

## TIME IMPACT ANALYSIS IN ENGINEERING & CONTRACTING PROJECTS: AN INDUSTRIAL CASE

**Paolo Sanvito** <sup>(P)</sup>

*PMP; IPMA B Certificate  
Subcontract Adm. Manager*

*phone +39-02-520-33646*

*SNAMPROGETTI S.p.A.*

*Viale De Gasperi, 15*

*20097 S. Donato Milanese (MI) – I*

*[paolo.sanvito@snamprogetti.eni.it](mailto:paolo.sanvito@snamprogetti.eni.it)*

**Franco Caron** <sup>(1)</sup>

*IPMA C Certificate  
Dept. of Management,  
Economics and Ind.*

*Engineering*

*Politecnico di Milano*

*Piazza L. Da Vinci, 32*

*20133 Milano – I*

*[Franco.Caron@polimi.it](mailto:Franco.Caron@polimi.it)*

**Simone Valentini** <sup>(2)</sup>

*Degree in Ing. Gest.  
Quality Control Manager*

*TECNO TERM*

*S.P. 181 km. 1, n° 3*

*26839 Zelo Buon Persico (MI)*

*[s.valentini@tenotermsrl.it](mailto:s.valentini@tenotermsrl.it)*

### ABSTRACT

Complex projects in the engineering & contracting industry, particularly in the case of lump sum turn key contracts, are often affected by claims, both on the side of the client and of the contractor. In this context the management of the claim may influence the financial performance of the project, since the overall value of contractual penalties may exceed ten percent of the project budget. The paper focuses on claims concerning possible delays in completing project activities; delays stemming from disruption events. Time Impact Analysis represents an analytical approach aiming not only at identifying causes and consequences of possible delays occurred during the execution of a project but also at assigning the corresponding responsibility to each party involved in the project. The paper describes the application of TIA to an industrial case concerning the construction of a petrochemical plant in the Middle East. The paper allows to compare a traditional “static” approach, based on the comparison between the “as planned” schedule and the current “as built” schedule, and the “dynamic” approach typical of TIA, considering step by step the event chain which has determined the current status of the project. The paper points out the different results achieved by the two different approaches and the effectiveness of the latter approach in order to apportion in a rigorous way both responsibility and corresponding penalties to each party involved in project completion delay.

### Introduction

The Time Impact Analysis (TIA) represents a methodology to analyze the delays occurring in a project in order to determine and apportion between the parties involved the responsibility of such delays or disruptions that brought them about.

The area of application of the TIA particularly concerns complex projects, like the ones typical of the Engineering & Contracting sector, where there is a very high number both of activities and of dependence links among them and where time represents a determinant constraint for the success of the project. Situations of this type lead to a high overlapping of the activities and to the presence of various potential critical paths.

The TIA requires a dynamic analysis of the project that takes into account what actually happened to date. The status of the project in fact evolves in time and it is possible that the critical path changes due to certain delays and affect activities that at the beginning were not considered critical.

The objectives of a TIA are first to determine the delayed sub-activity that affected the project execution and second to establish which are critical thus determining the slippage of the project completion date. It is then necessary to quantify the effect of each delay on the completion date apportioning the responsibility to the parties involved.

Among all the sectors where the TIA can be utilized we selected the Engineering & Contracting one because there the incidence of DLD's (delay liquidated damages) becomes particularly important when contractual obligations are not met.

The arising of claims among the parties may in fact lead to huge requests for damages that bring about disputes to be settled only through civil suits or costly and time consuming arbitration proceedings.

### **The Context**

If we consider for instance the execution of a petrochemical plant or a power generation unit worth from 50 to over 500 million euro, a very important item from the contractual standpoint is represented by the DLD's for delay that can reach up to 10% or more of the contract value.

The economic-financial outcome of the project can therefore be greatly influenced by their possible enforcement and it is likewise foreseeable that each party involved tries to charge the counterpart with the responsibility of the delays that took place to limit the impact of the DLD's.

The main parties involved in the project are fundamentally the Owner (including Financing Institutions) and the Contractor, but it is worth to underline that behind the Contractor there must be a network of other subjects such as suppliers, subcontractors, etc. who asked to share the risks in proportion to their obligations.

These companies take part in the project under the direct supervision of the Contractor, to whom they are bound by definite contracts that state the required performances.

The relative weight of this network of suppliers and subcontractors is getting more and more important both for the increasing variety of competencies required and for the massive use of outsourcing and externalization of non-core activities. If this on one side means a saving for the Contractor, on the other side it makes direction and supervision of the project more and more complex and expensive.

During the execution of the project the party that deems to have been damaged can find in the claim the formal instrument to try to recover time and / or cost resulting from change to the contracted bargain.

Claims are far more frequent where lump sum contracts are stipulated because the risk is entirely with the Contractor. There are many types of claims that can arise during the execution of a project, and the delay claims are of particular interest. The use of the TIA for a whole project or part of it becomes of paramount importance in two cases:

- in order to be able to lodge a claim as solid and sharp as possible that objectively identifies the impact of the delays occurred in the project and apportions the responsibilities to the parties involved;

- in order to be able to reject a claim, highlighting through the TIA the possible lack of objectivity and, in general, the lack of an accurate and fair allocation of responsibility for the delays occurred.

From the above the practical in addition to theoretical importance of the TIA, essential instrument to apportion rigorously the impact of the responsibilities (and by extension, the cost of delay) originating from the delays caused by the parties involved in the project.

### **Generals ( Delay Claims and the TIA )**

Project scheduling can be achieved through different tools: the most common are networks and bar-charts. The networks, and CPM in particular, have the advantage of showing the precedence links among the various activities and identifying the critical path of the project. On the other hand bar-charts are easy to prepare and can be understood at a glance. Today there are softwares that combine the advantages of the two methods, providing a diagram of the activities based on linked bar-charts.

Out of the various types of delay that can occur in a project, three main families can be identified: excusable and compensable, excusable and non-compensable, non-excusable. Particular attention must be paid when more delays, often caused by different subjects, take place contemporaneously in the same time frame. In this case the term “ concurrent delays “ should be used.

Concurrent delays are the most difficult to manage because it is always hard to find the portion of responsibility to be attributed to each party involved, and this undoubtedly strengthens the need to use the TIA under such circumstances deepening the analysis as far as possible.

The starting point of a TIA is the identification of the delays occurred in the project in order to establish at least the number and activities involved and the time when such delays took place.

There are fundamentally two ways of representing the project time schedule: the “as planned schedule” and the “as built schedule”.

- the former shows the programme originally prepared for the execution of the project, attached to the contract and approved by the Owner
- the latter reflects the true execution of the works and encompasses all the delays affecting the project and causing it to deviate from the planned track.

In order to identify the delays occurred it is not sufficient to compare the two mentioned representations by simply superimposing one on the other, but it is necessary to develop a series of snapshots of the project showing the evolution from the “planned” situation to the “actual” one.

**Step 1:** To this purpose the concept of the “adjusted schedule” is employed: through a series of subsequent representations of the project the portion already executed is shown by the “as built” schedule while the remaining part is described by the “as planned” schedule.

In order to get more consistency between the planned and the actual portion, there is a variant of the “adjusted schedule” named “as projected schedule” where for the portion of the project still to be executed the original data are not used as such but in a revised version, depending on the substantial modifications induced on the project.

**Step 2:** The next step for the application of the TIA concerns the detailed analysis of the network.

From this standpoint the problem lying in traditional analyses is basically linked to their “static” interpretation of the project, that is based on the comparison between as planned and as built schedule, while the TIA develops a dynamic analysis going to reconstruct the sequence of adjusted schedules describing the development of the project.

The TIA first starts considering the portion of the network subject to delays and listing for each of them amounts and relationships with the planned activities.

The occurred delays are then included into the original network like new project activities e.g., thus causing a revision of the planned activities in terms of durations and start-finish dates.

**Step 3:** In addition to this, in order to better understand the impact of a delay on a certain activity, it is often necessary to decompose the activity subdividing it into more elements, so as to isolate the portion actually affected by the delay. It is a matter of increasing the level of detail of the portion of the project subject to the delay. The portion of the network to be analysed to a greater level of detail is named “fragnet” (fragment of network).

**Step 4:** Due to the delays and their mutual effects then the critical path identified in the planning stage can change during the development of the project, shifting from one path of the network to another one and making it difficult to understand, through an exclusively static analysis, the actual impact of each delay on the total duration of the project.

A delay apparently trifling based on a static analysis, that by its nature assumes the constancy of the critical path, may instead influence the total duration if, due to previous delays, the critical path has changed and the delayed activity in question has become part of it.

The main risk of a static analysis is often to charge to one of the actors of the project the whole delay occurred without understanding how it actually developed in time. The TIA on the contrary appraises the evolution of the network in time with particular reference to the critical path and to the dependencies among the activities.

The preparation of a successful TIA must be supported by a thorough understanding of the contract and by a meticulous work of collection of all the project documentation (e.g. project and site foreman logs) so as to be able to prepare an analysis based as far as possible on factual elements.

The basic rules for the preparation of a correct TIA are summarized in the following:

- identify all the contractual parties directly or indirectly affected by the delay;
- determine what activities of the project plan are potentially influenced by the delay based on their criticality to the project itself;
- revise the project plan and determine start and finish dates for all the affected activities;
- identify and document the facts associated to change and/or delay events;
- prepare a detailed analysis through the use of “fragnets” that places the delay in the sequence of events and defines its relations with the logical scheme of the project plan valid at date, verifying the impact on the total duration of the project;
- prepare a written report of the whole analysis and establish the responsibilities of the parties involved for the occurred delays apportioning to each of them the entity of the corresponding delay.

Similarly, the advantages of the use of the TIA are reported below:

- dynamic identification of critical activities and critical path;
- estimate of the specific impact associated to each delay;
- identification of concurrent delays;
- forecast of the effect of the delays on the whole project;
- apportioning of delays responsibility to the involved parties;
- basic tool to support or reject a claim;
- identification of the most effective corrective actions at a certain stage of the project.

### **The Case Study**

The project selected for the application of the TIA concerns the construction of a plant for the separation of gas from oil located in a Middle East Country. From now on the project will be named “Taras Oil Project”.

The Main Contractor of the project, a major Engineering & Contracting Company, were awarded a lump sum turn key contract for the execution of the works worth approximately 220 MM\$, with penalties peaking up to a max. ceiling of about 17 MM\$.

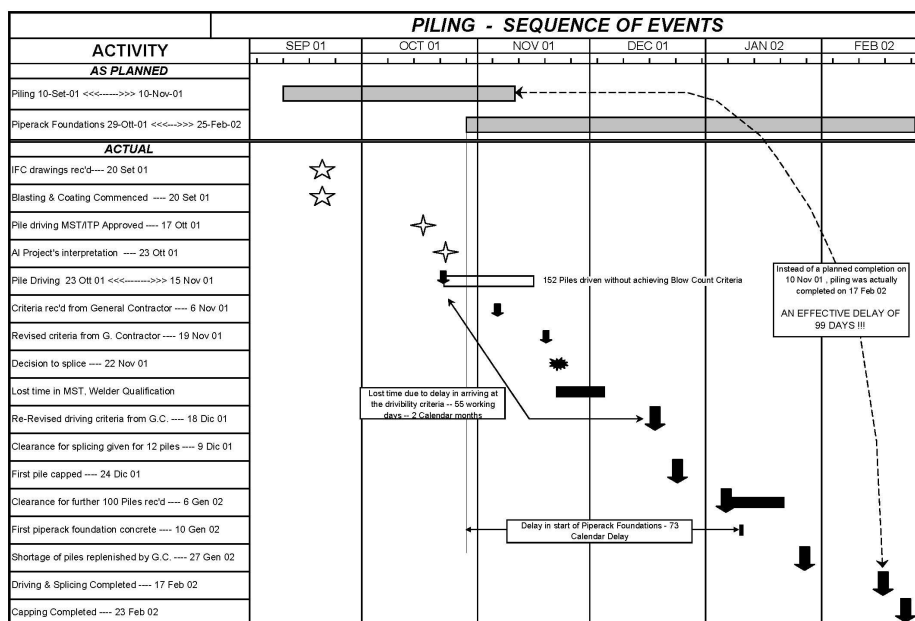
The Main Contractor’s scope of work included all the EPC phases. Most of the construction and erection works were then subcontracted to a series of specialized subcontractors, while the Main Contractor kept in their scope only the supervision of the works.

During the execution of the works a series of delays took place that postponed the final handing over, notwithstanding the recovery actions undertaken. Our analysis will focus on the delays occurred on a portion of the project relevant to the activity of a subcontractor that in the specific case concerned piling and underground piping erection.

The selection is due to the fact that both activities were critical for the execution of the project. Because of the two delays the subcontractor lodged a claim against the main contractor rejecting any responsibility and asking for time extension and compensation for the additional expenses incurred. The claim prepared by the subcontractor included as attachment both an analysis of the delays occurred on the piling activity and of the ones affecting the underground piping erection. Fig. 1 in the following shows the analysis of the delays carried out by the subcontractor for what concerns the piling activity.

The analysis is based on the comparison between the “planned” situation of the piling activities and the “actual” one as pointed out at site. The description of the actual execution highlights the presence of a series of events that disrupted the piling activity thus causing, against an original estimated duration of 60 days, a global delay of 99 days, affecting all the downstream activities and, in conclusion, the whole project.

The subcontractor analysis first shows how piling started in delay due to lack of technical documentation for construction and delays ascribable to the main contractor in releasing acceptance of the work procedure provided by the subcontractor. Once piling started, there were slowing downs and stoppages of the works due to the need not foreseen initially to proceed to the splicing and capping of piles through welding, which implied the issue of new Work Method Statements and the relevant approvals by the main contractor.



Allegato I  
Fig. 1: Subcontractor Analysis

The subcontractor deemed they were not responsible for the above and estimated the delay at 55 days. During the piling works there were other slowing downs that brought about a global delay on the start of the construction of the piperack foundations of 73 days.

Finally, due to a shortage of piles charged to the main contractor, piling and splicing activities ended on 17/02/02 with a total actual delay of 99 days against the planned date, i.e. 10/11/01.

The traditional analysis carried out by the subcontractor points out the following disruptive events attributable to the main contractor:

- delayed submission of drawings to start the piling activities;
- delay in the approval of the procedures for pile thrusting;
- additional requirement of pile splicing, not foreseen originally;
- delay in the finalization of new procedures for pile splicing;
- delay in the approval of the procedures provided to the main contractor.

The subcontractor, confident in their analysis, asked to the main contractor for a time extension of 99 days with regard to the contractual terms and the reimbursement of the extra-costs borne by them due to the activities that became necessary in the execution phase and had not been accounted for. The main contractor replied stating they were not responsible for the delays occurred and submitted a series of counter-argumentations:

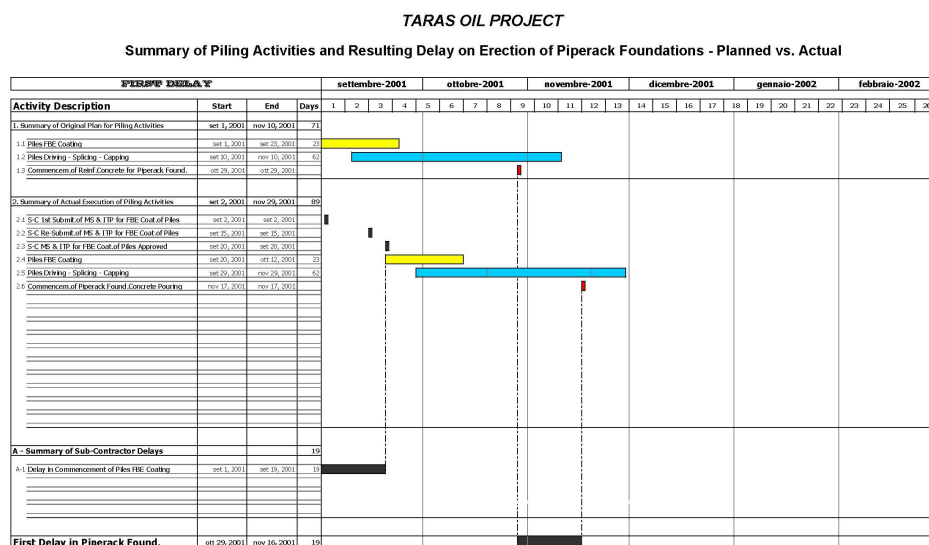
- the delay in the submission of the technical documentation for erection did not prevent the subcontractor from starting the activities of pile coating with FBE ( fusion bond epoxy ) to be carried out in a specialized workshop outside the site area;
- the subcontractor had to send the work procedures relevant to the piling activity at least one month before the foreseen starting date of piling, so as to allow the release of the subject acceptance in due time thus making it possible to perform any modifications deemed necessary;

- pile splicing and capping were included in the contract as subcontractor scope, if necessary;
- the subcontractor did not take enough care to guarantee the availability in due time of qualified personnel and relevant procedures for pile splicing activity;
- in practice the delay affecting the whole project is not made of by the 99 days of delay recorded at the end of the piling activity, but by the delay occurring on the start of the following activity of construction of the piperack foundation, being such delay estimated by the subcontractor at 73 days since the above mentioned activity is linked to piling by a “start – start” dependency laying on the critical path.

The analysis carried out by the subcontractor is a static one because a series of disruptive events attributed to the main contractor are just mentioned and only the global delay caused to the project is estimated, calculated as the difference between the actual and the planned date of piling completion.

Now let us see what happens if we implement the TIA on the portion of the project considered by the subcontractor in their analysis and relevant to the piling activity.

Fig. 2 shows the impact of the first delay on the project calculated through the TIA. The upper part of the figure shows the “as planned” situation where FBE coating of piles, piling and piperack foundation preparation are displayed according to the initial planning. In the central portion the actual execution of these three activities is shown including the new activities relevant to the delays occurred at site.



Allegato Piling I

Fig. 2: TIA – Impact of first delay (pile-coating)

Finally, in the lower portion of the figure the delays attributed to the subcontractor for the activities that have been analysed are highlighted.

The upper part of Figure 2 points out how the piling activity was in practice preceded and bound by the FBE coating of piles. In fact only after a certain amount of piles had been coated and were shifted to site, the following activity of insertion in the ground could start.

The subcontractor did not meet the time foreseen for the submission of the FBE pile coating documentation thus causing a delay on the subsequent approval of the main contractor and preventing in that way the piling activity from starting.

The amount of the registered delay to be charged to the subcontractor equals 19 days and fully impacts on the downstream activities of piling and piperack foundation construction.

Fig.3 shows the impact on the project of the second delay, concerning a slowing down in the FBE pile coating activity, such as to put off the start of the piling activity beyond the 10 days originally foreseen starting from the beginning of pile coating.

Only after 27 days from the beginning of pile coating the piles were handed over at site in a sufficient quantity to start piling. It is to be accounted therefore a delay of 17 days due to unavailability at site of coated piles entirely attributable to the subcontractor. Because of this second delay all downstream activities were shifted and the start/finish dates had to be calculated again.

At that point the total delay affecting the start of the construction of the piperack foundations is equal to 36 days.

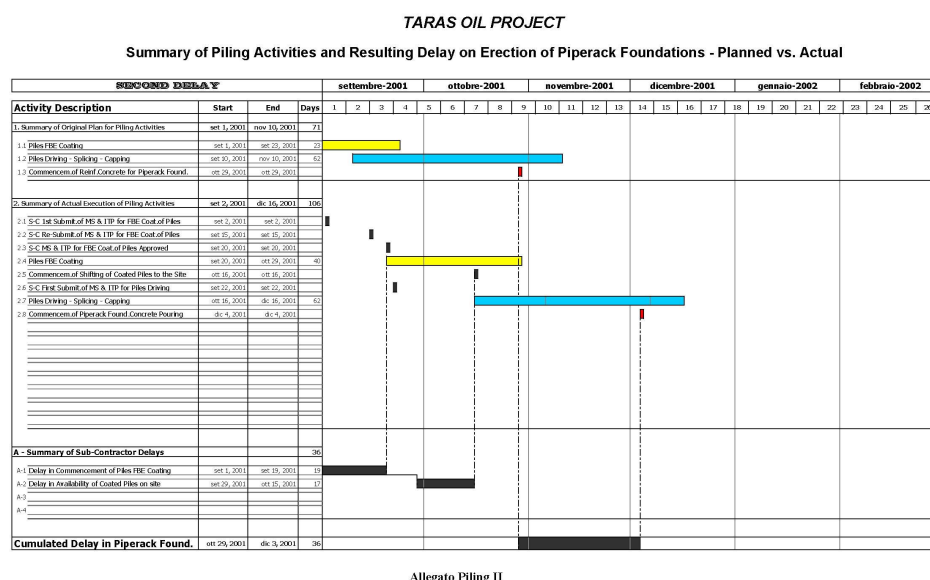


Fig. 3: TIA – Impact of second delay (pile unavailability at site)

Then a third delay occurred on the project displayed in Fig. 4 which is related to the delay in the start of pile driving for N/A of pile driving criteria.

Such delay, equal to 7 days, was due to the late submission by the subcontractor of the method statement for pile insertion operations for main contractor approval. The delay impacted the piling activity further postponing its start and the beginning of the piperack foundation preparation, then in delay by 43 days with respect to the original schedule.





Due to such delay the piperack construction activity could not meet the “start – start” dependency with the piling activity, which foresaw a planned delay of 49 days, bringing the actual gap between the start of the two activities to 91 days, corresponding to an actual delay of 42 days chargeable to the subcontractor.

Based on the four delays occurred on piling activity, a global delay of 85 days could be registered on the start of the piperack foundation construction:

- 19 days for the delay in pile coating;
- 17 days for pile unavailability at site;
- 7 days for lack of pile insertion procedures;
- 42 days for delay in piling execution.

The TIA adopted for the Taras Oil Project shows therefore the real responsibilities of the subcontractor on the project activities analysed through the evaluation of the actual impact on the project of each delay occurred, up to the global delay for which the subcontractor bore full responsibility.

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