

DELAY ANALYSIS FOR CONSTRUCTION PROJECTS: CLASSIFICATION OF EXISTING METHODS

by Alena VASILYEVA-LYULINA **

1. Introduction

Delay is one of the common and typical problems in construction projects. In the study of Assaf and Al-Hejji (2006)¹⁾ construction delay was defined as “the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project”. In the United Kingdom, a 2001 report by the National Audit Office, entitled “Modernising Construction,” revealed that 70% of the projects undertaken by government departments and agencies were delivered late (Lowsley and Linnett 2006)²⁾. Assaf and Al-Hejji (2006)¹⁾ did a survey on time performance of different types of construction projects in Saudi Arabia ran into the same conclusion (45 out of 76 projects were delayed). A study conducted by the Infrastructure and Project Monitoring Division of the Ministry of Statistics and Programme Implementation in 2004 in India reported that of 646 central sector projects, costing about \$50 trillion (U.S. dollars), approximately 40% were behind schedule, with delays ranging from 1 to 252 months (Iyer and Jha 2006)³⁾.

To recover the damage caused by delays, both the delays and the parties responsible for them should be identified. However, delay situations are complex in nature because multiple delays can occur concurrently and can be caused by more than one party, or by none of the principal parties (force majeure, etc.). As a result contract schedule and payment dispute are becoming two most common items of dispute during the construction phase.

2. Types of Delay

Construction project delays can be classified according to their origin into four groups:

- 1) Excusable compensable (caused by the owner): Owner initiated changes in work; Architect/Engineer supplied designs which are defective; Work site is not available to the contractor in timely manner, etc.
- 2) Excusable but not compensable (neither the contractor's nor the owner's fault): Force majeure; unusually severe weather conditions, etc.
- 3) Neither excusable nor compensable (caused by the contractor' or its subcontractor): Failure to mobilize work crews and start the work in timely manner; improperly allocating labor, material, and other resources; lack of coordination of subcontractors, etc
- 4) Concurrent (delay caused by multiple factors)

3. What is Delay Analysis?

Delay Analysis (DA) is an investigation (usually forensic) into what has caused the project to run late and who is responsible for the delay events. Delay analysis is performed in three steps:

- 1) Investigation
- 2) Description (Analysis of facts)
- 3) Presentation the case one is seeking to prove

Investigation is aimed to identify all delay events and parties which responsible for them. In starts with databasing relevant project records, then analyzing collected data, linking facts, aggregating, filtering, etc. Results are graphed using barcharts, tables, histograms, etc.

Second step consists description and analyzing collected information in order to identify the responsible party, draw final conclusions and prepare a presentation of the case.

There are various techniques available for analyzing and description stage. However these methods themselves cause a lot of debate. David Barry (2009)⁴⁾ used the word “dark arts” in order to describe the difficulty on delay analysis.

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**Doctoral Student, Dept. of Urban Management, Faculty of Eng., Kyoto University

(C1-3-182 Kyoto-daigaku-katsura, Nishikyo-ku, Kyoto 615-8540 JAPAN, alena.v@ax2.kyoto-u.ac.jp)

There are many papers⁵⁾⁶⁾⁷⁾ devoted to description of existing DA methods. However, there is no certain classification of all techniques, and moreover there is a lot of confusion in naming. Exactly the same techniques may have different name, as well as one name can be used by different methods. In table 1 there is a classification of most common DA methods mentioned in literature and used in practice.

Table 1: Delay Analysis Method's Classification

Delay Analysis Method	Retrospective	Perspective	Dynamic	Static	Theory based	Actual based
Global	x			x	x	
Net Impact	x			x	x	
As Built but-for	x		x		x	
As planned but for		x	x		x	
As planned Impacted		x	x		x	
As Planned vs. As built	x			x		x
Time Impacted Analysis		x	x			x
Window/Snapshot/Time slice/ Contemporary period analysis	x		x			x

DA methods can be prospective or retrospective, dynamic or static, theory or actual based. Prospective analyses refer to the future (moving forward) and used to determine the *likely* impact of particular event(s) on project completion. Retrospective analyses refer to the historic (moving backward) and usually seek to determine the *actual* impact of event(s) upon progress and completion. Dynamic analyses involve schedule calculations (often done by computers and special scheduling software). Static analyses do not require significant calculations and based on observing the components of the schedule. Theory based methods use planned schedule as a basement and consider theoretical impacts of delay event(s) on the schedule, while actual based methods refer to as-built program and actual impacts of the delay event(s).

4. Methods of Delay Analysis.

(1) *Global Impact Method:*

Requires planned schedule (not necessary based on Critical Path Method), list of delay events caused by one party (owner, for example) with known durations.

Procedure: the owner-caused delay periods are simply added to the end of the planned completion date, and then the actual completion date is compared with a calculated date. If the latter is equal or later than actual completion date, the contractor is entitled to full extension of time.

(2) *Net Impact Method:*

This method is the same as Global Impact Method with considering the issue of concurrency of delays. Requires planned schedule and a list of delay events caused by one party. If two or more listed events happened at the same time, only the longest one is considered. Calculations procedure is the same as for Global Impact Method.

(3) *As-planned Impacted.*

Identified delay event(s) are added into the As-Planned program (or Baseline) in chronological order and then the project completion date is reanalyzed until all of the delays have been impacted.

Advantages:

- As-built information is not needed
- Can be used to show the potential delaying effect of the owner's delay, or contractor's delay, or both together.
- Can be also used for what-if analysis to predict possible delays.

Disadvantages:

- Requires an accurate and realistic As-planned program:
 - The logic must be correct and could be performed
 - The activity durations should be accurately calculated
- Requires all information to be analyzed at one time
- The effects of imposed events are theoretical
- If the delay events are added to planned program in a different order, different conclusions can be drawn

(4) *As-planned but for*

Set of delay events related to one party is added into the planned baseline program, and then the impacted completion date is compared with the as-built completion date, and the difference is said to be how much earlier the project could have finished but for all other events (imposed by the other party) but which have not been analyzed.

Advantages:

- No need to consider actual progress of works (only completion date);
- Can be used to show delaying effects for different types of delay;

Disadvantages:

- Requires an accurate and realistic As-planned program;
- Requires all information to be analyzed at one time;
- It is a theoretical investigation;
- Drawn conclusions are different depending on perspective of analysis

(5) *As-built but for*

Similar to As-planned approach but in reverse: The As-Planned impacted analysis adds excusable delays into the As-planned schedule, while the but-for analysis subtracts excusable delays from the As-built program. The difference in overall program duration before and after this subtraction is said to represent the period of critical delay by the particular delay event removed. The main advantage is that the method is dealing with changes in project planning and execution

Disadvantages:

- Activities should be performed in proper and logical sequences. If they are not it may be necessary to revise the program logic and rerun the but-for simulations;
- It is a theoretical investigation and it is quite possible for both parties to produce analysis in which delays are ascribed to causes which suit their preferred case

(6) *As-planned versus As-built*

This methodology simply compares the activities of the original CPM or non-CPM baseline schedule with those of the as-built schedule for detailed assessment of the delays that occurred. The main advantages: it is inexpensive, simple, and easy to use or understand. Its limitations include failure to consider changes in the critical path and inability to deal with complex delay situations;

(7) *Window/Snapshot/Time slice/ Contemporary period analysis*

Follows the same basic philosophy the as-planned versus as-built method. Overall project duration is divided into periods or “windows” in order to make the analysis more incremental. The DA begins by updating the schedule within the first window using as-built information including all the delays encountered in that period, whereas maintaining the remaining as-planned schedule beyond this window. The difference between the end date from this analysis, and the end date from the previous window (or snapshot), represents the period of delay which arose in the current window.

(8) *Time Impact Analysis*

This method is a combination of the window technique and as-planned impact method. It concentrates on delay events and applies them to as-planned model on window by window;

The major distinction between the windows/snapshot and the time impact analysis is that the former is a retrospective analysis looking back at what actually happened and the latter is a prospective analysis looking into the future and assessing what might have happened in terms of delay.

Window and Time Impact Analysis share almost same advantages and limitations.

Advantages:

- Methods are dealing with changes in project planning and execution;
- Can be used during the currency of the works as well as for retrospective analysis;
- Consequential delays, concurrency, criticality, and acceleration are taken into account;
- The paucity of activities in each “window” makes analysis easier and results more convincing;

Conditions and Disadvantages:

- As each “Window” must be updated regularly complete detailed records are needed;
- Choosing the impact period is subjective;
- Complexity.

5. Conclusions

Ndekugri, I., Braimah, N. and Gameson, R. (2007)⁵⁾ made a survey on main obstacles to use of existing methods. Results are presented on table 2.

Besides these factors, like availability and quality of information, the main problem with current delay analysis techniques and a reason to call it a “dark art” is that delay analysis is fraught with manipulations. Applying the same facts to different methodologies results in different allocations between excusable and inexcusable delay. Moreover applying the same facts to same technique in different order may lead to contradictory conclusions.

A good example of applying three different methods (As-planned impacted, as-planned vs. as-built and Time Impacted Analysis) to one case is “The Great Analysis Debate” by J.Critchlow, A.Farr, S.Briggs, etc. (2006)⁸⁾. All used techniques showed different results. And obviously each party was trying to apply the one which proves its preferable case.

Table 2: Obstacles to the Use of Methods

Factors	Frequency index
Lack of adequate project information	75.9
Lack of familiarity with the techniques	75.0
Poorly updated schedules	74.4
Lack of skills in using the techniques	69.9
Baseline schedule without CPM network	67.5
High cost involved in their use	66.3
Difficulty in the use of the techniques	66.0
Lack of suitable scheduling software	65.7
Unrealistic baseline schedule	57.5
High time consumption in using them	52.0

Another problem is that there is not predetermined how delays should be analyzed either in terms of choosing methodology or dealing with such factors as float and concurrency.

The Society of Construction Law (UK) issued in 2002 the Delay and Disruption Protocol in which stated that Time Impact Analysis is the preferred method. However this Protocol itself is still a source of a lot of debate in the industry.

There are many other important issues connected to delay analysis, like various legal considerations, limitations and hence influence by available software, etc.

Because of all problem in field mentioned above the methodology of analysis of construction project delay and its causes, impacts and possible solutions in order to avoid delay claims and further disputes through project life circle seems to be important subject for research.

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