FORENSIC DELAY ANALYSIS: AN INVESTIGATION OF THE REASONS FOR DISAGREEMENTS IN TIME-RELATED DISPUTES

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Construction project delays are widespread and persistent. Disputes frequently occur, and their complexity and value has produced a role for experts specialising in Forensic Delay Analysis (FDA). Previous literature suggests that the main problem (and the main generator of escalated disputes) lies with the insufficiency and/or poor quality of available information. In this study, twelve disputes were examined for their key points of disagreement. These cases indicate that there are, in fact, four distinct factors: namely the availability, validity, and disclosure of relevant information, and the approach taken to its analysis. Insufficiency and poor quality of information was indeed a factor in these disputes, but not the only one; the apparently deliberate lack of transparency, the selective interpretation of information, and the subjective adoption of delay analysis method are at least as important in creating and amplifying the dispute. The resulting interplay between the availability of reliable data, the readiness of actors in providing it, and the conflicting motives behind the way it is analysed by experts results in a zero-sum gamble for the parties seeking the resolution of delays and their consequences. This could be partially or fully avoided by (i) exploiting advances in information technology; (ii) the introduction of agreed contractual delay protocols; and/or (iii) radical changes to the concept of 'ownership' of information. The work presented here is part of a wider study examining the impact of advances in information technology on the more efficient resolution (or even avoidance) of contractual disputes.

Keywords: case studies; contractual disputes; information technology; project delay

INTRODUCTION

Construction project delays are widespread and persistent (Adam, *et al.,* 2017; Ansah, *et al.,* 2018; Durdyev and Hosseini, 2019; Larsen, *et al.,* 2016), expensive and time consuming (Arcadis, 2020), one of the leading causes for disputes in the UK (NBS, 2018), and can lead to significant transaction costs (Atanasov, et. al. 2020). This study focusses on the evaluation of the issues that lead to time-related disputes, specifically the primary reasons for the divergence in delay expert opinion during dispute resolution proceedings. The empirical analysis reported here is based on twelve case studies and addresses those three propositions by evaluation, organisation and categorisation of (i) the arguments currently relied upon by delay experts, (ii) the

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critique and alternative case provided by their counterparts and (iii) the criticism of the parties and their delay experts by the decision makers. First, the contextual background is presented, and a literature-based summary is provided of the reasons for divergence in delay expert opinions in dispute resolution proceedings. The methodology describes a case study approach to data collection, the results of which were analysed to (i) provide further insight into the primary causes for divergence in expert opinion and (ii) identify the key issues for further examination. Finally, and with a view to the larger body of work that this study forms part of, a consideration of mitigation measures is provided to enable the more efficient resolution (or even avoidance) of contractual disputes.

LITERATURE REVIEW

Forensic Delay Analysis

In this paper the term delay relates "Delay to completion of the works by the completion date" is "an adverse effect upon completion by the date by which C [sc. The Contractor] is contractually obliged to complete the works, or any contractually defined section of the works…" (Burr, 2016:11). Project delays can lead to financial losses for all parties embroiled in disputes. However, the current contractual mechanisms are ineffective in preventing time-related disagreements. For example, the causes of dispute can vary from interpretation of terms, (like the word 'delay') to arguments relating to the most suitable delay analysis method (DAM) in the context (Parry, 2015 and Pickavance, 2010). The complexity and value of construction disputes has created opportunities for contentious lawyers (solicitors and barristers), claims management and dispute resolution consultants, and experts who specialise in 'Forensic Delay Analysis' (Kumaraswamy, 1997). Forensic Delay Analysis (FDA) experts form their opinions on records (such as contemporaneous programmes and progress reports) that are processed with the assistance of a delay analysis method (DAM) and a quantification technique like the Critical Path Method (CPM). It is the interaction between records and DAMs that is the focus of this paper, specifically the inconsistent (even contradictory) motives for selecting a specific DAM as driving force in delay disputes.

Delay Analysis Methods and Data Requirements

There are several widely recognised DAMs that can be generally divided into two categories: prospective and retrospective (SCL, 2002; 2017 and AACE, 2011). Although a detailed analysis of those methods is outside the scope of this paper, it is important to state that the categorisation derives from two key industry bodies - the UK Society of Construction Law (SCL) and the American Association of Cost Engineering (ACCE) - who use marginally different terminology to describe comparable methods. This paper adopts the SCL's description of those methods. The two so-called prospective methods are: Impacted As-Planned Analysis (IAP) and Time Impact Analysis (TIA), and four retrospective methods are: Collapsed As-built Analysis (CAB), Retrospective Longest Path (RLP) Analysis, As-planned vs As-built Analysis in Windows (Windows) Analysis and As-planned vs. As-built Time Slice (Time Slice) Analysis. The relative merits of different FDA techniques have been discussed in the literature (e.g., Kraiem and Diekmann, 1987; Braimah, 2013; Society of Construction Law, 2002, 2017; Scott *et al.,* 2004; American Association of Cost Engineering, 2011). Opinion as to what may be the most appropriate delay analysis method in a specific context varies, depending on criteria that are both objective and subjective. For example, the 2017 SCL Delay and Disruption Protocol (Society of

Construction Law, 2017: 13) recognises that any FDA method adopted must depend on objective criteria such as the nature extent and quality of both the programme information and records. Similarly, commentators have argued that it is the objective reasons (e.g., the availability and quality of records) that is the leading cause for disagreement between delay experts, rather than subjective criteria (Gibbs *et al.,* 2013:48 and Sanchez *et al.,* 2019). However, there is currently little to prevent players from selecting one DAM over another to prioritise their client's interest. Although it is accepted that insufficiency and poor quality of information can be important to the uncertainty of outcome, the argument presented here is that (i) currently the parties are rarely compelled to share such information, (ii) information is often available in various sources of divergent quality, (iii) information is not uniformly distributed among all players and (iv) its analysis can be subjective. Consequently, opportunities exist to perpetuate delay disputes by applying subjective motives and debateable reasoning for reliance on specific types of records and/or unrecognised DAM.

Quantification of project delays is usually supported by CPM-type analysis and is reliant upon the availability of regular and reliable programme updates. If the project records that are required to validate construction programmes are unavailable (as they often are) the CPM analysis can be highly speculative and subjective. The role of the FD Analyst may be to assist a party or its legal team in building a case or to act as an independent expert in dispute resolution. CPM is currently supported by CPM-software products (Barry, 2009; Keane and Caletka, 2015) and is a widely accepted method for quantification of critical construction project delay (Wickwire and Ockman, 1999).

METHODOLOGY

The purpose of the data collection is (i) identification of the primary reasons for disagreement among delay experts, (ii) categorisation of those reasons by using standard industry language and (iii) consideration of the interplay between the availability of reliable data, the readiness of actors in providing it, and the conflicting motives behind the way it is analysed by experts. The methodological approach is primarily archival and based upon analysis of the records of twelve contemporary case study projects (which include examples of the most common forms of dispute resolution) chosen from an initial sample of 38. Many types of dispute require the creation of expert reports to substantiate the EOT/LD claims (or referrals). Similar reports are produced for the defending (or responding) parties to (i) rebut the claimant's case and (ii) offer an alternative assessment. This process may involve an opportunity to produce a formal reply to the defending expert report and/or a schedule that provides a summary of the experts' position and areas of disagreement (i.e. adjudication or arbitration). Such disputes can also involve independent delay experts, that are appointed by the decision makers, to assist them with the evaluation of the delay analyses and, generally, terminate with a decision. These documents are rich sources of data for identifying, categorising and provide an analysis of the reasons for disagreements between delay experts.

The selection of cases was based on two criteria. The first was the existence of delay expert reports commissioned by both parties (where only one such report was available the case was excluded) and the second was recency: the case studies were selected from the period between January 2015 and January 2021.

Case studies

The sample includes projects based in the UK and overseas that were managed by various organisations. The project archives were provided by one private entity. Although these records are available to the several organisations involved in these disputes, they are unavailable to the public. For ethical reasons the cases have been anonymised and described by their function (i.e. Packaging Plant; Teaching Facility; Infrastructure deign) and location (i.e. UK or overseas). The key reasons for disagreement are outlined below on a case-by-case basis.

Case 1: Packaging Plant (UK)
The parties disputed the robustness of all programmes due to absent activity logic and validation. Consequently, the defendant (D) created a database to substantiate the actual progress of the works which was challenged by the claimant (C) because some of the activity descriptions in D's records did not match those in their programmes. The disagreement relating to the selection of a DAM and causation were related as the parties modified the former to justify the latter. C's expert was criticised for using a bespoke DAM and relying upon a global assessment of delay, and not changing their opinions and findings when further information was provided by D in their defence statement.

Case 2: Teaching Facility (UK)
Like Case 1, there were issues relating to the completeness of the programmes. The electronic version of these programmes (EV) was unavailable to D, even though D reasoned that a robust delay assessment cannot be produced without it. Similarly, some of the activities description in the records did not match those in the programmes. Many contemporaneous records were unavailable to D and the use of the as built in C's expert report was inconsistent (i.e. C selected the most advantageous dates from multiple sources, instead of using a single as built source). Thus, C's expert was criticised for modifying a recognised DAM and CPM by providing a partial analysis that lacked detail. D's expert response was limited to a critique as they were unable to complete a robust delay analysis due to the lack of records.

Case 3: Multi-storey Building (UK)
The experts disagreed on the most suitable baseline programme (BP). Like Case 2, C did not provide the EV to the experts. C's expert produced a partial delay analysis by using a modified retrospective DAM and incomplete CPM to substantiate their causation assessment. Thus, D's expert described their analysis as impractical and inaccurate, as the identification the critical path is unfeasible without an assessment of the construction process from start to finish.

Case 4: Infrastructure Design - Road (UK)
Like Case 3, the experts disagreed on the baseline and the EV was unavailable. C relied upon unvalidated PUs that D proved unreliable due to inaccurate representation of the as built. Neither expert used a recognised DAM and unmodified CPM.

Case 5: Infrastructure Design - Road (UK)
The main reason for disagreement in this case was C's expert decided to conduct a partial delay analysis. As with all previous cases, the existence of compensation events was not in dispute, but the parties disputed the effect of those events on the completion date.

Case 6: Infrastructure - Motorway (UK)
Like cases 3 and 4, the experts disagreed on the most suitable BP. It was accepted that the logic must be altered for the purpose of their analysis, but the changes completed by each expert were different. C's analysis excluded some aspects of the project. Both experts relied upon a modified DAM where C's expert argued this was required due to the incompleteness of records and the status of the project, specifically that it was incomplete at the time of the dispute. Originally, D's expert argued that TIA was the most suitable DAM because as built data was available, but changed their opinion, after C's expert adopted TIA, in that a retrospective delay analysis method is most appropriate. C's expert disagreed that a retrospective method is suitable in this context as the project was incomplete.

Case 7: Power Plant (overseas)
Like cases 3, 4 and 6 the experts disagreed on the BP and criticised each other for making assumptions that were advantageous to their client. D's expert successfully discredited the accuracy of C's records, and thus their case, because their DAM relied upon those records. The decision maker instructed an additional expert who preferred the D's delay expert report.

Case 8: Shopping Centre (overseas)
In this case, the parties formalised the dispute because C used a modified version of the contractual DAM due to unavailability of programmes and records. The scope of the formal dispute was affected by the tribunal's instruction that moving away from the contractual DAM would require compelling justifications. Here the experts disagreed on criticality even though they used identical DAM, records and programmes.

Case 9: Infrastructure Design - Motorway (UK)
Similarly, the experts disputed the suitability of the BP, used modified DAM/CPM and based their causation analyses on such unrecognised techniques.

Case 10: Infrastructure - Tunnelling (UK)
As with other case studies, the experts disagreed on the BP where C's expert was criticised for relying on the most advantages to their client PU. Furthermore, the decision maker suggested that (a) C used the fact that the project was incomplete to reply upon a prospective DAM, (b) the quantification of the effect of compensation events on the project should be conducted retrospectively to consider the facts and therefore (c) contract procedure should allow sufficient time for the contract administrator to conduct such assessments.

Case 11: Bridge (overseas)
The parties disagreed on the BP; however, D did not suggest an alternative BP and did not appoint an expert. C's expert used a recognised DAM whilst the D relied upon a bespoke DAM. The decision maker disagreed with both methods and relied upon a relatively more theoretical DAM (CAB) than the C's expert (Windows).

Case 12: Multi-storey Building (UK)
C's decision not to instruct a delay expert was criticised by the decision maker. The claim was described as 'global' as it did not rely upon a recognised DAM. D's expert relied upon a recognised DAM (IAP) but was criticised due to their reliance on a modified BP and absent reliance upon contemporaneous records associated with TIA. Consequently, the decision maker conducted their own analysis to reach judgement.

Data Analysis

The initial analysis revealed that the primary type of disagreement falls into two categories; records and analysis that can be categorised in terms of key issues, as follows:

Issue 1: Baseline Programme
Disputed robustness and integrity of the baseline programme (BP) was one reasons for disagreement, as it was critical to CPM analysis. The decision makers' rulings from the sample indicate that this was a relatively weak cause for argument because the baseline programme in all cases was a contractual document and, as such, formed an integral part of the agreement. Consequently, arguments against the use of the BP were rejected unless the BP lacked important detail, or logic.

Issue 2: Programme Updates and As-Built Programme
Unavailability of robust and credible programme updates (PU) was also a common reason for dispute. This includes criticism by the decision makers for withholding the electronic version of the programmes by the holder/owner.

Issue 3: Contemporaneous Records
Unavailability of accurate contemporaneous records was rarely a fundamental cause for disagreement in the sample. However, validation of the PU was required in all cases to provide an accurate status of the works. This was often the basis for disagreements because (i) more than one source was used to validate progress and (ii) the sources often included conflicting start or completion dates for different activities. Consequently, the conflict in the as built data was relied upon in the CPM analysis.

Issue 4: Delay Analysis Methods (DAM)
Contradictory rationale for the selection of the most appropriate DAM and the relative robustness of the chosen DAM was another reason for disagreement. In all case studies, it was alleged (by at least one of the delay experts) or ruled (by the decision maker) that at least one of the parties, or their delay expert, employed a 'novel', 'modified', 'unrecognised' or a 'bespoke' DAM to arrive with their conclusions as to the measurement and causation of delay. The cases indicate that this was a key disagreement, and the decision makers were often asked to prefer one side's method over the other.

In other cases, the decision maker adopted a DAM different to the ones adopted by the parties' delay expert on grounds of robustness and contextual considerations. This indicates that the motives behind the use current approach to delay analysis can be controversial at best. For example, in Case 8 the decision maker instructed the parties to use an unrecognised DAM. When this instruction was resisted, the decision maker employed a relatively more theoretical DAM to quantify the delay.

Issue 5: Causation Analysis
Although all cases involved disagreements relating to causation, in all instances at least one delay expert was criticised for partiality, specifically that their analysis suggested that they altered the critical path without strong justification which misrepresented the criticality of events. The criticism suggested that the causation analysis results depended on the selection of an 'unrecognised' DAM, or modification of programmes when conducting the CPM assessment. Consequently, the data suggests that the causation analysis issue was linked to the selection of the DAM and the robustness of the CPM assessment.

Table 1 provides a summary of the key reasons for disagreement in relation to the project delays relating to the twelve case studies (C1 to C12).

Table 1: Summary of key reasons for disagreement

Category			Reason	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Problem - reasons for disagreement	Records	Baseline	High level or Incomplete	×	×		×		×	×					
			Lack of logic - assumption of logic	×						×					
			Erred logic - modification of logic		×	×	×		×	×		×			×
			Disagreement on BP/reliance on a different baseline			×	×		×	×		×	×	×	×
			Electronic version unavailable to one party		×	×	×	×							×
		PU	Lack of detail		×	×									
			Lack/modification of logic	×	×	×			×	×					×
			Inaccurate representation of the progress of the works	×	×		×	×	×	×				×	×
			Electronic version unavailable	×	×	×	×	×				×			×
			Irregular programme updates	×	×				×					×	×
		Records	Unavailable to the project												
			Unavailable to one of the parties		×		×								×
			Available but incomplete	×	×		×	×							×
			Availability of multiple conflicting as-built records	×		×		×	×	×					
			Disputed accuracy of records	×	×		×	×	×	×				×	×
			Inconsistent as built source selection		×		×								×
	Analysis	Delay	Disagreement on the most suitable DAM	×	×		×	×	×	×		×	×	×	×
			Reliance upon a modified/unrecognised DAM	×	×	×	×	×	×	×		×	×	×	×
			Modified CPM	×	×	×	×	×	×	×	×	×	×	×	×
			Weak selection rational for DAM	×	×	×	×	×	×	×		×	×	×	×
			High level analysis by one or both parties	×	×		×		×					×	×
			Partial analysis by one or both parties		×	×		×	×						

The table above indicates that the key issues raised include irregular programme updates, lack of access to as built records and the electronic version of the programmes and disputed as-built status of the works. However, the use of unrecognised DAM and modified CPM were the most common reasons for disagreement. Furthermore, alteration of the contractual baseline was never accepted as a justification by the relevant decision maker when the baseline programme was a contractual document. Assumptions as to the baseline logic were only accepted if the baseline did not provide logic. This suggest that disagreements relating to the as-built programme, withholding of relevant records and programmes, and the selection of DAM were the most significant issues. Moreover, if contemporaneous records were withheld the delay analysis was theoretical because it relied on assumptions rather than facts and was rejected by the decision maker.

DISCUSSION AND CONCLUSIONS

Based on twelve cases, the key reasons for disagreement in delay disputes were identified and categorised. The primary data indicates that there are two main areas (records and analysis) including five categories: baseline programme, programme updates, contemporaneous records, delay analysis method (including CPM) and causation analysis. The analysis of those categories indicates that there are four issues, namely availability, validity, disclosure and analysis of information.

Availability of information

Although it is accepted that the arguments presented by Gibbs *et al.,* (2013: 48) that uncertainty of outcome can be driven by the insufficiency and/or poor quality of information upon which the analysis relies, the data here indicates that baseline programme and as-built records, although sometimes incomplete, were always available to one of the parties. These cases also reveal a frequent problem, when such information was not available to both parties, specifically increased uncertainty because information such as as-built records and the electronic versions of the programmes are necessary to produce accurate delay assessments. It is the interplay between availability, validity, disclosure and analysis of information that can be exploited by one of the parties to create uncertainty of outcome. Similarly, information asymmetry encourages opportunistic behaviour which in turn creates problems. Consequently, the driving factor does not appear to be the lack of records but their disclosure and/or subjective analysis.

Validity of information
It is, of course, possible that the validity of information can be addressed with technology that can (i) generate accurate records, (ii) automate key aspects of delay analysis and (iii) share the data among all parties. Advances in technology such as the introduction of sensors (Akinci and Anumba, 2008), 3D scanners (El-Omari and Moselhi, 2008), blockchain (Li, Greenwood and Kassem, 2019) and drones (Li and Liu, 2019) present an opportunity for accurate contemporaneous collection and sharing of construction project progress.

Disclosure of information
Currently, the information holder may decide to refuse to make information available and/or to prefer one source over another even if contractual obligations to act in mutual spirit of trust and cooperation (or good faith) exist. The evidence suggests that such practices are inefficient and ineffective for dealing with time-related disputes. Consequently, to reduce (or avoid) delay disputes, availability of information should be supplemented by the introduction of contractual delay protocols and/or radical changes to the concept of 'ownership' of information. It is contended that such changes are necessary to reduce (i) the uncertainty that is currently caused by information asymmetry associated with the administration of construction and engineering contracts and (ii) the opportunistic behaviour in the context of time-related disputes, hence increasing contractual certainty.

Analysis of information
Contractual certainty can also be improved by agreeing to use a contractual protocol for delay analysis and/or change the ownership of programmes, records and the analysis. Some of the case studies indicate that the former is a potential solution. For example, the use of contractually stipulated DAM appears to narrow the scope of the disputes significantly if such method is synchronised with the contract. The SCL Disruption and Delay Protocol (2017) suggests that it is the context that should influence the decision on the selection of a DAM (not the other way round) and accordingly recommends six methods. It is commonly accepted that the parties can identify and rely upon the most suitable delay analysis method(s) at the outset of a project (SCL, 2002; 2017 and AACE, 2011). Indeed, it has been suggested that recommending a 'best of the rest' method for delay analysis should be best practice, specifically Windows or TSA (Parry, 2015). The courts also indicate (i) support for retrospective approach even with contracts that favour prospective assessment of delay and costs like NEC3, specifically if the prospective approach lacks substantiation, and (ii) refusal to hand over records is in the breach of the well-known NEC obligation to act in mutual spirit of trust and cooperation. Another issue with prospective methods is that it is difficult to accurately measure mitigation and the contractor often has a contractual duty to mitigate delays (Northern Ireland Housing Executive v Healthy Buildings (Ireland) Limited, 2014). This suggests that prospective delay analysis should only be used where and when it is unfeasible to use a retrospective method i.e., to reach agreements in principle that EOT is due, or in a timely and substantiated manner with contracts that favour prospective assessment.

CONCLUSION

The evidence presented here shows that behavioural economics is at the core of time-related disputes as delay experts (and/or their clients) are often criticised for (i) withholding available information, (ii) neglecting to revise expert opinion when such information is presented during dispute resolution proceedings, (iii) inconsistent reasoning for selection of DAM, (iv) modification of recognised DAM to suit their analysis, (v) selective use of programmes in the CPM analysis and (vi) changing the start/completion dates of activities to suit the CPM analysis. Both the data and the literature indicate that the primary reasons for disagreement are availability, validity, disclosure and analysis of information. The evaluation of the issues and potential solutions presented here indicates that certainty of outcome in delay disputes can be improved by (i) the exploitation of technology and contractual delay protocols and/or (ii) changing the ownership of relevant information.

LIMITATIONS AND FURTHER RESEARCH

There are certain limitations to drawing conclusions from these findings. Although significant the sample is relatively small and requires further cases. It should also be noted that even though the sources are reliable, and the standard industry terminology was used to summarise the primary issues, it is recommended that further research is carried out, including investigation of the relative importance of each factor, creation and testing of a requirements model and scenario analysis to determine the applicability of such a model. This research is currently underway, and it is intended to present these results in future published work.

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