PRACTICALITIES OF DELAY ANALYSIS: RETROSPECTIVE ANALYSIS

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The legal arguments that surround delay and disruption claims offer little practical guidance for the 'delay analyst'. Most publications proclaiming guidance overlook the technicalities of documenting, recording and analysing project data. Embedded in delay analysis are 'logical' assumptions used to interlink tasks and activities. Practices vary and there is little reliable advice on what 'logic' is and is not acceptable. Through a case study, retrospective analysis was applied to a subcontractor's work package to assess the impact of delays caused by the main contractor. The report discusses the practical issues associated with retrospective analysis and the obstacles that need to be overcome in order to produce a coherent model of events. Reflections on the experience of gathering data associated with time, resource and logic from both subcontractor and contractor are discussed along with the issues associated with retrospective analysis. Although many emphasise the importance of the critical path analysis, it is argued that this is just a part of the resource logic and the disruption surrounding the critical path can be equally important. Logical assumptions made and their potential limitations are presented and discussed.

Keywords: delay, disruption, time impact analysis.

INTRODUCTION

Although there are no real agreed or universally recognised methods of analysing and quantifying delay and disruptions claims (Lal 2002; Ward 2005), the SCL (2002) Delay and Disruption Protocol and legal precedence suggest that 'critical path method' and 'time impact analysis' are preferred methods of demonstrating delays. Indeed failure to identify critical activities and the critical path has been detrimental to a party's case (*Balfour Beatty Construction Ltd. v. The Mayor and Burgess of the London Borough of Lambeth*). However, a critical path method or time impact analysis is not evidence of delay. When attempting to produce a valid programme links must exist with contemporaneous data: the data is used to evidence events as the project unfolds. Contemporaneous documents are needed to support and validate the analysis; however, problems over the nature of such evidence are often given scant consideration. And, while resources used are central to the disruption claim, few publications or cases make any comments as to whether delay analysis should incorporate either resource driven programmes or if a time impact analysis should be merely supported by method statements and diaries that allude to the resources affected.

It is estimated that delay and disruption cost the UK construction industry in excess of eight billion pounds per annum (Pickavance 2003); although there is no guidance on

Gorse, C A, Bates, M and Hudson-Tyreman, A (2006) Practicalities of delay analysis: retrospective analysis. *In:* Boyd, D (Ed) *Procs 22nd Annual ARCOM Conference*, 4-6 September 2006, Birmingham, UK, Association of Researchers in Construction Management, 501-510

how such figures are derived or who estimated the cost. Nevertheless, in addition to the lost time, direct costs and inefficient use of resources, resources will be consumed in negotiations. The vagueness that surrounds delay procedures and analysis mean that time will be wasted addressing whether the analysis tools are appropriate, reliable and properly applied. Even though there is much debate about the methods that are most appropriate few publications identify the practical difficulties experienced when attempting to analyse delays. Using a case study, some problems experienced when gathering data and producing a retrospective analysis are exposed. The candid reflections presented add information to the debate around delay claims and the use of critical path analysis, especially when used as part of a retrospective analyse.

Analysis and evidence: Critical path method (CPM)/ analysis (CPA)

Pickavance (2000) notes that delay analysis performed without CPM does not show the interrelation between activities, degree of interdependency, critical path nor float. Without the use of CPM it is considered impossible to demonstrate the effects of concurrency, parallel delays, unproductive working, secondary delay, consequential delay or acceleration (Pickavance 2005). Although the critical path method is the preferred method to demonstrate the effects of delay and disruption (SCL 2002), there is no judicial guidance on what logic should be included to determine the critical duration. The manual method of undertaking critical path analysis is relatively simple and can be found in many project management textbooks. The critical path method is described as a technique used to predict the project duration by analysing which sequence of activities has the least amount of scheduling flexibility (Stevens 2002).

Factors that are associated with CPM include:

- It defines all the project's critical activities that must be completed on time.
- Earliest start dates and finish dates are calculated, this then establishes the earliest possible completion date for the project.
- A second calculation is undertaken to determine the latest time that each task can be completed without delaying the project completion date.
- For some tasks there will be a difference between the earliest finish time and the latest finish time, the difference in the time represents the degree of float that a task has.
- Where the earliest completion date and latest completion date of the task are the same they are critical and it is these tasks that form the critical path. If any of the critical events take longer than anticipated the overall completion date will be delayed.

(Stevens 2002).

The 'time impact analysis', sometimes referred to in American cases, is an extension of the critical path analysis. To predict the consequences of a delaying event, the delaying event is added into the project's logic, the programme may then be affected such that the critical path is extended or a new critical path emerges. Time impact analysis is described in the SCL protocol as (SCL 2002) a "method of delay analysis where the impacts of particular delays are mapped out at the point in time at which they occur allowing the discrete effect of individual events to be determined"

While the manual method of producing the critical path is clear and straight forward, the critical paths produced by planners and analyst are produced on powerful software

packages that can be driven by many different settings including resources, preferred start dates and other preference settings, rather than just the linear logic which would be used in manual analysis. Each package uses complicated algorithms to calculate completion dates and critical paths. In the UK, the computer print outs and hard copy documents are preferred by the courts (Pickavance 2005), but without enquiring into how the logic was entered and preferences set, it would be impossible to determine what was driving the programme. Nevertheless, critical paths generated by computers are an accepted method of demonstrating delay.

Wright (2002) notes that, in the case of *Balfour Beatty Construction Ltd. v. The Mayor and Burgess of the London Borough of Lambeth*, that the contractor's failure to establish the critical path was held against the contractor's claim. Generally, where plans are presented without logical links they prove to be unsuccessful in court. In the American case of *Minmar Builders (1972)*, there was no interrelationship shown between tasks, the charts were unable to demonstrate which activities were dependent on those delayed and it was impossible to assess whether the overall project duration was affected. In the Minmar case it was suggested that preparing a schedule without CPM prevented assessors identifying whether any activity was on the critical path or affected the pace of the project. Also in the *Detwiler Company (1989)* case, the board noted that because the contactor chose only to show the scheduled work and actual progress on a simple bar chart the information was considered too 'vague'.

Most cases in the UK are dealt with by arbitration and adjudication so the details of the case are unreported. Even where cases do go to court, little comment is made on the nature of delay analysis and the validity of the method used. In the case of *London Underground Ltd. v. Kenchington Ford and Others (1998)* the courts where somewhat critical of the evidence of delay prepared by the expert, but the court did not mention the approach taken nor comment on the aspects of delay analysis which caused the case some 'difficulty'.

The suggestion, by the courts, that a critical path method should be used to demonstrate delay does narrow options slightly, removing the use of simple bar charts without logical links. However, there are many methods and practices that can be used to generate a critical path and show the logical consequence. A debate, which was conducted in front of an audience of 300 construction and law professionals, on delay analysis put forward arguments for use of as-planned and as-built; impacted as-planned; collapsed as-built and the time impact analysis techniques (Critchlow *et al*. 2006). All methods incorporated the use of critical paths yet the results produced were different. Following the debate, the audience rejected the motion that time impact analysis was the most effective method; furthermore, none of the methods advocated commanded a clear majority as the most preferred method. Critchlow *et al*. concluded that parties are likely to adopt those methods that best suit their respective positions. Interestingly none of the methods advocated were resource driven, even though the planning and analysis software used was capable of accepting resources. Lloyd L.J. in *McAlpine Humberoak Ltd. v. McDermott International Inc. (No.2)* was particularly critical of programmes that did not show the true impact on resources or made inappropriate assumptions about resources and their affects on the programme. Where technology exists and resource data is available it should be used to show patterns of work, changes and affects on resources. Currently the subjective nature of the much of the analysis methods and inconsistent approaches makes the position, at best, unclear. Some Judges, such as His Honour Judge David Wilcox, prefer not to concentrate on the relative merits of the critical path analysis, but adopt a more factually based

approach (See *Skanska Construction UK Ltd v. Egger (Barony) Ltd.).* Such approaches place greater emphasis on the contemporaneous information.

Contemporaneous information

The SCL (2002) suggests that contemporaneous material, as well as programmes and plans, should be used to evidence delays. In the guidance section of the Protocol emphasis is placed on the link between method statements and the program. The method statements, which describe in detail how the work is to be carried out, should be fully cross-referenced to the appropriate section of the programme. Method statements should provide the descriptions of the work and identify the human and other physical resources used to undertake the work. Pickavance (2005) suggests that there are three types of contemporaneous documents that should be kept in relation to any project, these are, day-to-day communications including activity reports and correspondence, documents relating to events that may lead to claims and disputes, and cost data for labour, plant and materials. The full list of contemporaneous information that Pickavance claims should be maintained spans over four pages of the publication and is inclusive of most documents used in construction projects. Carnell (2000) and Pickavance (2005) suggest that the factors which influence the strength of the contemporaneous data are timeliness, neutrality of records, approval and acceptance, first hand records collected at the time of the event, secure processing that prevents manipulation and corroboration of records.

The two main components of demonstrating delay are the programme and contemporaneous material. The contemporaneous documents are used to support, corroborate and validate events. However, pulling together and assembling such information may not be as simple as it seems. While there is some guidance about what should be used, it is important to understand the practical problems faced when attempting to gather the contemporaneous data and assemble it into a logical framework. Consideration should also be given to the data and tools that power the network and produces the critical path.

RESEARCH METHOD

Using contemporaneous information, including diaries, notes, letters, programmes and faxes and through interviews with a subcontractor, two researchers with construction and project management experience attempted to retrospectively plan and analyse delays caused by a contractor that impacted on the subcontractor. The delays caused by the subcontractor's own acts were also considered. The case study reports the problems encountered and the assumptions made when attempting to perform retrospective analysis.

The value of the subcontract package in question was relatively small, just over £900,000 and the subcontractors prediction of the associated delay and disruption claim was £300,000. The contract was to supply and install modular rooms into a serviced building structure. In order to install the units, the structure where the units were to be housed had to be fully complete. The claim was negotiated and settled out of court.

RESULTS: OBSERVATIONS

The following represents issues that emerged during attempts to undertake a retrospective analysis of the subcontractor programme. The subcontractor had limited understanding of project management techniques. The only plan in place during the

project was a hand drawn gantt chart, project management software had not been used to plan nor monitor the project.

The subcontract believed they were entitled to an extension of time. On application to the main contractor, the subcontractor was asked to supply a critical path, identifying critical tasks, dependencies and labour levels as well as identifying any delay items that the subcontractor was responsible for. The subcontractor had little understanding of the nature of what was being requested.

To determine the cause of the delays and evidence their existence the main contractor's programme and the subcontractor's programmes were reviewed. The information within the programmes was compared to correspondence and diary records in an attempt to validate the programme as a record of events.

When compared to the contractor's own correspondence none of the programmes issued by the contractor proved to be correct, the contractor's own programmes were not validated by the contemporaneous information which they supplied. Programmes which had been issued for the subcontractor to work to were out date on the day issued, some of the milestones and summary bars which showed start times and windows for the subcontractor to work to had already passed. The detailed programmes and information provided by the contractor conflicted. It appeared that the programmes had been developed to show the contractor's progress rather than show the subcontractor when and where they could start work. On comparison with the subcontractor's diary and the times when the subcontractor actually worked the programme presented neither a factual document of progress nor a plan of works showing when the subcontractor could perform their work. There was a general sparsity of updated plans provided by the main contractor, and those plans provided were not useable as they conflicted with correspondence and instructions provided by both the contractor and subcontractor. The plans provided by the contractor were months out of date and did not represent the work being undertaken. While the contractor asked the subcontractor for a plan which showed a critical path it is interesting to note that the main contractor's plan did not show a critical path. Both the contractor's and subcontractor's management plans were less accurate and detailed than the subsequent analysis being requested.

The contract documents, which required the work to be phased and completed in sections, had mistakes. A typing error meant that one of the sections of work was due to be complete before it commenced, the year part of the date was incorrect. The slip of such a fundamental part of the contract left both the contractor and subcontractor in an awkward position regarding that particular section of work. Neither party had noted this mistake and addressed it in subsequent correspondence. Both the subcontractor and contractor had failed to notice that the completion date for this section of works occurred almost a year before the start date.

There were numerous delaying events which meant that the subcontractor was unable to access the site as anticipated. When undertaking the retrospective analysis, it proved impossible to establish a sequence of logical events based on the programme information supplied by the contractor and subcontractor. The correspondence showed that the main contractor had provided a series of windows into which the subcontractor had to fit and perform their work. Initially, the working periods shown on the programme were used to build the retrospective programme logic. The logic did start to enforce a critical path. However, the windows and timescales changed with each plan issued by the main contractor. It was clear that the programme and as-built

records were not representative of work undertaken. Such information did show that the main contractor was failing to supply information that the subcontractor could work to. Furthermore, it was impossible to develop a logical interpretation of events based on the contractor's plans and tracking documents.

The first real stage of the analysis was to establish that the subcontractor's hand drawn programme was feasible. Working with the subcontractor, a list of tasks was developed. Most tasks were related to the completion of a block of work, which involved installing the modules and fitting out rooms. The total time to complete each unit or block of work was calculated. The work was then broken up into the periods worked and a productivity factor was introduced. Where dependencies occurred logical links were introduced. The number of resources required to complete each task were also identified. The subcontractor was then asked to identify the number of resources that he had anticipated to be employed on the task. Some of this information was gained from method statements and where information was incomplete the subcontractor was asked to identify the resources. The network that was subsequently produced showed that the subcontractor's initial programme was slightly optimistic. If work had been undertaken as planned, the resource histogram produced in the analysis showed that the number of resources required exceeded those anticipated to be available. The project was resource levelled to show the true predicted resource demand of the project.

Once a realistic anticipated plan was produced the affected and actual plans were developed. There were many delaying events, most of which were caused by the main contractor delaying access into required areas or the contractor failing to complete their tasks, meaning that the subcontractor had to return to undertake work out sequence. The sequence of work undertaken was very different to that anticipated. Resources could not and were not used in the manner foreseen by the subcontractor's method statement and the contract documents. As workers could only gain access to part of the works, and resources were often taken from their job to allow other main contractor works to take place, the effectiveness of the workforce was reduced. It was considered impracticable to provide meaningful critical path using time based logic alone. Using the anticipated plan of work, which was resource driven, the impact of the change events was imposed on the tasks and resources. The constraints of some delaying events were relatively easy to impose. When events could not start, tasks could be delayed by adding a delaying task or imposing a new start date for the task. Some operations took much longer than anticipated due to stop-start working patterns caused by surrounding event. Some tasks took twice as long as anticipated while others typically experienced 20-50% extended durations. It should be noted that the subcontractor's diary only showed which blocks were worked on and not how much was achieved. The tasks were plotted against the supporting contemporaneous information; however, it was difficult to ascertaining whether the delay plotted was reasonable. Without first-hand documents there was no evidence to suggest whether the workforce was being used as effectively as possible, even though delay was experienced. The subcontractor's diary and correspondence were being used to establish working patterns; however, there were often times when work was unreported. Notes were made on the affected programme, cross-referring tasks and events to the correspondence, which helped to corroborate events.

During the actual work, the subcontractor had reduced the number of resources because it was unable to provide continuous work for their employees. Reducing the resources on site mitigated the resource costs incurred; however, the disruption and

costs experienced from reorganising resources and turning down further business because of changes in working commitments could not be assessed, as no evidence was available.

Due to delays on site, the subcontractor had to store substantial materials at their own warehouse; the subcontractor experienced disruption in their own warehouse and could not store materials for other work. By mitigating events and storing the modules at their own factory rather than renting a storage unit, the lack of invoices and documentation meant that it was difficult to determine the actual costs incurred and degree of disruption experienced.

REFLECTIONS

Many small contractors and subcontractors do not use project management tools, so sophisticated work requiring the use of planning and tracking tools arguably leads to difficulties. In this case study, the subcontractor had no formal project management training, did not use project management software and did not know what critical path analysis was.

The subcontractor used manual plans. The plans identified the resources available and linked them to each tasks, the sequence of the tasks were dictated by the number of resources available. When performing the delay analysis, it was logical to drive the computer programme by the same logic the subcontractor used. The as-built programme, which was created to reflect events, was resourced, resource levelled and used priority settings to drive the software. Working constraints imposed by the contractor and the some sequential logic between events was also used. Despite some assumptions, adding in the resource information and task constraints derived from subcontractor documents tied the management data into the retrospective programme. This helped to create a more objective reflection of events. Building a programme from method statements, resource information and management records offers some benefits when compared to simply sliding around bars on a gantt chart. The contemporaneous data supplied in most cases only provided part of the story. Where possible documents were used and cross-reference to the programme to show that the gantt chart information was compiled from multiple sources and tied in with the main contractor's documents. However, when fitting information together it was necessary to use diary records, which could not be corroborated. Furthermore, to fill any gaps, those working on the project were asked to recount events, and while useful, there were varied recollections of events that took place 12 months earlier.

Many of the problems with documentation could have been eliminated if the subcontractor had used planning and tracking tools during the project. The delay could have been predicted and the disruption monitored. Failing to use project management tools often means that there is limited base line information available against which the affects of disruption can be monitored and measured. If the subcontractor had used management tools on site and in the factory, where modules were manufactured and stored, most of the disruption would have been easily evidenced. The main contractor had also failed to use project management tools appropriately, while this showed evidence of neglect on their part, the level of disruption experienced was difficult to measure as the subcontractor's records and attempts to manage the process were sporadic.

While the contractor emphasised the importance of demonstrating what was on the critical path, it is argued that this was not the most significant feature of this case. The

work patterns changed so much that disruption was experienced on most units of work. In some cases, the pattern of work distorted to such a degree that the original logic of the initial plan had to be rescheduled because it would not fit with the new arrangements. Occasionally, when changes were added into the logic and forecasts produced they did not always reflect the delays actually experienced. Once impacted with changes some of the delays forecast were greater than those experienced. The results indicated that the subcontractor had mitigated the affects of the potential delay by rescheduling and reducing resources, this produced a very different working pattern. Had the subcontractor predicted such affects during the contract period the parties may have been able to agree a change and an allowance for the disruption. If the agreement had not been reached, the forecasts and mitigation would have considerably strengthened any subsequent claim.

DISCUSSION

Increasing pressure is being placed on construction parties to manage problems and disputes as they occur rather than waiting for the full blown dispute to manifest. From the difficulties experienced in putting together retrospective claims it is clear why the American courts and the SCL Protocol encourages parties to deal with matters at the time they are first suspected. It does seem that the courts are becoming even keener on parties resolving matters early using procedures given in the contract. By reducing the costs awarded, in the case of *Dunnett v. Railtrack*, the courts penalised the winning party for failing to the use of ADR. Since the introduction of the 1998 Woolf Reforms, using the Overriding Objective, the Civil Procedure Rules, the Pre-Action Protocols and numerous judgements, the English legal system has placed increased pressure on the parties to use adjudication (Law Now 2005). The courts are taking the view that litigation is the last resort. Leaving EoT claims until after the contract is complete means that analysis is retrospective and the potential to mitigate the event by change management is lost. While the subcontractor in this case study did mitigate the effects of disruption, failing to deal with matters at the time did reduce the strength of their claim.

Where parties do not use dispute resolution procedures, the statutes and judgements that emphasise early resolution of disputes have been used to reduce costs awarded. Failing to use dispute resolution processes during construction period to resolve EoT claims could have a bearing on the costs awarded. Although some argue that parties should ‘wait and see’ what the extent of the delay actually is, this case study emphasises that retrospective analysis has its weaknesses. More importantly parties who ‘wait and see’ lose the opportunity to mitigate or remove losses by not adopting proactive change management procedures.

Horne (2003) criticised the SCL Protocol for encouraging parties to use planning tools for delay and disruption claims, noting that such tools are used for planning and co-ordination. However, by being proactive and predicting change, the Protocol encourages change management.

In the case study reported, the planning and recording of events for the purpose of managing and administrating the project was poor and made the process of retrospective analysis difficult. In light of this experience, it is interesting to note that some parties still challenge the advice given by the SCL Protocol on management and administrative procedures. Parisotti (2002) suggests that the programming and record keeping advised by the Protocol places considerable administrative burden on the

parties and will increase costs. In addition to this, Henchie (2002) believes that in following the advice given by the Protocol the risk of disputes developing is likely to increase. According to Farrer (2004), the increased overheads required to maintain the records advocated by the Protocol will make the contractor less competitive. However, much of the administration required by the Protocol is nothing more than good management practice, indeed Nash (2002) suggests that the construction industry as a whole would benefit from more attention being devoted to proper programming. Fenn (2002) suggests that only when a dispute has manifest are the parties concerned with the dispute, and only then with the resolution. He notes that to avoid disputes, the parties must seek to predict them, because by predicting them they can take the necessary action to avoid them.

CONCLUSIONS

The guidance on what is and what is not acceptable practice to demonstrate delay and disruption is vague. Unfortunately, the term critical path is used so loosely that construction professionals often request or even use it, without understanding the nature of events, resources, logical links or preferences that drives the programme and creates 'critical events'. Indeed, the focus on the critical path, especially in disruption claims can be misleading. The word time impact analysis is also used to describe methods of analysis, yet such terms are not easily defined and leave plenty of scope for different interpretations and applications.

By using method statements and programmes, contractors and subcontractors, large and small, can identify the number of resources expected to be used. The resources information within method statements is required in order to fulfil Health and Safety legislation, therefore the collection of this information adds little extra work. Networks that use resource information and are resource driven represent a more accurate planning method. The effects of change events and the possible consequences on resources can be predicted. Currently, there is very little mentioned in case law and construction law publications about the validity of programmes that are resource driven rather than driven by tasks and logical links alone.

If changes to the anticipated course of events are considerable it may be necessary to rethink and reschedule the whole plan of work. In such situations, new logic may be introduced resulting in a new critical path. If such issues are dealt with during the course of the works the agent may be willing to accept the new programme as mitigation or agree to the change. Arguably, presenting new logic at different stages in retrospective analysis seems to be giving the analyst the freedom to make changes to logic wherever s/he feels appropriate. In this case the logic did change part way through the project; furthermore, it is considered unlikely that the analyst's interpretation is the only interpretation of events.

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