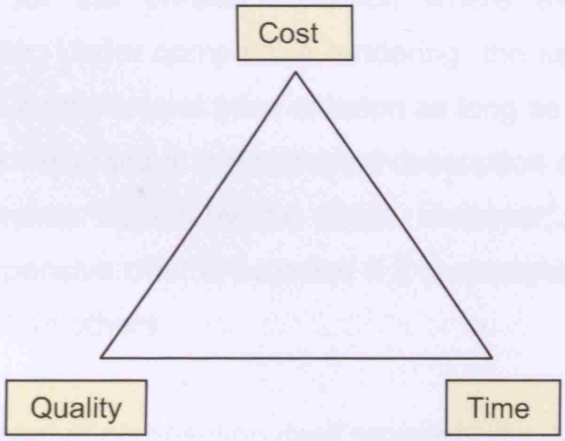

Figure 2. The Iron Triangle

2.2 MEETING THE SCHEDULE TARGETS

2.2.1 The Means Available to the Client to Encourage Timely Completion

The client's role in the project process involves a great deal of decision making and the primary decision clients are called to make concerns the selection of the most effective and efficient suppliers that will provide the services and resources required. "In construction, the process of selecting competent suppliers is known as the process of *procurement*" (Winch, 2002). The selection of the proper procurement route is the predominant tool available to the client to encourage the contractor to complete on time, and should therefore be given the appropriate attention.

The two prevalent ways of procurement in Greek construction projects are *competitive tendering* and *appointment of supplier*.

Competitive tendering is most often used in large projects for selecting the main contractor for the on-site execution where the level of dynamic uncertainty is lower. Under competitive tendering, the selection of the winner is normally based on the lowest price criterion as long as the offer conforms to the specifications explained in the technical description of the project and the supportive documents issued by the client. However, there can be cases where a more expensive offer is selected if it is assumed that the supplier is more competent than others.

Although the concept of competition itself provokes effort for higher production efficiency, competitive tendering does not always appoint the most efficient supplier. Because the selection of supplier is based almost solely on price criteria and only limited information on supplier competence and trustworthiness may be available to the client, problems of inexcusable delays and disputes may arise later on in the process. This can be avoided in the case of *selective competitive tenders* (applied in the selection of designer as well), where selected suppliers are invited to tender. Generally, the fact that

there is a great focus on price often leads suppliers to presenting under-estimated offers. Thus, they are bound to delivering a project for an under-estimated price and this may result into loss of their interest and motivation for timely completion or even into them being involved in multiple contracts at the same period of time.

Appointment of supplier is more appropriate where the levels of uncertainty are high. Thus, it is normally used for procuring design services in large projects although it is also cited in cases of work acceleration or limited time constraints where the time required for preparing the tendering process is not available.

In smaller projects a single supplier is usually appointed to undertake both design and execution of project (design and build) and this can indeed be more efficient in completing a contract in time. However, it is not appropriate for large and complex projects where the degree of inherent uncertainty is higher.

Under appointment, the client has the discretion to select a supplier with whom the client has collaborated on past projects, or a supplier whose competence and reputation is well known and whom the client can trust. In this way of procurement the focus is not so much on the price (as there is no competition really) although negotiations can take place. Regarding motivation of suppliers for timely completion, appointment has an advantage over competitive tenders as, because the choice is more personal based on trust, the supplier has a high incentive to deliver the service in time and according to specifications in order to satisfy the client, to establish a good relationship with them and secure repeat business.

Moreover, in order to encourage the contractor to complete in a timely way, special payment mechanisms and schedule incentives/disincentives can be included in the contract. Thus, a monetary scheme can be implemented to reward/penalize contractors depending on before-target-date/delayed completion in order to "motivate the contractor to produce a system that will

meet or surpass performance goals, on or before a target date" (Finchum, 1972). The bonus/penalty is usually calculated on a daily basis (an amount of money for each day of before-target-completion/delay). Before a penalty is imposed, it must be assured that the delay is solely attributable to the contractor's actions. If for any reason the contractor delays more than a predetermined period of time, the owner possesses the right to replace them.

2.2.2 The Means Available to Contractors to Achieve Timely Completion - Project Management Tools and Techniques

Since 1960s, several management tools have been developed and widely used for the temporal planning and control of projects to facilitate their timely completion.

The first step in the management and control of time is setting the construction schedule targets. The scheduling of projects represents the process of determining when an activity should start and when it should finish. The simplest and most widely used tool to accommodate this process is the *Gantt (bar) chart* which was developed in the USA by Henry Gantt for production scheduling at the Frankford Arsenal in 1917 (Morris, 1997). The Gantt chart is a rectangular diagram which demonstrates when an activity starts and when it finishes providing also information regarding the progress of the schedule. Although the Gantt chart has the advantage of being very simple, practical and easily comprehensible by the users, it does not provide a mathematic model based on which the production procedures and several influential factors can be investigated (Efremidis, 2001). Furthermore, it does not give any information on resource level for the activity or on precedence relationships. For these reasons, *network scheduling techniques* are found more appropriate as they are more detailed, and therefore more reliable.

The *Network Scheduling Techniques*, as opposed to the bar charts, introduce a mathematical aspect in scheduling instead of just using simple graphs. They

provide quantitative data regarding the duration of the project as a whole or the activities comprising it, the planned availability of the resources, the construction cost in relation to the construction duration, etc. Network scheduling techniques are also very useful during the construction phase of the project for calculating and controlling the schedule as they provide valuable information about the project progress in all the levels of analysis (Efremidis, 2001). Moreover, they give information on the margins of time for each activity, as well as data on the speeding-up of the process during construction in cases of delays, with the minimum additional cost.

The first network scheduling techniques for temporal planning, known as *Critical Path Method (CPM)* and *Programme Evaluation and Review Technique (PERT)*, were developed in parallel in July 1957 whereas, in the construction sector, they were introduced in the early 1960s and were greatly supported by the use of computers in the organisation of construction projects. The most widespread CPM- and PERT-based software programmes are Primavera and Microsoft Project and Power Project. CPM is a network-style representation of the temporal sequence of tasks. CPM's ability to meet construction schedules is limited as it does not handle the resourcing of tasks (assumes that resources are infinite) and the inherent uncertainty of task duration (assumes that the duration is a fixed number) and for this reason it is most commonly used for execution on site. On the other hand, PERT network is a more probabilistic method in which the duration is a stochastic variable although it tends to underestimate project duration with the risk of project time overrun.

CPM's limitations are likely to disappear with the use of the *Critical Chain Method (CCM)* –a development of CPM– which is based on the theory of constraints. CCM includes resourcing issues in its approach and uses the *average* estimated duration to address the problem of reliability of task duration estimates. Another recently developed technique that addresses this problem is the *Last Planner* which proposes 'quality assignments' in the context of 'shielding production' (Ballard and Howell, 1998) to increase efficiency and eliminate work flow uncertainties on a weekly work plan basis.

"The certainty of work flow from one production unit to the next is a key to productivity." (Ballard and Howell, 1998) According to Ballard and Howell (1998), work flow uncertainties can only be eliminated if the quality of assignments is improved in terms of definition, soundness, sequence, size, learning.

Moreover, due to the negative effect an inefficiently organised site can have on the productivity and, hence, the duration of the project, certain tools have been developed to accommodate the planning of space, labour and equipment. The WorkMovePlan (Choo & Tommelein, 1999) is a "system that supports the Last Planner in checking the quality of assignments not only constraint satisfaction but also in terms of their space requirements." (Choo & Tommelein, 1999) Essentially, it is a 2-D representation of the spatial information on site, taking account of the flow of the material, labour and equipment. "WorkMovePlan treats space as an explicit resource that can be assigned individually to any or all resources in a work package or group of work packages." (Choo & Tommelein, 1999)

Another planning method, although not that widely used, is *Line-of-Balance (LOB)* which is particularly useful in projects (such as highways) comprising of repetitive activities, as it shows the activity as a single line on a graph with time on the 'x' axis and m, m^2 or m on the 'y' axis. Thus, LOB chart provides information regarding the sequence and interdependency between one group of activities and the subsequent one, as well as the impact of delay of one group on the subsequent groups. LOB scheduling can be performed more efficiently when combined with network technology.

Both clients and contractors possess the means to facilitate timely completion of a contract. It is very important that the appropriate procurement method is selected based on the levels of uncertainty involved in the given type and life-cycle phase of the project. Therefore, the advantages of both appointment and competitive tendering should be exploited. Competitive tendering can be more effective if a combination of quality and price criteria is pursued. On the

other hand, there is a number of management tools available which must be appropriately selected and utilised, taking account of their limitations in their application.

3. THE GREEK CONSTRUCTION INDUSTRY

3.1 INTRODUCTION

It is widely accepted that today in a typical modern society, construction projects and, more specifically infrastructure projects (transportation, energy production, environmental protection, telecommunication, etc.) play a significant role in the country's social and economic development, forming therefore, one of the governments' major fields of investment along with defence, health care and education expenditures. Thus, due to the increasing demand for infrastructure projects during the last few years, the construction industry has become a business sector that plays a substantial role in a country's national economy while it generates around 10% of national wealth (Gross Domestic Product) in a typical modern society.

3.2 THE CONTRIBUTION OF THE CONSTRUCTION SECTOR TO THE GREEK ECONOMY

The construction sector is considered as one of the most important sectors of the Greek Economy closely related with the country's economic growth, while its importance in the formation of trends and developments in the figures of the Greek Economy is unquestionable. The flow of capital from the third Community Support Framework regarding the completion of major development projects, as well as the Olympic Games of 2004, have made the Greek construction sector one of the most significant growth factors with its contribution to the Gross National Product (GNP), from 6.48% in year 1997, now reaching almost 10% (Ipsilantis, Sirakoulis, 2005). The construction sector currently consists of 2,500 firms most of which are family owned and of

small to medium size, while only 16 of them hold the 7th class contractors certificate (Attikat, 2007).

3.3 The Current State of Knowledge

The increased construction demand combined with the fact that the available resources (materials, capital, equipment and people) are declining have led to an increase in the clients' requirements and expectations which mainly refer to the performance of the project (both functionally and aesthetically), the quality standard against which the project is measured, the total cost of the project and the time required from conception of the project to occupation. These requirements place the burden on construction firms which are responsible for doing things right and doing the right things in order to accomplish the principal mission of the project, i.e. meet the client's objectives, contribute to the country's economic development and add value to the society. Moreover, the competition is so intense that, for several Greek construction firms, the prospect of re-engineering and re-organisation is viewed as a matter of survival. In this context, the focus of the construction firms is expected to be placed on activities such as: the improvement of the production technology by purchasing new equipment and advanced know-how, the adoption of modern project management methods and techniques and the training of their personnel.

Although project management is widely spread in the public sector, in private construction projects it has only started to develop over the last few years, the main reason being that clients and contractors didn't believe that project management could contribute much to the project outcome and that it was not worth any effort, time or money input. It took a number of unsuccessful projects and significant losses to admit that it is worth investing in project management as, when this is properly implemented, it can save both clients and contractors a lot of time and unnecessary expenditures. However, contractors of small size projects (residents, repair & maintenance, etc.) are

still reluctant to adopt advanced management techniques, as their relatively low annual turnover cannot recoup the additional costs generated by investing in such techniques or in the appropriately skilled staff, for the timely completion of a contract.

A questionnaire survey conducted in 2002 regarding the Greek experience in managing construction projects revealed that the most widespread management methods and tools are: Gantt charts, quality certification techniques (ISO 9000) and PERT and CPM methodologies (Pantouvakis, 2002). In a similar survey (Sirakoulis et al, 2004), in 5 prefectures and 119 organizations, responses showed that 90% of the respondents are aware of the term 'project management' but only 58% actually apply any of the available project management methodologies in their projects, whereas only 37% of the organizations use project management relevant software. According to this survey, the most popular technique is the Gantt chart which the simplest yet not the most appropriate technique to support the management of large construction projects.

4. CAUSES AND EFFECTS OF DELAYS

4.1 INTRODUCTION

The problem of delays in the construction industry is a global phenomenon. Many surveys have been conducted aiming to assess the frequency as well as the severity of construction project delays. All of these surveys have concluded that, time overruns are rather common in the construction industry globally. In Saudi Arabia, Assaf and Al-Hejji found that 45 out of 76 projects considered in the survey were delayed and that the average of time overrun was between 10% and 30% of the original duration. Similarly, a survey conducted by Al Kahlil and Al Ghafly in Saudi Arabia showed that, 60 out of 161 projects experienced delays. Kumaraswamy and Chan found that project delays are fairly common in Hong Kong as well whereas, in 2005, about 17.3% of 417 government contract projects in Malaysia were considered sick (more than three months of delay or even abandoned). Moreover, Mezher and Tawil studied the causes of delays in large private and public construction projects in Lebanon and revealed differences in perceptions of the relative importance of causes between contractors, owners and A/E firms.

4.2 IDENTIFICATION OF CAUSES OF DELAYS

The factors causing delays in construction projects can be classified into a number of relevant categories. Kraiem and Diekman (1987) have identified three broad types of delays, namely: compensable, excusable and non-excusable. *Compensable* delays are those caused by the owner and are within the control of the contractor. *Excusable* delays are those that are not caused by either the contractor or the owner whereas, *non-excusable* delays are those resulting from the contractor's wrong actions.

The relevant literature suggests there are a number of factors causing delays in construction projects. Driven from the literature, the most common delay factors can be divided in the following 10 main categories.

4.2.1 Client/owner-related factors

This category includes client-initiated variations or delays such as: change in orders during construction or slow decision-making. The project manager and all parties involved in the project should be aware of these factors and be able to rapidly respond to them. This category comes under the *compensable* delays.

4.2.2 Environment-related factors

These factors include extreme weather conditions (extremely high or low temperatures, high wind, rain or snow). Under such weather conditions significant delays may occur in the progress of the works due to reasons such as: reduction of the labour productivity, damages to construction sites, work stoppages, repetition of work or other (for example, extremely high or low temperature has an impact on the concrete strength development and therefore some special measures need to be taken and extra days may be needed). Effects on social and cultural issues are also included in the environment-related factors, which are *excusable* delays.

4.2.3 Design team-related factors

This category mainly refers to delays caused by the design team's wrong actions or incompetence.

Poor design management can also be the reason for design-related delays. The design process is in essence a complex decision making process which

requires the involvement of many designers. Therefore, the design process needs to be closely managed so that information can be efficiently transferred across the design teams, and the focus on the project objectives is maintained. "Some managers believe that (...) due to the creativity and other uncertainties design is regrettably unmanageable. In fact design has to be managed just as much as anything else and the uncertainties that are involved are no more serious or disruptive than the uncertainties inherent in any other task within industry that has to be managed" (Geoffrey Constable, Head of Industrial Division, Design Council, letter to author 17 March 1987).

4.2.4 Coordination-related factors

Delays caused by poor coordination and lack of effective communication between different parties involved in the project process are common in construction projects and may often result in conflicts.

Construction projects involve interfaces between different actors that comprise the project team and, unless these interfaces are effectively coordinated, they can generate negative effects on the project outcome. There are a number of reasons that may cause poor coordination or cooperation. One of them is when not all parties involved in the project are brought into the project from the very early stages. For instance, the contractor should be brought into the project during the design phase when core decisions regarding the construction and constructability of the project are made. It is harmful for the project to keep the design team isolated from the construction team, the main reason for it being for buildability to be achieved. Over recent years, the term 'buildability' has become associated with the influence of design on construction cost and practicability of execution and has been defined by the CIRIA (1983) as "the extent to which the design of a building facilitates ease of construction, subject to the overall requirements for the completed building".

The degree of involvement and the role of the client in the construction process are of great significance and, client, designer and contractor should work closely together and have a mutual understanding and a common perception of the problems in order to avoid disputes, poor performance and client dissatisfaction. Besides, the contractor should be a person whom the client fully trusts and who he believes can convert his desires and needs into a successful construction project. Moreover, as Appleton (2003) has stated, no dispute can be resolved if the contractor believes that the project owner tries to undervalue the contractor's efforts and make a profit at his expense or if the project owner suspects that the contractor's only concern is to over-maximize his own profits.

Poor communication between the parties engaged in the project is another aspect of coordination-related delay factors. Effective and open communication is an essential prerequisite for sound cooperation between the parties. Besides, according to Burke (2001), if managed well, communication can be the single most important factor determining quality, efficiency, productivity and satisfaction, in other words project success.

4.2.5 Site conditions-related factors

Every site is unique as far as its characteristics are concerned. There is an intense movement of crews, materials and equipment and, when the workspace is not organised adequately, congestion may be caused resulting into delays and productivity drop. For this reason, every site should be appropriately organised taking account of its special characteristics and boundaries in order to most efficiently accommodate the works that will take place there.

The dynamic nature of the construction site layout requires that layout-planning tools be implemented to support the scheduling of the space required to accommodate the execution of each work package on site. The

site layout planning should describe: "WHERE is WHAT scheduled to be used WHEN for HOW LONG" (Choo & Tommelein, 1999).

4.2.6 Project Management-related factors

Time overruns caused by the management of the project may include: slow information flow between project team members, poor site management and supervision etc. Furthermore, inaccurate and unrealistic resource and project duration estimation in the beginning of the project will inevitably lead to works being done under pressure generating errors in construction and time overruns.

According to Walker (2002), "the programme should represent a realistic coordinated plan of the time needed for the project from the start until, and including, commissioning. As for any plan, it should be carefully monitored, controlled and adapted as necessary".

Poor supervision is another factor that may cause significant delays. Prior to the commencement of construction, the project manager together with the design engineer and the contractor agree on the frequency by which the appointed engineer will visit the site in order to monitor the progress of the works (apart of the supervision provided by law). The supervision terms are included in the contract and site supervision is included in the contractor's payment.

4.2.7 Finance-related factors

The norm of the Greek construction industry reality in medium and large projects, as far as progress payments are concerned, is generally as follows: with the completion of each design phase (i.e. pre-design phase, final design phase and execution design phase) the corresponding designs are being delivered to the project manager who checks them to make sure they have no

deficiencies and conform to specifications and then provides a written approval of the relevant certification. The payment is done in parts in a manner that has been agreed in the contract (for example, with the submission of the design documents to the municipality, with receipt of the construction permit, with the progress of the supervision, with the final submission of the project, etc.).

The payment of the contractors follows a similar norm. It is done in parts, according to the agreement and depending on the progress of the works. Usually contractors are paid for each completed part of work they deliver after its quantity survey and certification. Essentially, the payment mechanisms must be clearly pre-defined in the contract.

4.2.8 Material/equipment-related factors

Problems such as late delivery, shortages or changes during the construction either in quantity or in specifications of materials and equipment utilised in the construction process, or even using either old-technology equipment or unskilled equipment operators may cause delays.

4.2.9 Contractor-related factors

Poor supervision by the contractor during the construction phase which may provoke construction errors and therefore delays, poorly qualified technical staff, delays in subcontractors' work, etc. are *non-excusable* delays attributed to the contractor's actions.

4.2.10 Unforeseeable/external factors

Delays caused by such factors are *excusable* and may include: unforeseen ground conditions; delay in obtaining permits from municipality; historical findings which are rather common in many areas in Greece etc. If the

construction site is located in an area of potential archaeological interest, the presence of an archaeologist during the excavations is required and in cases where there is evidence of historical findings, trial pits and investigations are performed and, if necessary, archaeological excavations are conducted by the official service of the Ministry of Culture as any findings must be protected. This is a time-consuming and costly procedure during which construction works are being delayed.

The table of Appendix 1 shows a list of the 10 delay factor categories and the respective causes of delay.

4.3 The Impact of Delays on Project Performance

Delays caused by any of the factors discussed above can be extremely harmful to the overall project performance. When projects are delayed, they are normally either extended (if the requested time extension is approved) or accelerated. In both cases, additional costs leading to cost overruns are unavoidable. Thus, in most of the cases of projects experiencing delays, time and cost overruns are interrelated. Moreover, when for some reason time extension is not approved and the project process and works need to be accelerated in order to meet the time limits, several other problems are very likely to occur. Such problems usually arise from insufficient supervision, lack of attention in the details of the works, very fast and wrong decision making, overlooking specific contract requirements, etc. due to the pressure of time.

Work acceleration

More specifically, the need for acceleration of works may emerge from any one of the reasons discussed previously and can be accomplished in one or more of the following ways:

- Increase of the daily and weekly working hours
- Increase of the crews size

- Increase of the crews number
- Disposal of additional equipment for the project
- Increase of the supervision staff
- Implementation of a 2nd and, sometimes, of a 3rd shift. (Sirakoulis et al., 2004)

In principle, the productivity of the working staff is reduced when working overtime, due to fatigue. Moreover, productivity drop is also observed in the case of crews being constituted of many members, as well as in the case where many crews, in order to accelerate the works, have to work simultaneously in a limited space, forming an overcrowded work area where the resulting congestion disco-ordinates them. Many researches have been conducted worldwide for the measurement of the productivity drop under the aforementioned conditions and it is generally acceptable that, in the state of work acceleration, the productivity drops by 5% for every additional five-hour work in the working week. Similar percentages of productivity drop have also been internationally verified when many crews work in limited spaces or for crews that, for reasons of acceleration, are comprised of a greater number of workers than the ideal one.

Unpleasant effects of the acceleration of works are the usually inevitable mistakes and the need to reconstruct parts of the project due to poor workmanship, the increased frequency of minor accidents and the subsequent increase of the supervision staff, as well as the effects that are connected to the limited availability of reliable staffing sources within a relatively small period of time.

Thus, in the case of work acceleration, the difference between the actual productivity that has been achieved and the productivity that should have been achieved according to the original estimations, depending on the quantity of works, provides the measure of loss due to the acceleration of works. (Sirakoulis et al., 2004)

Sambasivan and Soon (2007) argue that, causes and effects of delays should be considered together as, "identification of causes and effects alone does not help the project managers to take appropriate remedial or preventive steps. The project managers need to understand, for example, what causes or factors result in time or cost overrun. Once these factors become clear, the managers can take proactive steps to avoid such situations" (Sambasivan and Soon, 2007).

According to Sambasivan and Soon (2007) and Aibinu and Jagboro (2002), apart from time and cost overruns, delays may also give rise to disputes, arbitration, litigation and total abandonment. Factors such as delay in the payments of completed work, changing requirements, lack of communication between the various parties and unforeseen site conditions give rise to disputes between the various parties and, if not resolved amicably, can lead to arbitration or litigation.

4.4 Summary and Conclusion

Construction project delays are a global phenomenon cited profoundly in Greece as well. Identifying the roots of delays and linking them to the effects is vital for taking appropriate action in order to overcome or even avoid them. In this chapter 10 broad delay factor categories have been identified each one having its own degree of significance (which will be assessed in chapter 6) and impact on the project performance. The common effects of delays are cost overruns, work acceleration, productivity drop, disputes, client dissatisfaction etc.

5. SURVEY METHODOLOGY AND LIMITATIONS

The questionnaire (given in Appendix 2) developed for the purposes of the present survey, was based on:

1. The means available to both the client and the contractor to achieve timely completion of contracts discussed in chapter 2.
2. The professionals' state of knowledge regarding project management techniques as well as their willingness to adopt such techniques
3. The 48 probable causes of delay identified and listed above.

The questionnaire was distributed to 12 professionals involved in the construction process, 9 of whom replied. It was pursued that the sample of the 12 professionals would consist of a variety of professions involved in the construction process in order to arrive at more objective conclusions. Therefore, the sample included contractors, design engineers, consultants and clients/owners of medium- and large-scale construction projects in the private sector in Greece.

Due to the fact (discussed in chapter 3) that project management is relatively recently introduced in the private sector, it was selected that the survey would be solely concentrated on this sector in order to gain an insight into the roots of project delays and how project management is evolving there.

Moreover, recognising that project management practice is primarily applied in larger size projects rather than smaller ones, the questionnaire was intended for representatives of firms undertaking medium (commercial buildings, etc.) or large scale projects (infrastructure, highways, tunnels, bridges, etc.).

The first part of the questionnaire refers to the respondent's/ respondent's company details. All respondents have over 16 years of experience in the construction industry and, more specifically in the development of infrastructure, commercial and energy projects whereas, the annual turnover

of the company they represent varies between €10,000,000 and €300,000,000.

The second part attempts to receive rough estimations drawn from the respondents' experience, about the percentage average of Greek construction projects experiencing major delays and the percentage average delay that Greek construction projects experience. Moreover, the open-ended questions were formulated in a way to allow enough space for further discussion and attempted to gain insight into the Greek experience and familiarity with the whole project management concept on one hand, and into the extent to which contractors are willing to, and are actually applying project management tools and techniques on the other hand. For this purpose, respondents are asked to give information about them/ their company having placed project management among the project process. They are also asked about their experience in project management tools and techniques as well as their opinion regarding the adoption of project management tools by Greek construction and project management firms.

Part three of the questionnaire contains the list of delay causes and for each one of these causes respondents are asked to evaluate the frequency of their occurrence as well as the importance in terms of the deviation they cause from schedule. The evaluation is based on a ranking scale of 1 to 4.

The questionnaire survey was supplemented by follow-up interviews to clarify and further discuss some of the responses. Out of the 9 respondents only 6 were available for interview.

Limitations of Research

The present research is limited by several factors including the low number of respondents. In addition, the research was limited to practitioners working for firms based in Athens which may not necessarily mirror the experience in other parts of Greece. Another limiting factor is the objectivity as there may be

a bias in the individual responses and in the way the interviewees express their views.

6. ANALYSIS OF COLLECTED DATA

From the responses I received on the questionnaire, and the interviews I had with some of the respondents, the following conclusions were drawn. (A summary of the evaluation of each delay factor's frequency and significance representing the majority of the respondents is given in Appendix 3.)

6.1 ANALYSIS OF DATA COLLECTED FROM PART 2.

The respondents' views regarding the Iron Triangle (time-cost-quality) converged in that the aim is to pay equal attention to the management of all three aspects in order to secure the desired economic and quality outcome and deliver the project within the time constraints determined by the employer in the contract. According to the majority of respondents, the clients' interest in the three aspects depends on the type of the project. In many cases the quality is selected according to the economy. Nevertheless, clients are in most cases inclined to accept higher cost (as long as good relation between cost and quality is maintained) in order to receive quality that meets their commercial, operational and aesthetic objectives. In essence, in private projects, clients are usually inclined to sacrifice the three aspects of the iron triangle in the following order: completion time – cost – quality, which appears to be in line with the typical weighting suggested by Walker (2002), mentioned in chapter 2.

However, when asked whether there are cases where clients' expectations regarding time, cost and quality are unrealistic, 100% of the respondents answered that clients are often unrealistic in their expectations especially regarding time and cost. The client may require the project to be delivered within a very limited time frame. As long as the contractor accepts this request, he owes to respect the client's wishes and be in the position to deliver the project within the time constraints. This of course implies that

works will be accelerated and quality will inevitably fall and additional costs will be generated. A respondent mentioned the case of a construction project of 2000 m² that was requested to be delivered in 2 months from the commencement of works. The contracting company agreed to deliver the project and had to employ extra engineers, technical assistants and equipment and implement 2-3 shifts, raising significantly the cost for the contractor (acceleration of works and its effects were discussed in section 4.3). Thus, it is very important that the client, the project manager and the contractor work closely together and have a smooth cooperation so that the client's needs are fully understood on the one hand and, on the other hand, unrealistic expectations are eliminated as, through realistic open conversations with the contractor, the client may gain sufficient knowledge of what is achievable, re-define his objectives and settle for more realistic ones. Table 2 and figure 3 demonstrate the respondents' views regarding the extent to which clients' objectives are met in practice. As shown in figure 3, the majority believes that clients' requirements are almost always fully met.

	Percentage of Requirements met
Initial	60%-70%
Re-defined	90%

Table 2. Percentage of client's requirements met in practice

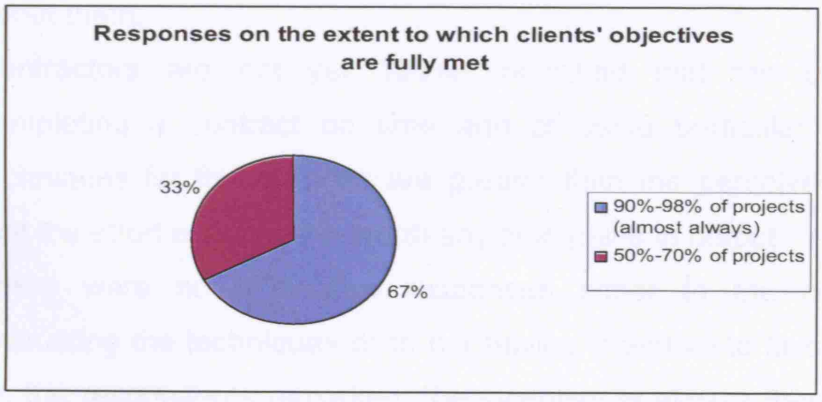

Figure 3. Clients' objectives are almost always *fully* met

Some respondents have also stressed that, deviations from the plan are usually initiated by the clients (changes in design, alterations in construction, etc.).

Regarding the project management tools used for the temporal planning and monitoring of the projects, it was discovered that all 9 respondents are aware (at least have heard) of most of the advanced project management tools available. 5 of them have *pretty good* knowledge of certain tools, 2 of them have *excellent* knowledge and 2 have only *limited* knowledge. All 9 respondents are willing to adopt such tools in the management process of their projects and are always seeking to update their familiarity with new methods and techniques. However, those respondents with limited knowledge on particular tools admit that their willingness is inhibited by the lack of competent staff and, most importantly, by the extra cost that the adoption of such techniques generates. This may also explain the fact that they have not yet invested in gaining advanced knowledge of such techniques and be able to apply them. Moreover, respondents have clearly made the distinction between large, medium and small contractors. Thus, 100% of large contractors and about 90% of medium ones are willing to, and actually should, adopt such techniques, whereas the equivalent percentage for small contractors is only 20%-25%. The responses on the factors that may inhibit contractors' willingness revealed the following:

- Greek contractors', and particularly small ones', willingness to adopt advanced tools is 70% inhibited by the lack of staff knowledgeable about them.
- Contractors are not yet 100% convinced that the benefits of completing a contract on time and of using particular tools and techniques for this purpose are greater than the perceived costs or that the effort expended is worth any time gains in output.
- There were no affirmative responses either to the contractors' distrusting the techniques or to not having incentive to finish on time. As the respondents remarked, the incentive is always there; it is the increasing competition and the fact that contractors realise that they

must complete the contract having fulfilled the client's requirements in a way that the constructed project will satisfy them and secure repeat business for the contractor. As long as the incentives are there, contractors are increasingly driven towards this direction of realising the need for investing in project management as well as implementing it correctly as, contractors may be aware of certain project management techniques but they have still not fully realised the importance of applying them in a wider project management process.

According to the survey, the most well known and applicable tools are Gantt charts, Microsoft Project, Project for Windows and Primavera Project Planner. The respondents find these tools very useful but underlined the fact that they are just project management *supporting* tools and should not be viewed as Project Management per se. They facilitate the plotting of the general project management and control plan, of the important activities in accordance with the set deadlines, and of the sequence of the project tasks, as well as the creation of temporal and financial progress curves. Each project has its own special characteristics and requires its own planning and organising methodology making use of all the supporting tools and techniques available to the contractors, which are particularly useful in monitoring the progress.

As shown in table 4, the collected data revealed that a large number of projects (more than half of the total projects) encounter delays of around 20%-50% of the initial schedule.

Project Size	Delay (% of deviation from schedule)	% of Projects
Large	50%	75%
Medium	20%	60%
Small	30%	50%

Table 3. Delays encountered in Greek construction projects

Identifying and evaluating the roots of the delays may help understand how these can most efficiently be faced by implementing the elements of sound project management.

6.2 Analysis of data collected from Part 3

Client/ owner- related factors causing delays

Most respondents have rated this factor category as *extremely significant* and *somewhat common*. In particular, *change orders* by the client during the construction phase as well as *slow decision making* by the client are the most common causes of delay of this kind, followed by *delays on behalf of the client in approving design documents*.

Clients are in the habit of initiating variations during the construction phase. In most cases, this means changes in the designs, changes in material orders, extra working hours; in other words, extra cost and delays. According to the respondents, contractors are aware of this reality and should expect it. However, because their principal aim is that the final project matches as much as possible the client's needs and requirements, they admit that, when the client insists on the changes, there is not much they can do but accelerate the works while keeping the quality but increasing the cost. Besides, 100% of the respondents agreed that the application of a specific tool or technique could not help overcome this delay factor.

On the other hand, contractors with their experience and expertise can help the clients make the right decisions in less time and avoid the delays that, according to the respondents, occur in around 20%-60% of the projects due to slow decision making by the client.

The 'briefing problem' is to a certain extent relevant in this delay factor category and, overcoming this problem can help in a great degree overcome client-related delays. According to some respondents, in many cases the

contractors notice that "even the clients themselves are not sure about what they want". Whether this is the case or the client's basic objectives and specific requirements are not clearly articulated in the brief, misunderstandings are very likely to occur and later on, during construction, clients may find that certain things have not been done as they would like, leading to unavoidable delays and cost overruns. For this reason, the respondents have stressed the importance of clearly defining and communicating the project objectives in the very early stages of the project to facilitate conformance to these objectives.

Environment-related factors causing delays

The majority of the respondents have evaluated environment-related factors *not significant* and *seldom*. 100% of the respondents believe that it is rather rare in Greece to witness delays caused by *social and cultural issues* or by *extreme weather conditions.* However, due to the rather warm climate, there are some cases where extremely high temperatures during the summer may cause delays attributable to stoppages in certain works such as excavations and concreting, as workers cannot work under such climatic conditions. Such delays are usually on the full responsibility of the contractor, unless agreed otherwise in the contract.

Design team-related factors causing delays

This delay factor has been mostly rated as *significant* and *not that common* although there are a couple of respondents who find design team-related delays in large projects 'extremely significant' and 'somewhat common'. *Errors and omissions in design documents* in particular were characterised extremely common by a couple of respondents who also believe that, unless these errors are immediately corrected, they will almost certainly result into extremely significant delays in large and medium size projects. For this reason, it is vitally important that the design documents have no deficiencies and are fully prepared subject to the constructability and the overall client's requirements. Namely, the designs, the technical specifications, the selection

of materials, the schedule and the cost estimate should be clearly and fully predetermined.

According to the respondents' experience, there are cases of large projects which suffered delays due to deficiencies in construction that were solely the result of insufficient design management, errors and wrong actions taken during the design phase. All respondents agree that design team-related factors causing delays can be avoided by applying planning tools and techniques and by following the essential design review procedures. Moreover, further to Geoffrey Constable's view mentioned in chapter 4, the respondents believe that, eventually, more attention should be placed on the management and control of the design process itself which involves a great amount of decision making and creativity.

Coordination-related factors causing delays

This category has been in average characterised by the majority of the respondents as *significant* cited in 20%-60% of the projects. However, there are a couple of certain causes coming under this category which the respondents have classified more strictly than others, i.e. *poor coordination and communication between the owner and design engineer during the design phase* and *between the owner and contractor* .

The interviewees underlined the importance of enhancing the coordination and communication as well as sound cooperation between the parties involved in the project process throughout the project life cycle (from conception to completion) as, failure to do so may lead to reworks, misunderstandings, disputes and significant delays. Therefore, as the interviewees stressed, good coordination among the owner of the project, the project manager, the site engineer, the contractor and the design team, is not just desired, it is required, as it determines to a great extent the success of the project.

The interviewees believe that each party's contribution to the early stages of the project can be valuable and should not be overlooked. Specifically, in reference to the contractor's contribution, the respondents agreed that the contractor should be given the opportunity to tell his opinion regarding the buildability of the design before the design documents are complete so that not only can suggested alterations take place early enough (without affecting the project's schedule), but also specific design requirements can be directly communicated to the contractor's team in time. This will help to avoid misunderstandings and errors generating delays later on in the construction.

In the same sense, the owner of the project should also be a part of the decision making process and have a smooth cooperation with the designer and contractor. As already discussed in the client orientated delay factors, clients must be clear of their requirements in their brief and must make commitments and positive decisions whenever they are asked to, without delaying. For this reason, according to the interviewees, the contractor is always prepared to suggest alternative solutions taking primary account of the client's needs and requirements along with the project's constructability, functionalism and aesthetics, although, according to the interviewees' experience, clients are often unrealistic in their expectations regarding time, cost and quality. The client, in turn, considers these alternatives and, together with the contractor, makes the most appropriate decision. By following this norm in practice, the respondents are optimistic that not only can clients' requirements be met but the final project may as well fulfil their expectations, create value for money for the client and therefore secure repeat business and profit maximisation, which is the wanted, for the contractor.

Regarding the communication aspect of the coordination-related delays, respondents have mentioned that poor communication may be the result of inadequately designed information flow channels by the project manager. Efficient information flow to both directions (senior and subordinate members) should be achieved to ensure that every party receives complete and enough information in time, in order to enhance their effective contribution to the project progress.

Misunderstandings and disputes attributable to poor coordination may have a very unpleasant turn as they may go to arbitration in order for the parties to sort out their disagreements. This, of course, although rare, is a time consuming and costly procedure which can be avoided if the parties realise that it is to their interest to come to an amicable arrangement. Thus, it is very important that all parties engaged in the project process fully understand their role, i.e. their duties, their rights, their room for interference in the works progress, etc. Each party's role is also described in the contract documents in order to more officially clarify it and avoid confusions or misunderstandings. Moreover, the interviewees believe that coordination and communication, as much as any other aspect of the project, need to be managed throughout the project lifecycle and the application of specific tools and techniques together with special management skills can help towards this direction.

Site conditions-related factors causing delays

According to the respondents, this factor category is *not that common* and may cause delays of 5%-30% of the original duration. However, *site organisation* is the most significant and frequently cited factors of this category generating delays over 30% of the initial schedule.

According to the interviewees' experience, the site location as well as its formation may impose restrictions and obstructions regarding the following: the access capability to plant equipment which should be maintained throughout the stages of the construction sequence; the ability of storage and unloading of materials; the working room available for movement of the plant; the capability to temporarily close a road (in this case, a relevant permit must be obtained from the municipality); the noise limitations set by the local authorities, especially when the site is located within a residential area, in order to prevent the public from the noise of construction operations. Such restrictions will definitely affect the sequence of the works and determine the choice of the type and size of plant and should therefore be seriously considered.

The interviews revealed that the respondents are not aware of specific management tools developed to accommodate spatial planning such as the WorkMovePlan mentioned in section 2.2.2. However, they believe that such delays can be avoided if, after studying the site in depth, special attention is drawn to the proper planning of the site well before the construction works commence.

Project management-related factors causing delays

Project management-related factors were valued *extremely significant* but *not that common*. *Poor site management and supervision* is related to extremely significant delays and is somewhat common in Greek construction projects. Similarly, although not that common, *critical tasks overlooked* is also related to extremely significant delays along with *slow information flow*. Delays caused by *inaccurate and unrealistic resource & project duration initial estimation* has been characterised extremely significant by the majority of the respondents (75%), 50% of whom have evaluated the frequency of this kind of delay as not that common, whereas 33% consider it common. Nevertheless, all respondents recognise the need for implementation of a sound project management system in every large construction project with the aid of advanced management tools and techniques.

More specifically, based on their experience, respondents have mentioned cases where the initial project duration estimation was inaccurate as the duration of each task has not been carefully estimated and the preparation of the project's programme has not been given enough attention. Quoting some respondents, instead of suffering the negative effects of the resulting delays when, for example, certain tasks will start overlapping making it impossible to keep pace with the programme, it is preferable to invest some time and effort at the early stages of the project in preparing a detailed and accurate project plan (without, however, overdoing it and missing the "big picture" as, minor deviations from the plan will almost certainly happen and, as soon as these are realised through the progress control process, the programme of the tasks

that have not yet started should be immediately revised in order to adapt to the changes).

The respondents also underlined the importance of sound and efficient supervision, stating that it can secure quality control in all aspects of the project; i.e. temporal and cost plan, quality of construction and conformance to specifications.

The significance of direct and efficient information flow has already been discussed in the communication-related factors. The responsibility of efficient information flow to both directions lies with the project manager who is responsible for designing the communication channels and determining the form, the amount and context of the information, as well as the frequency of the reports passed to the senior members of the project. For this purpose, the respondents believe that the application of planning tools and techniques can be significantly helpful.

Finance-related factors causing delays

Most respondents find that finance-related factors are *somewhat common* and responsible for *extremely significant* delays. Out of the three delay factors mentioned in the questionnaire under this category, the one that was judged by the respondents as the most significant and most common was *delays in owners' progress payments to contractors*.

All respondents admitted that delays in the payments by the owner are rather common and, in most cases they act as barriers not only to the timely completion of the project but also to the smooth cooperation between the owner and the contractor. Moreover, delays in payments also act as de-motivating factors of early, or even timely, completion of the projects, as contractors may refuse to deliver certain works if they have not been paid for precedent completed work. On the contrary, extra bonus for early completion may have the exact opposite effect as it is considered the best motive for the contractors to deliver the project as early as possible.

Material/ equipment-related factors causing delays

90% of the respondents believe that material/equipment-related factors may cause *significant* delays but are *not that common* and can be avoided with the application of management tools and techniques.

The most common delay related to the material or equipment used in the construction of a project is attributable to their *late delivery*. Although orders may have been placed in time, the deliveries in some cases may be delayed due to *shortages* or due to suppliers being very busy, or other reasons which are not in the responsibility of the contractor. However, some respondents have also admitted that material/equipment-related delays may be initiated by the contractor when orders are placed late or when material/equipment quantity and specifications are not adequately clarified and material selection fully specified in the contract, or even when specifications and material selection change during the construction phase for some reason. In this case, contractors may be faced with the possibility of unavailability of materials and equipment or unavailability of skilled equipment operators. Prior to the commencement of the works and after having decided on the construction method and the materials and equipment to be used, it should be reassured that these will be available in the desired quantities and in the desired time. Otherwise, alternative solutions should be considered using other materials or equipment.

Contractor-related factors causing delays

This category of delay factors has been evaluated as *extremely significant* but *not that common* and even *seldom* by some respondents. It should be noticed that, because the majority of the respondents are contractors, there may be a bias in their answers.

According to the responses, each delay factor of this category has a different significance to the overall project performance. Thus, effective site supervision is regarded vital for the project progress determining to a great extent the project outcome as, *poor supervision by contractor during*

construction causes significant delays. Similarly, *repetitions of works due to errors, as well as change of subcontractors during construction are* extremely significant but rarely cited in Greek construction projects. However, it is obvious that no management tool can help overcome this delay factor and other actions should be taken instead.

The respondents have stressed that the contractor's credibility and the quality of services and technical staff he employs (as far the level of skills, experience and competence are concerned) play a significant role in the overall project performance. Moreover, as far as the Greek construction industry is concerned, some respondents admitted that "there are a lot of 'bad' contractors and some 'good' ones. Finding and working with the 'good' ones is very important."

Unforeseeable/ external factors causing delays

According to the respondents, unforeseeable/ external delay factors, although *not that common*, may cause *significant* delays. The two most significant and most commonly experienced delay factors in Greek construction projects are *historical findings* and *delay in obtaining permits from municipality*. Historical findings can generate extremely significant delays in large construction projects in Greece. Respondents have mentioned cases of projects where due to archaeological excavations, construction works had to stop for a long period of time, while many workers of the archaeological service were required to complete the excavations, raising the cost of the project. However, such delays cannot be foreseen or resolved with the application of any management technique.

In summary, the most significant and frequently cited delay factors are those shown in table 4.

No.	Cause of Delay	Significance of Delay	Frequency
1	Change in orders by client during construction	Extremely significant	Common
2	Slow decision making by client	Extremely significant	Somewhat common
3	Insufficient and unclear information and details in design documents	Significant	Somewhat common
4	Lack of knowledge and experience of design team	Significant	Somewhat common
5	Poor coordination/communication between owner and design engineer during design phase	Extremely significant	Somewhat common
6	Poor coordination/communication between owner and contractor	Extremely significant	Somewhat common
7	Site organisation	Extremely significant	Not that common
8	Poor/ lack of design management	Extremely significant	Not that common
9	Critical tasks of projects being overlooked	Extremely significant	Not that common
10	Slow information flow between project teams	Extremely significant	Not that common
11	Poor site management and supervision	Extremely significant	Somewhat common
12	Inaccurate and unrealistic resource & project duration initial estimation	Extremely significant	Not that common
13	Delays in owner's progress payments to contractors	Extremely significant	Somewhat common
14	Late delivery of material/ equipment	Significant	Somewhat common
15	Repetition of works due to errors	Extremely significant	Seldom/ hardly ever
16	Change of subcontractors during construction	Extremely significant	Seldom/ hardly ever
17	Historical findings	Extremely significant	Not that common
18	Delay in obtaining permits from municipality	Extremely significant	Somewhat common

Table 4. The most significant and frequently cited delay factors

7. CONCLUSIONS

Over 50% of the total Greek construction projects suffer time overruns of 20%-50% over the initial schedule, calling for professionals to take appropriate actions in order to limit this percentage.

The most significant delay factors have proven to be the client/owner-, project management-, coordination/communication- and finance-related ones whereas, most commonly cited in the Greek construction industry are the client/owner-, and coordination/communication-related factors (particularly between client-designer and client-contractor). There is a profound tendency in Greek projects to blame the client for the project's delays. However, coordination/communication- and client-related factors are rather interrelated. Thus, good communication between the client and the designer and contractor can help the client communicate his needs and be assisted in making the right decisions in less time. Therefore, delays attributed to change orders and slow decision making can be avoided. Moreover, effective communication is inextricably linked with efficiently designed information flow channels, which should be given special attention, to ensure that every party receives complete and enough information in time.

It has been noticed that there is a polarization in the respondents' views regarding the frequency of the "poor supervision by contractor" delay factor. Thus, there are 5 "seldom/hardly ever" and 4 "somewhat common" responses. Considering the fact that most respondents are contractors, it is assumed that there was a bias in their responses. Nevertheless, poor supervision and contractor-related delays in general can be diminished if considerable attention is paid to selecting a competent contractor for the project by selecting the most appropriate procurement route and by providing the means to encourage the contractor to complete the contract in time.

Moreover, historical findings and delays in obtaining permits from the municipality are cited in 40%-60% of Greek construction projects but, since they are unforeseeable factors, management techniques cannot help overcome them. Most of the delay factors identified in this research however, can be avoided with the implementation of sound project management and the application of certain tools and techniques within this context.

Although project management has only started to develop the past few years in the private sector (where the respondents of this survey come from), contractors are increasingly recognising -although not fully recognised yet- its contribution to the achievement of the project's objectives. This is more profound in contractors of large/medium projects. Moreover, contractors are, in their majority, aware of most project management techniques and the relevant software applications. The most well known tools are Gantt charts, Microsoft Project, Project for Windows and Primavera Project Planner. However, the aforementioned percentage of overrunning projects shows that, although most contractors are aware of certain project management techniques, they are either not applying them effectively (within the broader context of project management) or they do not have staff knowledgeable about them, while the majority of small firms do not apply them at all.

As 'the management of a construction project is an inherently uncertain process' (Winch, 2002) and, unless the management techniques can cope with these uncertainties they will inevitably have limitations on their ability to help meet the schedule targets as there are some delay factors (such as historical findings, unforeseen ground conditions, delays in obtaining permits from municipalities) that embody inherent risks.

BIBLIOGRAPHY and REFERENCES

Aibinu A.A, Jagboro G.O (2002). Cited in Sambasivan, M., Soon, Y.W. (2007), 'Causes and effects of delays in Malaysian construction industry', *International Journal of Project Management*, Vol. 25, No. 5, pp 517-526.

Alexopoulos, K. (1999), 'The Greek construction sector and the Athens stock exchange: A study of the growth and evolution of those listed and unlisted construction firms', Built Environment MSc Thesis. London: Bartlett School of Graduate Studies, UCL

Al-Khalil, M., Al-Ghafly, M. (1999), 'Delay in public utility projects in Saudi Arabia', *International Journal of Project Management*, Vol. 17, No. 2, pp.101-106

Alkass, S., Mazerolle, M., Harris, F. (1996), 'Construction delay analysis techniques', *Construction Management and Economics*, Vol. 14, No. 5, pp. 375-394

Appleton, R. (2003). Cited in Ipsilantis, P.G., Sirakoulis, K.I. (2005), *Project Management: The Greek Experience*. Athens: Propobos

Arditi, D., Pattanakitchamroon, T. (2006), 'Selecting a delay analysis method in resolving construction claims', *International Journal of Project Management*, Vol. 24, No. 2, pp.145-155

Arditi, D., Yasamis, F. (1998), 'Incentive/Disincentive Contracts: Perceptions of Owners and Contractors', *Journal of Construction Engineering and Management*, Vol. 124, No. 5, pp. 361-373

Assaf, A.S., Al-Hejji, S. (2006), 'Causes of delay in large construction projects', *International Journal of Project Management*, Vol. 24, No. 4, pp.349-357

Association of Project Management (APM), Body of Knowledge (BoK) (1995). Cited in Atkinson, R. (1999), 'Project Management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria', *International Journal of Project Management*, Vol. 17, No. 6, pp. 337-342

Atkinson, R. (1999), 'Project Management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria', *International Journal of Project Management*, Vol. 17, No. 6, pp. 337-342

Attikat, S.A. 'Investor Relations: The Sector', retrieved on 30/01/2007 from http://www.irwebpage.com/attikat/indexe.html?irp=psector

Ballantine, J. (1996). Cited in Atkinson, R. (1999), 'Project Management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria', *International Journal of Project Management*, Vol. 17, No. 6, pp. 337-342

Ballard, G., Howell, G. (1998), 'Shielding Production: Essential Step in Production Control', *Journal of Construction Engineering and Management*, Vol. 124, No. 1, pp. 11-17

Bordoli, D.W., Baldwin, A.N. (1996), 'A methodology for assessing construction project delays', *Construction Management and Economics*, Vol. 16, No. 3, pp. 327-337

Burke (2001). Cited in Lazaridou, Ch. (2002), 'Managing time in major construction projects: A case study of the Athens 2004 Olympic Village', Built Environment MSc Thesis. London: Bartlett School of Graduate Studies, UCL

Choo, H.J., Tommelein, I.D. (1999), 'Space scheduling using flow analysis', *International Group for Lean Construction, Proceedings of the Seventh Conference*, Berkley, CA

Constable, G. (1987). Cited in Nikolaou, A. (1996), 'An approach to the design management of the new Attiko Metro', Built Environment MSc Thesis. London: Bartlett School of Graduate Studies, UCL

CIRIA (Construction Industry Research and Information Association) (1983). Cited in Illingworth, J.R. (2000), *Construction Methods and Planning.* London: E & FN Spon

Cooke-Davies, T. (2002), 'The "real" success factors on projects', *International Journal of Project Management*, Vol. 20, No. 3, pp. 185-190

Crosby, P.B. (1979). Cited in Nikolaou, A. (1996), 'An approach to the design management of the new Attiko Metro', Built Environment MSc Thesis. London: Bartlett School of Graduate Studies, UCL

De Wit, A. (1988), 'Measurement of project success', *International Journal of Project Management*, Vol. 6, No. 3, pp. 164-170

Efremidis, Ch.I. (2001), *Construction Management*. Athens: Simetria

Fincum Jr., J. A. (1972). Cited in Arditi, D., Yasamis, F. (1998), 'Incentive/Disincentive Contracts: Perceptions of Owners and Contractors', *Journal of Construction Engineering and Management*, Vol. 124, No. 5, pp. 361-373

Illingworth, J.R. (2000), *Construction Methods and Planning.* London: E & FN Spon

Ipsilantis, P.G., Sirakoulis, K.I. (2005), *Project Management: The Greek Experience*. Athens: Propobos

Jha, K.N., Iyer, K.C. (2007), 'Commitment, Coordination, Competence and the Iron Triangle', *International Journal of Project Management*, Vol. 25, No. 5, pp. 527-540

Konstantopoulos, S. (2002), 'Project planning and control for a motorway: A case study for a specific part of "Egnatia Odos Motorway"', Built Environment MSc Thesis. London: Bartlett School of Graduate Studies, UCL

Kraiem, Z.M., Diekman, J.E. (1987). Cited in Mezher, T. M., Tawil, W. (1998), 'Causes of delays in the construction industry in Lebanon', *Engineering, Construction and Architectural Management*, Vol. 5, No. 3, pp. 252-260

Kumaraswamy, M.M., Chan, D.W.M. (1998), 'Contributors to construction delays', *Construction Management and Economics*, Vol. 16, No. 1, pp.17-29

Lazaridou, Ch. (2002), 'Managing time in major construction projects: A case study of the Athens 2004 Olympic Village', Built Environment MSc Thesis. London: Bartlett School of Graduate Studies, UCL

Lim, C.H, Mohamed, Z. (1999). Cited in Morris, P.W.G., Pinto, J.K. (2004), *The Wiley Guide to Managing Projects.*

McCoy, F.A. (1987). Cited in Atkinson, R. (1999), 'Project Management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria', *International Journal of Project Management*, Vol. 17, No. 6, pp. 337-342

Mezher, T. M., Tawil, W. (1998), 'Causes of delays in the construction industry in Lebanon', *Engineering, Construction and Architectural Management*, Vol. 5, No. 3, pp. 252-260

Microsoft Office, 'Microsoft Office Project Standard 2007', retrieved on 7/03/2007 from http://www.microsoft.com/preview/programs/project

Morris, P.W.G. (1997), *The Management of Projects.* London: Thomas Telford Services Ltd.

Morris, P.W.G., Hough, G.H. (1987). Cited in Morris, P.W.G., Pinto, J.K. (2004), *The Wiley Guide to Managing Projects*.

Morris, P.W.G., Pinto, J.K. (2004), *The Wiley Guide to Managing Projects*.

Ng, S.T., Skitmore, R.M., Lam, K.C., Poon, A.W.C. (2004), 'Demotivating factors influencing the productivity of civil engineering projects', *International Journal of Project Management*, Vol. 22, No. 2, pp.139-146

Nikolaou, A. (1996), 'An approach to the design management of the new Attiko Metro', Built Environment MSc Thesis. London: Bartlett School of Graduate Studies, UCL

Orfanos, I. (2003), 'Relationship management: Te contractor-client relationship', Built Environment MSc Thesis. London: Bartlett School of Graduate Studies, UCL

Pantouvakis, P.M. (2002). Cited in Ipsilantis, P.G., Sirakoulis, K.I. (2005), *Project Management: The Greek Experience*. Athens: Propobos

Pantouvakis, P.M. (2003), *Construction Project Management: Programming and Control of Projects*. Athens: NTUA

Pinto, J.K, Slevin, D.P. (1988). Cited in Atkinson, R. (1999), 'Project Management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria', *International Journal of Project Management*, Vol. 17, No. 6, pp. 337-342

Planning Engineers Organisation. 'Line of Balance', retrieved on 27/08/2007 from http://www.planningengineers.org/publications/papers_download.aspx?id=30-

Primavera, 'Primavera Project Planner® (P3®) Brochure', retrieved on 27/02/2007 from http://www.primavera.com/customer/products/p3.asp

Ramo, H. (2002), 'Doing things right and doing the right things. Time and timing in projects', *International Journal of Project Management*, Vol. 20, No. 7, pp. 569-574

Saarinen, T. (1990). Cited in Atkinson, R. (1999), 'Project Management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria', *International Journal of Project Management*, Vol. 17, No. 6, pp. 337-342

Sambasivan, M., Soon, Y.W. (2007), 'Causes and effects of delays in Malaysian construction industry', *International Journal of Project Management*, Vol. 25, No. 5, pp 517-526.

Schoderbek, P.P. (1965), 'A Study of the Applications of PERT', *The Academy of Management Journal*, Vol. 8, No. 3, pp. 199-210

Sirakoulis, K.I. et al (2004). Cited in Ipsilantis, P.G., Sirakoulis, K.I. (2005), *Project Management: The Greek Experience*. Athens: Propobos

Turner, J.R. (1999), *The Handbook of Project-Based Management*. UK: McGraw-Hill International Limited

Walker, A. (2002), *Project Management in Construction*. Oxford: Blackwell Science Ltd.

Wateridge, J. (1998). Cited in Atkinson, R. (1999), 'Project Management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria', *International Journal of Project Management*, Vol. 17, No. 6, pp. 337-342

Winch, G.M. (2002), *Managing Construction Projects*. Oxford: Blackwell Science Ltd.

Zantanidis, S., Tsiotras, G. (1998), 'Quality Management: A new challenge for the Greek construction industry', *Total Quality Management*, Vol. 9, No. 7, pp. 619-632

APPENDIX 1

List of causes of delay

No.	Category	Cause of delay
1	Client/Owner-related	Change in orders by client during construction
2		Slow decision making by client
3		Delays in approving design documents by client
4	Environment-related	Extreme weather conditions (extremely hot or cold weather; rain; snow)
5		Social & cultural issues
6	Design team-related	Errors and omissions in design documents
7		Delays in preparing design documents
8		Insufficient and unclear information and details in design documents
9		Lack of knowledge and experience of design team
10		Inaccurate evaluation of soil quality
11		Insufficient data on technical information on soil/hydrology conditions
12	Coordination-related	Poor coordination/communication between owner and design engineer during the design phase
13		Poor coordination/communication between owner and contractor
14		Poor coordination/communication between owner and consultant
15		Poor coordination/communication between subcontractors
16		Poor coordination/communication between contractor and consultant
17		Poor coordination/communication between consultant and design engineer
18		Poor coordination/communication between contractor and design engineer
19	Site conditions-related	Traffic control and restrictions at construction site
20		Storage problems
21		Accidents during construction
22		Site organisation
23		Site location

24	Project management-related	Poor/ lack of design management (poor design reviews)
25		Critical tasks of project being overlooked
26		Slow information flow between project team members
27		Poor site management & supervision
28		Lack of management support
29		Inaccurate and unrealistic resource & project duration initial estimation
30	Finance-related	Delays in owners' progress payments to contractors
31		Contractor difficulties in financing the project
32		Cash problems during construction
33	Material/Equipment-related	Late delivery of material/equipment
34		Shortages of material/equipment
35		Breakdowns of material/equipment
36		Changes in quantity of material/equipment
37		Changes in specifications of material/equipment
38		Use of old-technology equipment
39		Unskilled equipment operators
40	Contractor-related	Poor supervision by contractor during construction
41		Repetition of works due to errors
42		Poorly qualified technical staff
43		Change of subcontractors during construction
44		Delays in subcontractors' work
45	Unforeseeable/External	Historical findings
46		Unforeseen ground conditions
47		Unavailability of utilities in site (water, electricity, etc.)
48		Delay in obtaining permits from municipality

List of causes of delay

APPENDIX 2

The Questionnaire

Part 1. Respondent's profile

- Profession:

- Number of years of experience in the construction industry:

- What types of projects does your company undertake?

- What is the annual turnover of your company?

Part 2.

1. In managing construction projects, does your company pay equal attention to *time*, *cost* and *quality* management or is one of these factors considered more important than the others? If the latter is the case, which of the three factors mentioned is considered more important and why?

2. Based on your experience, are *clients* interested equally in time, cost and quality of projects being inclined for example, to accept a higher cost if it is essential for achieving better quality, or do they usually insist on cheap, fast and high quality construction?

3. Based on your experience, are there cases where clients' expectations regarding time, cost and quality are being unrealistic?

4. To what extent in practice are the requirements of your clients met? How often would you say their requirements are *fully* met?

5. In your opinion, what is the percentage average of construction projects that generally experience major delays in Greece?

Large projects (such as infrastructure projects, highways, tunnels, bridges, etc.): %

Medium projects (such as commercial buildings, etc.): %

Small projects (such as residence, repair & maintenance, etc.): %

6. According to your experience, what is the percentage average delay (deviation from the duration set in the contract) that occurs in construction projects?

   In large projects (such as infrastructure projects, highways, tunnels, bridges, etc.): %

   In medium projects (such as commercial buildings, etc.): %

   In small projects (residential buildings, repair & maintenance, etc.): %

7. Does your company use particular methods and techniques for the temporal planning and monitoring of projects?

   - If yes, what kind? (e.g. Gantt charts, PERT/CPM methods, Work Breakdown Structure Analysis, Earned Value, CPM software packages such as Primavera Project Planner etc, or other)

8. To what extent are *you* aware of specific advanced management tools and techniques (such as those mentioned above)?

9. Are you willing to adopt such tools and techniques in order to achieve timely completion of your contracts?

10. Are there any factors that may inhibit your willingness to adopt such techniques?

11. In your opinion, to what extent are *Greek contractors* aware of specific advanced project management tools and techniques?

12. To what extent are contractors/companies willing to adopt project management tools and techniques in order to achieve timely completion of their contracts?

13. Which of the following factors (if any) mostly inhibit the *willingness* of the contractors to adopt such techniques? (please mark as many as appropriate)

— Contractors do not think that the effort expended is worth any time gains in output.
— Contractors simply distrust the technique.
— Contractors do not have staff *competent* in the use of such techniques.
— Contractors do not have the *incentive* to finish on time.
— Contractors believe that the perceived *costs* are greater than the *benefits* of completing a contract on time and of using particular tools and techniques for this purpose.
— Other:

Category of delay factor	No.	Cause of delay	Significance of Delay*	Evaluation of Frequency**	Would the application of a specific planning tool or technique have helped overcome this delay factor?***
Client/Owner-related	1	Change in orders by client during construction			
	2	Slow decision making by client			
	3	Delays in approving design documents by client			
Environment-related	4	Extreme weather conditions (extremely hot or cold weather; rain; snow)			
	5	Social & cultural issues			
Design team-related	6	Errors and omissions in design documents			
	7	Delays in preparing design documents			
	8	Insufficient and unclear information and details in design documents			

Category of delay factor	No.	Cause of delay	Significance of Delay*	Evaluation of Frequency**	Would the application of a specific planning tool or technique have helped overcome this delay factor?***
(Design team-related)	9	Lack of knowledge and experience of design team			
	10	Inaccurate evaluation of soil quality			
	11	Insufficient data on technical information on soil/hydrology conditions			
Coordination-related	12	Poor coordination/communication between owner and design engineer during the design phase			
	13	Poor coordination/communication between owner and contractor			
	14	Poor coordination/communication between owner and consultant			
	15	Poor coordination/communication between subcontractors			
	16	Poor coordination/communication between contractor and consultant			

	17	Poor coordination/communication between consultant and design engineer			
	18	Poor coordination/communication between contractor and design engineer			
Site conditions-related	19	Traffic control and restrictions at construction site			
	20	Storage problems			
	21	Accidents during construction			
	22	Site organisation			
	23	Site location			
Project management-related	24	Poor/ lack of design management (poor design reviews)			
	25	Critical tasks of project being overlooked			
	26	Slow information flow between project team members			
	27	Poor site management & supervision			
	28	Lack of management support			
	29	Inaccurate and unrealistic resource & project duration initial estimation			
Finance-related	30	Delays in owners' progress payments to contractors			
	31	Contractor difficulties in financing the project			
	32	Cash problems during construction			

Category of delay factor	No.	Cause of delay	Significance of Delay*	Evaluation of Frequency**	Would the application of a specific planning tool or technique have helped overcome this delay factor?***
Material/Equipment-related	33	Late delivery of material/equipment			
	34	Shortages of material/equipment			
	35	Breakdowns of material/equipment			
	36	Changes in quantity of material/equipment			
	37	Changes in specifications of material/equipment			
	38	Use of old-technology equipment			
	39	Unskilled equipment operators			
Contractor-related	40	Poor supervision by contractor during construction			
	41	Repetition of works due to errors			
	42	Poorly qualified technical staff			
	43	Change of subcontractors during construction			
	44	Delays in subcontractors' work			

Category of delay factor	No.	Cause of delay	Significance of Delay*	Evaluation of Frequency**	Would the application of a specific planning tool or technique have helped overcome this delay factor?***
Unforeseeable/External	45	Historical findings			
	46	Unforeseen ground conditions			
	47	Unavailability of utilities in site (water, electricity, etc.)			
	48	Delay in obtaining permits from municipality			
Other (please indicate)					

* How significant deviation from schedule does each factor cause? Please rank **1 – 3** and within the brackets please define significance as you perceive it:

3 indicates: **extremely significant delay** (% of the initial schedule)
2 indicates: **significant delay** (% of the initial schedule)
1 indicates: **not significant delay** (% of the initial schedule)

** How common is the occurrence of each delay factor?

Please rank **1 – 5:** **5** indicates: **extremely common** (80% or more of projects you are aware of)
4 indicates: **common** (60%-80% of projects you are aware of)
3 indicates: **somewhat common** (40%-60% of projects you are aware of)
2 indicates: **not that common** (20%-40% of projects you are aware of)
1 indicates: **seldom/ hardly ever** (0%-20% of projects you are aware of)

*** Please answer Yes ("Y") or No ("N")

APPENDIX 3

Summary of responses of part 3

Category of delay factor	No.	Cause of delay	Significance of Delay*	Evaluation of Frequency**	Would the application of a specific planning tool or technique have helped overcome this delay factor?***
Client/Owner-related	1	Change in orders by client during construction	3	4	N
	2	Slow decision making by client	3	3	
	3	Delays in approving design documents by client	2	3	
Environment-related	4	Extreme weather conditions (extremely hot or cold weather; rain; snow)	1	2	N
	5	Social & cultural issues	1	1	
Design team-related	6	Errors and omissions in design documents	2	2	Y
	7	Delays in preparing design documents	2	2	
	8	Insufficient and unclear information and details in design documents	2	3	

Category of delay factor	No.	Cause of delay	Significance of Delay*	Evaluation of Frequency**	Would the application of a specific planning tool or technique have helped overcome this delay factor?***
(Design team-related)	9	Lack of knowledge and experience of design team	2	3	
	10	Inaccurate evaluation of soil quality	2	2	
	11	Insufficient data on technical information on soil/hydrology conditions	1	2	
Coordination-related	12	Poor coordination/communication between owner and design engineer during the design phase	3	3	Y
	13	Poor coordination/communication between owner and contractor	3	3	
	14	Poor coordination/communication between owner and consultant	2	3	
	15	Poor coordination/communication between subcontractors	2	2	
	16	Poor coordination/communication between contractor and consultant	2	2	

	17	Poor coordination/communication between consultant and design engineer	2	1	
	18	Poor coordination/communication between contractor and design engineer	2	2	
Site conditions-related	19	Traffic control and restrictions at construction site	2	2	N
	20	Storage problems	1	1	
	21	Accidents during construction	1	1	
	22	Site organisation	3	2	
	23	Site location	2	2	
Project management-related	24	Poor/ lack of design management (poor design reviews)	3	2	Y
	25	Critical tasks of project being overlooked	3	2	
	26	Slow information flow between project team members	3	2	
	27	Poor site management & supervision	3	3	
	28	Lack of management support	2	2	
	29	Inaccurate and unrealistic resource & project duration initial estimation	3	2	
Finance-related	30	Delays in owners' progress payments to contractors	3	3	Y
	31	Contractor difficulties in financing the project	3	2	
	32	Cash problems during construction	2	2	

Category of delay factor	No.	Cause of delay	Significance of Delay*	Evaluation of Frequency**	Would the application of a specific planning tool or technique have helped overcome this delay factor?***
Material/Equipment-related	33	Late delivery of material/equipment	2	3	Y
	34	Shortages of material/equipment	3	2	
	35	Breakdowns of material/equipment	2	1	
	36	Changes in quantity of material/equipment	1	2	
	37	Changes in specifications of material/equipment	2	2	
	38	Use of old-technology equipment	2	1	
	39	Unskilled equipment operators	2	1	
Contractor-related	40	Poor supervision by contractor during construction	2	1	Y
	41	Repetition of works due to errors	3	1	
	42	Poorly qualified technical staff	2	1	
	43	Change of subcontractors during construction	3	1	
	44	Delays in subcontractors' work	2	2	

Category of delay factor	No.	Cause of delay	Significance of Delay*	Evaluation of Frequency**	Would the application of a specific planning tool or technique have helped overcome this delay factor?***
Unforeseeable/External	45	Historical findings	3	2	N
	46	Unforeseen ground conditions	2	2	
	47	Unavailability of utilities in site (water, electricity, etc.)	2	1	
	48	Delay in obtaining permits from municipality	3	3	
Other (please indicate)					

* **3** indicates: **extremely significant delay** (>30% of the initial schedule)
  2 indicates: **significant delay** (10%-30% of the initial schedule)
  1 indicates: **not significant delay** (5%-10% of the initial schedule)

** **5** indicates: **extremely common** (80% or more of projects respondents are aware of)
  4 indicates: **common** (60%-80% of projects respondents are aware of)
  3 indicates: **somewhat common** (40%-60% of projects respondents are aware of)
  2 indicates: **not that common** (20%-40% of projects respondents are aware of)
  1 indicates: **seldom/ hardly ever** (0%-20% of projects respondents are aware of)

*** **"Y"**: Yes
  "N": No