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Corrigendum to: Factual disagreements in construction delay disputes: identification, evaluation and testing of the justifications for difference in opinion.

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2022

Corrigendum: Factual Disagreements in Construction Delay Disputes: Identification, Evaluation and Testing of the Justifications for Differences in Opinion (*IOP Conf. Ser.: Earth Environ. Sci.* 1101 052001)

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Description of corrigendum:

Page 1: the following text appears:

Factual Disagreements in Construction Delay Disputes: Identification, Evaluation and Testing of the Justifications for Difference in Opinion

This should read:

Factual Disagreements in Construction Delay Disputes: Identification, Evaluation and Testing of the Justifications for Differences in Opinion

Page 1: the following text appears:

The literature is generally highly critical of the cost and frequency of construction delay disputes, specifically noting that such disagreements are one of the leading causes for disputes not only in the UK [1] but also globally [2]. They are expensive, time consuming, widespread, persistent [3] and can add to considerable transaction costs in construction projects [7]. Whilst previous studies address 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, this study focuses on improving the comprehensiveness of the list of factors and the identification of their impact. The empirical analysis reported here is based on twenty case studies and fifty survey questionnaires that address these objectives by (i) organisation and categorisation of the arguments currently relied upon by delay experts, (ii) measurement of the importance of those factors, (iii) provision of additional evidence to support the feasibility of suggested solutions (or mitigation measures) and (iv) recommendation of additional solutions to address issues that emerge from this study...



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The literature is generally highly critical of the cost and frequency of construction delay disputes, noting that such disagreements are one of the leading causes for disputes not only in the UK [1], but also globally [2]. They are expensive, time consuming, widespread, persistent [3, 4, 5, 6] and can add to considerable transaction costs in construction projects [7]. Whilst previous studies address 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, this study focuses on improving the comprehensiveness of the list of factors and the identification of their impact. The empirical analysis reported here is based on twenty case studies and fifty survey questionnaires that address these objectives by (i) organisation and categorisation of the arguments currently relied upon by delay experts; (ii) measurement of the importance of those factors; (iii) provision of additional evidence to support the feasibility of suggested solutions (or mitigation measures) and (iv) recommendation of additional solutions to address issues that emerge from this study...

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Currently, most construction contracts require the contractor to complete the works by the completion date (or the section completion dates). Any delays to the completion dates have adverse effect and can lead to significant financial loss and expense to the parties involved in such disagreements [7]. However, contractual provisions and procedures are presently ineffective in preventing time-related disagreements where the causes can vary from different interpretations of terms like the word 'delay' [9] to arguments relating to the most suitable delay analysis method in the context [10]. The result is often high value, highly problematic extension of time (EOT) disputes where EOT means an extended contractual period that provides a later date by which the works should be completed by the contractor and to relieve it from liability for delay damages [11].

Such context generates opportunities for claims management and dispute resolution consultants like commercial professionals who specialise in 'Forensic Delay Analysis' [12]. Forensic Delay (FD) experts form their opinions on records (such as contemporaneous programmes and progress reports) that are processed with the assistance of delay quantification techniques (e.g. the Critical Path Method, or CPM) and delay analysis methods [13]. It is the interaction between the materials and documents (or records) and the matters of interpretation (or analysis) that is the focus of this paper. Specifically, identification, evaluation, ranking and categorisation of the factors (or justifications for the difference in expert opinion) that lead to disagreements on EOT entitlements. Along with the subjective interpretation of facts involving the absence of necessary materials, documents, contractual procedures and the flawed use of delay analysis approaches.

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Page 3: the following text appears:

The authors undertook a systematic literature review of all academic articles and doctoral dissertations from four data bases; namely, (i) the Association of Researchers in Construction Management ('ARCOM') research database, (ii) the 'ICONDA' library that is the online repository containing publications relating to the Council for Research and Innovation in Building and Construction ('CIB'), (iii) Google Scholar and (iv) the British Library 'Ethos'. From this literature it is clear that the identified published work (excepting those of the author) is predominantly focused on the factors that cause delay, and not on explaining how or why disagreements occur over what should be matters of fact in delay claims and disputes. This is driven by an entirely different set of factors. This study offers (i) a comprehensive list of those factors and (ii) research methods that rely upon access or recourse to documents submitted as evidence in dispute resolution forums; specifically, the justifications for differences in expert opinion on extension of time entitlements stated by delay analysts in evidential material. Without this understanding efficient and effective solution to this problem cannot be offered.

This study is grounded upon a large sample of real case material and the availability of such information to the authors was critical to the identification of a comprehensive list of factors and root causes and underpins the development and ultimate contribution of this research. The study also provides evidence that the sector concurs with the proposition that identifying and implementing the most suitable delay analysis method at the inception stage of a project (or before the contract is signed – also known as *ex ante* agreements) can be a part of the solution.

3. Research Methodology

The aim of this study is to identify, evaluate, categorise and rank the factors (or justifications for the difference in expert opinion) that lead to disagreements on EOT entitlements. The research methods are archival research (involving the content analysis of twenty case studies) and a survey questionnaire that tested those results, by asking participants to (i) rank the thirty-three factors and (ii) add to the list of reasons for disagreements over matters of fact in construction delay claims and disputes.

Construction delay disputes require substantiation. This usually involves the production of multiple delay (expert and/or non-expert) reports, including responses and replies to such testimonials that indicate each party's case and the claimed EOT entitlement. The disputes terminate with a decision unless non-binding forms of dispute resolution like negotiation or mediation are used successfully. Each case study represents a dispute that took place between January 2015 and November 2021. Therefore, one of the criterions for

selecting the case study sample was recency. The other was response. For example, where only one delay report was available the case was excluded. In other words, at least two delay reports must be available, one representing each party's case. Based on these selection criteria, twenty case studies were selected from an initial sample of forty-three. Content analysis was conducted to identify, categorise and evaluate the factors. The sample includes projects based in Africa, Asia, EU and the UK that were managed by various organisations. The project archives were provided by one private entity. Under the normal principles governing arbitrations and other 'alternative' dispute resolution forums, these records are available to the organisations involved in the disputes but are not publicly available. For ethical reasons the cases have been anonymised and described by their function (e.g. 'Packaging Plant'; 'Teaching Facility'; 'Infrastructure') and approximate location. The table below provides a brief description of the case studies including project type, service, type of contract, location, client, and dispute resolution forum.

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This study contributes towards the fulfilment of this research gap in that it offers (i) a comprehensive list of such factors and (ii) a research methodology that relies upon access or recourse to documents submitted as evidence in dispute resolution forums; specifically, the justifications for differences in expert and non-expert opinion on extension of time entitlements (or factors) stated by delay analysts in evidential material. It is argued here that, without an in-depth understanding of those factors, among other things, an efficient and/or effective solution to this problem cannot be offered. Therefore, this study is grounded upon a large sample of real case material and the availability of such information to the authors was critical to the identification of a comprehensive list of factors and root causes which underpins the development and ultimate contribution of this research. The study also provides evidence that the sector concurs with the proposition that identifying and implementing the most suitable delay analysis method at the inception stage of a project (or before the contract is signed – also known as *ex ante* agreements) can be a part of the solution.

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Table 1 is incorrect and should be:

Table 1. Case studies (CS).

CS	Project Type	Service	Location	Client	Contract	Forum ¹
1	Mixed use development	Independent delay report	UK	Contr.	JCT	Adj.
2	Building	Independent delay report	UK	Eng.	Bespoke	Adj.
3	Building	Independent delay report	UK	Eng.	Bespoke	Adj.
4	Infrastructure	Independent delay report	UK	Eng.	NEC	Adj.
5	Infrastructure	Independent delay report	UK	Design.	NEC	Adj.
6	Infrastructure	Independent delay report	EU	Contr.	Bespoke	Arb.
7	Power Station	Independent delay report	EU	Contr.	Bespoke	Arb.
8	Shopping centre	Independent delay report	Asia	Subcon.	FIDIC	DAB
9	Infrastructure	Independent delay report	UK	Contr.	NEC	Adj.
10	Infrastructure	Independent delay report	UK	Contr.	NEC	Adj.
11	Bridge construction	Independent delay report	Africa	Contr.	FIDIC	DAB
12	Building	Independent delay report	UK	Client	Bespoke	Adj.
13	Shopping centre	Independent delay report	Asia	Subcon.	FIDIC	DAB
14	Mixed use development	Delay analysis report	UK	Eng.	JCT	Neg.
15	Mixed use development	Delay analysis report	UK	Eng.	JCT	Neg.
16	Residential development	Delay analysis report	UK	Client	JCT	Neg.
17	Infrastructure	Independent delay report	UK	Contr.	NEC	Adj.
18	Building	Independent delay report	UK	Client	JCT	Adj.
19	Railway services	Delay analysis report	UK	Eng.	NEC	CAP
20	Data centre	Independent delay report	UK	Contr.	JCT	Adj.

Page 4: the following text appears:

From the above cases, thirty-three factors were identified and included in a survey questionnaire. This questionnaire was distributed via LinkedIn to all English-speaking professionals that currently identify their occupation as delay analyst, or scheduling/programming expert, or forensic planning specialist, or construction claims

¹ Adjudication (Adj.); Arbitration (Arb.); Negotiation (Neg.); Claims Avoidance Procedure (CAP); Dispute Adjudication Board (DAB).

professional. This criterion was based on a pilot study and the archives that suggest (i) FD analysts have the necessary expertise to rank the factors and (ii) FD analysts can operate across multiple legal systems including Australia, England and Wales, India, Finland, Peru, Slovenia, Scotland, Spain, the UAE and several states in the USA. Some four hundred participants were identified and invited to complete the questionnaire, specifically to rank the factors on a Ten-point Likert Scale where 1 is the least important and 10 is the most important. Fifty responses were received between June 2021 and November 2021. This is a sample of 15%. It is argued that this sample is meaningful as this is a niche profession that consists of many small firms and few larger organisations, and the small players require advertisement of their services via the world's largest professional networking website LinkedIn. Furthermore, senior and junior personnel from all large firms also use this social media platform.

4. Findings and Discussion

The discussion centres around the findings from the two data collection methods, but also thematically; specifically, around the factors emerging from (i) the archives and (ii) the survey questionnaire.

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The discussion centres around the findings from the two data collection methods, but also thematically; specifically, around the factors emerging from (i) the archival case material and (ii) the survey questionnaire.

Figure 1 is incorrect and should be:

Category	Factors	Impact	
Archival Research	Materials and Documents Baseline Programme	BP high level and/or incomplete	7.1
		BP lacks/erroneous logic (e.g. assumption/modification of logic/critical path)	6.9
		Disputed duration of BP activities (e.g. overestimated planned durations)	5.4
		Disputed BP status (e.g. lack of acceptance)	5.7
		BP unavailable to one party	5.5
		BP unavailable electronically to one party	5.0
		BP does not exist (e.g. not required by the contract)	6.0
		BP contradicts another contract document/term	5.9
	Materials and Documents PU and AB Records	PU lack detail (e.g. high level or missing activities/areas/buildings)	6.5
		PU lack/erroneous logic (e.g. assumption/modification of logic)	6.7
		PU are inaccurate representation of the progress of the works	7.1
		Disputed status of the PU (e.g. lack of acceptance)	6.3
		PU are irregular (e.g. not required by the contract)	6.4
		PU exist but are unavailable to one party	4.9
		PU exist but are unavailable electronically to one party	4.9
		PU do not exist (e.g. not required by the contract)	8.3
		AB records exist but are unavailable to one party	6.3
		AB records exist but are incomplete, inaccurate, or contradictory (e.g. multiple records)	7.3
		AB records contradict the programme(s) (e.g. logic, float, activity durations)	7.0
		Interpretation of progress records to match the BP/PU activities (e.g. lack of coding)	5.7
	Matters of Interpretation Analysis	Reliance upon a modified/unrecognised delay analysis method (DAM)	6.2
		Reliance upon a modified/incomplete Critical Path Analysis	6.4
		Alternative to longest path arguments (e.g. magnitude of delay)	6.8
		Use of effective/substantial completion dates	5.0
		Weak selection rational for DAM (e.g. each party used a different recognised DAM)	6.6
		High level analysis (e.g. global delay claims)	6.7
		Partial/incomplete cause and effect analysis (e.g. analysis of delays caused by one party only)	6.8
		Resource/mitigation/acceleration arguments	6.2
		Other programme-based arguments (e.g. complexity, common sense)	5.9
		Exclusion of a specific item (e.g. area/building from the analysis of a section/milestone)	5.2
	Others	Snagging and time of completion	5.0
		Concurrency arguments	7.5
		Other legal arguments (i.e. not subjects of this study)	5.9

Figure 1. Survey questionnaire results: ranking of the factors by their importance.

Page 5: the following text appears:

The overall survey questionnaire results indicate that each one of those thirty-three factors was considered important by the FD analysts. Furthermore, the overall results were divided by the five groups of participants based on the number of construction delay disputes each professional was involved in (i.e. (i) less than five disputes, (ii) five to twenty-five, (iii) twenty-five to fifty, (iv) fifty to one hundred and (v) over one hundred disputes). These results were compared to establish if significant deviations (i.e. more than two points on the Linkert scale) exist between those groups. The findings indicate that the rankings are generally consistent between the experience groups. This provides further strength to the overall results. Consequently, the proposed solution should aim to address all factors as the impact score variance is not significant enough to ignore some factors, though prioritisation is feasible. The average overall rankings vary from 4.9 to 8.3 points where 'materials and documents' scored high, specifically the absence of records ranked the highest, followed by incomplete, inaccurate, or contradictory records and programme updates and high level and/or

incomplete baseline programme. The 'matters of interpretation' category also ranked high where incomplete analysis, weak selection rational for delay analysis methods and high-level analysis were considered most important. From the 'others' category the concurrency arguments were the highest ranked factor.

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Page 5: the following text appears:

Besides ranking the identified thirty-three factors, the participants were invited to add to the list. Fifteen additional factors were provided and categorised. The findings are illustrated in the figure below. The aim of the categorisation was to identify the main issues. The grouping is based on root cause analysis seeking to identify the underlying drivers that should inform the development of effective solutions. However, it is difficult to accurately categorise these factors because a degree of interpretation is required to ascertain the root causes. For example, submitting unconsolidated claims may be due to lack of knowledge (or understanding), or motivated by bias to exaggerate the impact of a specific event. Nevertheless, it can be said that bias, lack of knowledge and contractual arguments were the main themes (or reasons for disagreements) emerging from the root cause analysis. These reasons along with the above findings in terms of materials and documents and matters of interpretation are discussed further below.

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arguments were the main themes (or reasons for disagreements) emerging from the analysis of root causes. These reasons along with the above findings in terms of *materials and documents* and *matters of interpretation* are discussed further below.

Figure 1 is incorrect and should be:

Category		Factors
Survey Questionnaire	Behaviour	Bias
		Human involvement
		Emotion
		Misaligned expectations
		Partiality of the contract administrator
		Unexplained modification of records
		Reliance on document not included in the contract
	Knowledge	Hypothetical claims i.e. no actual impact on the project
		Inadvertent modification of records
		Lack of understanding of the adopted DAM
		Lack of understanding of the conditions of contract
		Submitting unconsolidated claims
		Failure to submit EOT claims in a sequential order
Others	Contract	
	Contractual arguments about culpable and non-culpable delays	
	Time barring notice and claim particulars	
		Float ownership arguments

Figure 2. Factors identified from the survey questionnaire.

Page 6: the following text appears:

The conclusions are organised according to the emerging themes, namely materials and documents, matters of interpretation, lack of knowledge, concurrent delays and strategic behaviour.

This should read:

The conclusions are organised in accordance with the emerging themes; namely, *materials and documents*, *matters of interpretation*, *inadequate knowledge*, *concurrent delay*, and *strategic/opportunistic/tactical behaviour*.

Page 6: the following text appears:

The findings indicate that the integrity of baseline programmes is pivotal to the analysis of delay disputes. Specifically, the BP should be detailed (as opposed to high level) to enable the FD analysts to conduct accurate EOT assessments, and to reduce the opportunities to speculate with the agreed plan including making assumptions as to, among others, the intended activity logic, sequence and durations. Such speculations can create uncertainty and encourage opportunistic behaviour.

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to enable the FD analysts to conduct accurate EOT assessments, and to reduce the opportunities to speculate with the agreed plan (e.g. making assumptions as to, among other things, the intended activity logic, sequence and durations). Such speculations can create uncertainty and encourage strategic/opportunistic/tactical behaviour.

Page 7: the following text appears:

...Consequently, this study supports earlier work by Atanasov *et al.*, upholding the assertion of Gibbs *et al.* that uncertainty of outcome can be driven by the insufficiency and/or poor quality of data [18] [19]. Contract procedures that require the production and acceptance of regular programme updates and the use of technology to record and share data appear to offer effective solutions to such problems. Sensors [21], 3D scanners [22], blockchain technology [23], and drones [24] are among the existing technology that can generate and share accurate records (or even capable of automating aspects of the process e.g. contemporaneous validation of as built programmes) or, at least, to produce high quality validated as built programmes and records. Therefore, procedural and technological solutions are available that can reduce factual disagreements in construction delay disputes, specifically those concerning materials and documents.

5.2. Matters of Interpretation

The findings indicate that (i) ten factors relate to the analysis of delays and (ii) delay analysis usually involves interpretation of relevant facts. Consequently, those factors can be described collectively as 'matters of interpretation'. Generally, the degree of interpretation required to form an expert opinion is dependent on the available facts. In other words, if data (or evidence) are unavailable to substantiate the facts, the FD analysts are required to make assumptions including planned and actual programme logic, sequence and activity durations. Alternatively, a 'high-level analysis' can be completed. However, this approach lacks accuracy. This factor, along with 'weak selection rational' of delay analysis methods and 'partial analysis' were among the highest ranked. Although the literature suggests that FD analysts accept that the use of different delay analysis methods should not lead to differences in the EOT entitlement, the evidence (from both the archival study and the survey) suggests that this is often the case. This study supports earlier empirical work by the authors in that these were among the most frequent reasons for disagreements. The survey findings also indicate that (i) high-level analysis, weak selection rational and partial analysis are among the most important reasons for disagreements and (ii) EOT assessments often involve bias. Consequently, interpretation can be influenced by bias. It must be noted that the sample involves delay disputes that were settled in alternative dispute resolution forums where the privacy of the parties and delay experts is guaranteed. It is argued that this is an important factor which can act as a catalyst of bias and perpetuate disagreements by encouraging (or, at least, not preventing) subjective assumptions. Specifically, the archives indicate that in all case studies at least one of the FD analysts relied upon either a different delay technique or a 'modified' delay analysis method. Often these two factors were stated as the primary reasons for disagreements on EOT entitlements. Conducting incomplete analyses can also generate and prolong EOT entitlement-related disagreements. For example, critical path arguments, including (i) the analysis does not discuss adequately the near-critical paths; (ii) the identified critical path lacks substantiation; and (iii) the analysis is inadequate because it only includes select aspects of the project.

In summary, the analysis above indicates that opportunistic behaviour and bias are at the core of the issue. However, such opportunities can be significantly restricted by improving the acceptability of delay analysis methods through implementation of ex ante contract-specific delay analysis protocols. Such agreements should stipulate the accepted

method and provide a detailed description of it (see subsection 5.3 below), including a statement of the parties' responsibilities to record and share relevant materials and documents. Additionally, radical changes to the ownership of data by implementation of trusted and transparent technology at project level is recommended. The analysis of the archives supports earlier work by Atanasov *et al.* in that the primary types of disagreements can be divided into two categories: records and analysis [19].

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...Consequently, this study supports earlier work by Atanasov *et al.*, upholding the assertion of Gibbs *et al.* that uncertainty of outcome can be driven by the insufficiency and/or poor quality of data [18]. Contract procedures that require the production and acceptance of regular programme updates and the use of technology to record and share data appear to offer effective solutions to such problems. Sensors [19], 3D scanners [20], blockchain technology [21], and drones [22] are among the existing technology that can generate and share accurate records (or even capable of automating aspects of the process e.g. contemporaneous validation of as built programmes) or, at least, to produce high quality validated programmes and as built records. Therefore, procedural and technological solutions are available that can reduce factual disagreements in construction delay disputes; specifically, those concerning materials and documents [23].

5.2. *Matters of Interpretation*

The findings indicate that (i) ten factors relate to the analysis of delays and (ii) delay analysis usually involves interpretation of relevant facts. Consequently, those factors can be described collectively as *matters of interpretation*. Generally, the degree of interpretation required to form an expert opinion is dependent on the available facts. In other words, if data (or evidence) are unavailable to substantiate the facts, the FD analysts are required to make assumptions including planned and actual programme logic, sequence and activity durations. Alternatively, a 'high-level analysis' can be completed. However, this approach lacks accuracy. This factor, along with 'weak selection rational' of delay analysis methods and 'partial analysis' were among the highest ranked. Although the literature suggests that FD analysts accept that the use of different delay analysis methods should not lead to differences in the EOT entitlement, the evidence (from both the archival study and the survey) suggests that this is often the case. This study supports earlier empirical work by the first author in that these were among the most frequent reasons for disagreements. The survey findings also indicate that (i) high-level analysis, weak selection rational and partial analysis are among the most important reasons for disagreements and (ii) EOT assessments often involve bias. Consequently, interpretation can be influenced by bias. It must be noted that the sample involves delay disputes that were settled in alternative dispute resolution forums where the privacy of the parties and delay experts is guaranteed. It is argued here that this is an important factor which can act as a catalyst of bias and perpetuate disagreements by encouraging (or, at least, not preventing) subjective assumptions; specifically, the archival case material indicates that in all case studies at least one of the FD analysts relied upon either an 'unendorsed' (by the SCL/AACE protocol /practice Direction) delay technique and/or a 'modified' delay analysis method. Often these two factors were stated as the primary reasons for disagreements on EOT entitlements. Conducting incomplete analyses can also generate and prolong EOT entitlement-related disagreements. For example, critical path arguments, including (i) the analysis does not discuss adequately the near-critical paths; (ii) the identified critical path lacks substantiation; (iii) the analysis amounts to a 'global' (or 'total cost') claim and (iv) the analysis is inadequate because it only includes select aspects of the project.

In summary, the analysis above indicates that opportunistic behaviour and bias are at the core of fact-related delay disputes. However, such opportunities can be significantly restricted by improving the acceptability of delay analysis methods through implementation of *ex ante* contract-specific delay analysis protocols. Such agreements should stipulate the accepted method and provide a detailed description of it (see subsection 5.3 below), including a statement of the parties' responsibilities to record and share relevant *materials and documents*. Additionally, radical changes to the ownership of data by implementation of trusted and transparent technology at project level is recommended. The analysis of the archival case material supports earlier work by Atanasov *et al.* in that the primary types of disagreements can be divided into two categories: *records* and *analysis* [24].

Page 7: the following text appears:

5.3. *Lack of Knowledge, Training and Delay Analysis Clauses*

This should read:

5.3. *Inadequate Knowledge, Training and Delay Analysis Clauses*

Page 8: the following text appears:

The archives indicate that such clauses can be used successfully in identifying and implementing the most suitable delay analysis method at the inception stage of construction projects, or before the contract and subcontracts are signed. As indicated by the quotation above such clauses can be very prescriptive in terms of the steps that must be undertaken to complete the analysis of delays. A recent DAB decision also indicates that the parties are free to implement such clauses in the contracts and that terms like this one are upheld by decision makers in the UAE. Consequently, the sector appears to be endorsing ideas like the use of contractual delay protocols to reduce uncertainty in the context of factual delay disputes by improving the acceptability of delay analysis methods. As indicated in the literature review, this recommendation appears to be co-ordinated with current guidance, including the most recent SCL protocol and AACE practice direction.

5.4. *Concurrent delays*

Besides matters of interpretation, the survey questionnaire results indicate that 'concurrency' arguments and other contractual arguments like 'float ownership' can perpetuate disagreements. The term 'concurrent delay' concerns circumstances where two or more delay events arise at different times, but the effects of those events are felt at the same time. However, for the purpose of this paper, concurrency does not become an issue unless both an employer risk event and a contractor risk event lead to delay to the completion date [11]. Although this category is not the focus of this study it can be said that some legal systems, including England and Wales, have recently indicated that the parties to a contract are free to allocate the risk of concurrent delay by incorporation of concurrent delay clauses that use clear wording to allocate such risk to contractors [26]. Otherwise, the risk will be allocated in a fashion established by the courts. For example, in England and Wales contractors are usually entitled to extensions of time but not payments for loss and expense [27]. In Scotland, the delay will be apportioned [28]. Consequently, the potential solution to this issue appears to be in the making, at least in the UK.

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Page 8: the following text appears:

5.5. Strategic behaviour

As indicated above, the participants used words like 'human involvement', 'emotion' and 'partiality' to describe factors that indicate bias. These findings support a hypothesis that strategic behaviour is at the core of factual delay disputes. On the other hand, all factors have been ranked important. Consequently, it is argued that an effective solution must address the problem holistically but nevertheless acknowledge that strategic behaviour aimed at creating opportunities is at the core of the issue. The evidence presented here indicates that the absence (or withholding) of materials, records and documents can be exploited by the parties and their advisors (or consultants) by making assumptions that are beneficial to their case. The evaluation of the issues and potential solutions presented here indicate that certainty of outcome in delay disputes can be improved by the provision of adequate training, exploitation of technology, contractual delay protocols and/or radical changes to the ownership of relevant data at construction project level.

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5.5. Strategic/opportunistic/tactical behaviour

As indicated above, the participants used words like 'human involvement', 'emotion' and 'partiality' to describe factors that indicate bias. These findings support a hypothesis that strategic/opportunistic/tactical behaviour is at the core of factual delay disputes. On the other hand, all factors have been ranked important. Consequently, it is argued that an effective

solution must address the problem holistically but nevertheless acknowledge that strategic/opportunistic/tactical behaviour aimed at creating opportunities is at the core of the issue. The evidence presented here indicates that the absence (or withholding) of materials, records and documents can be exploited by the parties and their advisors (or consultants) by making assumptions that are beneficial to their case. The evaluation of the issues and potential solutions presented here indicate that certainty of outcome in delay disputes can be improved by the provision of adequate training, exploitation of technology, contractual delay protocols and/or radical changes to the ownership of relevant data at construction project level.

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There are certain limitations to drawing conclusions from these findings. Although the sample is relatively small, it was tested with fifty relevant professionals of whom sixteen have been involved in more than twenty-five delay disputes. The ranking of the factors by highly experienced professionals (or those involved in more than twenty-five delay disputes) and relatively less experienced professionals (five to twenty-five delay disputes) was generally consistent. This provides further strength to the findings. Consequently, the creation and testing of an effective solution, namely a requirements model is recommended. This research is currently underway and the results will be presented in future published work. Exploration of the previously noted issue of using forms of alternative dispute resolution where the privacy of the parties and their experts is guaranteed, specifically if this creates uncertainty and opportunities for disagreements, and investigation of effective solutions to mitigate this problem would also be a valuable line of enquiry.

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Page 9: the following text appears:

References

- [1] National Building Specification 2018 National Construction Contracts and Law Report (National Building Specification)
- [2] Arcadis 2021 Global Construction Disputes (Arcadis)
- [3] Adam A, Josephson P E and Lindahl G 2017 Aggregation of factors causing cost overruns and time delays in large public construction projects: Trends and implications *Engineering, Construction and Architectural Management* 24 393-406
- [4] Ansah R H, Sorooshian S and Mustafa S B 2018 The 4Ps: A framework for evaluating construction projects delays *Journal of Engineering and Applied Sciences* 13 1222-7
- [5] Durdyev S and Hosseini M R 2019 Causes of delays on construction projects: a comprehensive list *International Journal of Managing Projects in Business*
- [6] Larsen J K, Shen G Q, Lindhard S M and Brunoe T D 2016 Factors affecting schedule delay, cost overrun, and quality level in public construction projects *Journal of Management in Engineering* 32 04015032
- [7] Atanasov V, Greenwood D and Robson S 2020 The Management of Disputes as an Element of Construction Transaction Costs: An Empirical Study In Proc. of the 36th Annual ARCOM Conf. (Glasgow: ARCOM) pp 235 - 45
- [8] Burr and Castro A M 2016 *Delay and Disruption in Construction Contracts* (CRC Press)
- [9] Pickavance K 2010 *Delay and Disruption in Construction Contracts* (London: Sweet and Maxwell)
- [10] Parry A 2015 *The Improvement of Delay Analysis in the UK Construction Industry* (Newcastle upon Tyne: University of Northumbria at Newcastle)
- [11] Society of Construction Law 2017 *Society of Construction Law Delay and Disruption Protocol* (Society of Construction Law)
- [12] Kumaraswamy M M 1997 Conflicts, claims and disputes in construction *Engineering Construction and Architectural Management* 4 95-111
- [13] Keane P J and Caletka A F 2015 *Delay analysis in construction contracts* (Oxford: Wiley Blackwell)
- [14] American Association of Cost Engineers 2011 RP 29R-03 Forensic Schedule Analysis no 29 (American Association of Cost Engineers)
- [15] Kraiem Z M and Diekmann J E 1987 Concurrent delays in construction projects *Journal of Construction Engineering and Management* 113 591-602
- [16] Braimah N 2014 Understanding construction delay analysis and the role of preconstruction programming *Journal of Management in Engineering* 30 04014023
- [17] Scott S, Harris R A and Greenwood D 2004 Assessing the new United Kingdom protocol for dealing with delay and disruption *Journal of Professional Issues in Engineering Education and Practice* 30 50-9
- [18] Gibbs D J, Emmitt S, Ruikar K and Lord W 2013 An investigation into whether building information modelling (BIM) can assist with construction delay claims I. J. 3D. I. M 2 45-52
- [19] Sanchez D, Greenwood D J, Benghi C, Atanasov V A and Parry A 2019 Specifying the information requirements for Forensic Delay Analysis In Proc. of the CIB W78 (Newcastle upon Tyne: CIB W78) pp 679 - 88
- [20] Atanasov V, Greenwood D, Thurairajah N and Hatcher C 2021 Forensic delay analysis: an investigation of the reasons for disagreements in time-related disputes In Proc. of the 37th Annual ARCOM Conf. (Glasgow: ARCOM) pp 460-70
- [21] Akinci B and Anumba C 2008 Sensors in construction and infrastructure management *Journal of Information Technology in Construction* 13 69-70
- [22] El-Omari S and Moselhi O 2008 Integrating 3D laser scanning and photogrammetry for progress measurement of construction work *Automation in construction* 18 1-9

- [23] Li J, Greenwood D and Kassem M 2019 Blockchain in the built environment and construction industry: A systematic review, conceptual models and practical use cases *Automation in Construction* **102** 288-307
- [24] Li Y and Liu C 2019 Applications of multirotor drone technologies in construction management *International Journal of Construction Management* **19** 401-12
- [25] Walter Lilly & Co Ltd v Mackay & Anor [2012] EWHC 1773 (TCC)
- [26] North Midland Building Ltd v Cyden Homes Ltd [2017] EWHC 2414 (TCC)
- [27] Henry Boot Construction (UK) Ltd v Malmaison Hotel (Manchester) Ltd (1999) 70 Con LR 32
- [28] City Inn Ltd v Shepherd Construction Ltd [2010] ScotCS CSIH 68
- [29] Northern Ireland Housing Executive v Healthy Buildings (Ireland) Ltd (2014) NICA 27

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- [1] National Building Specification 2018 *National Construction Contracts and Law Report* (National Building Specification)
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- [4] Ansah R H, Sorooshian S and Mustafa S B 2018 The 4Ps: A framework for evaluating construction projects delays *Journal of Engineering and Applied Sciences* **13** 1222-7
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- [6] Larsen J K, Shen G Q, Lindhard S M and Brunoe T D 2016 Factors affecting schedule delay, cost overrun, and quality level in public construction projects *Journal of Management in Engineering* **32** 04015032
- [7] Atanasov V, Greenwood D and Robson S 2020 The Management of Disputes as an Element of Construction Transaction Costs: An Empirical Study *In Proc. of the 36th Annual ARCOM Conf.* (Glasgow: ARCOM) pp 235 - 45
- [8] Burr and Castro A M 2016 *Delay and Disruption in Construction Contracts* (CRC Press)
- [9] Pickavance K 2010 *Delay and Disruption in Construction Contracts* (London: Sweet and Maxwell)
- [10] Parry A 2015 *The Improvement of Delay Analysis in the UK Construction Industry* (Newcastle upon Tyne: University of Northumbria at Newcastle)
- [11] Society of Construction Law 2017 *Society of Construction Law Delay and Disruption Protocol* (Society of Construction Law)
- [12] Kumaraswamy M M 1997 Conflicts, claims and disputes in construction *Engineering Construction and Architectural Management* **4** 95-111
- [13] Keane P J and Caletka A F 2015 *Delay analysis in construction contracts* (Oxford: Wiley Blackwell)
- [14] American Association of Cost Engineers 2011 RP 29R-03 *Forensic Schedule Analysis no 29* (American Association of Cost Engineers)
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- [17] Scott S, Harris R A and Greenwood D 2004 Assessing the new United Kingdom protocol for dealing with delay and disruption *Journal of Professional Issues in Engineering Education and Practice* **30** 50-9

- [18] Gibbs D J, Emmitt S, Ruikar K and Lord W 2013 An investigation into whether building information modelling (BIM) can assist with construction delay *claims I. J. 3D. I. M* **2** 45-52
- [19] Akinici B and Anumba C 2008 Sensors in construction and infrastructure management *Journal of Information Technology in Construction* **13** 69-70
- [20] El-Omari S and Moselhi O 2008 Integrating 3D laser scanning and photogrammetry for progress measurement of construction work *Automation in Construction* **18** 1-9
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- [23] Sanchez D, Greenwood D J, Benghi C, Atanasov V A and Parry A 2019 Specifying the information requirements for Forensic Delay Analysis *In Proc. of the CIB W78* (Newcastle upon Tyne: CIB W78) pp 679 - 88
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