Construction Programmes and Programming: A Critical Review

Oluseun Olubajo, Will Hughes and Libby Schweber
School of Construction Management and Engineering, University of Reading, Reading, United Kingdom

Abstract

Purpose – The purpose of the study is to explore the dominant ideas in research on the management of time in construction. The focus of research has been to improve techniques for optimising the timing and sequence of activities.

Design/Methodology/Approach – A critical review of research on construction time management, challenging the typical focus. We examine the assumptions different authors make, underline the limitations of the dominant research approaches and examine the prospects for developing a new approach to researching these issues.

Findings – The dominant approach in literature focuses on unique activity traits in construction planning and measurable patterns between time-related variables. This assumes that time in construction can be managed by changing the way activities are calculated. These approaches have not been correlated with improvement in performance. Social practice theory may help to explain how programmes figure as one of many objects used during construction.

Research Limitations/Implications – The focus is on reviewing indicative literature from key journals in construction management. The implication is that research is needed about how such documents are used in practice, which goes further than optimising plans in theory.

Practical Implications – Future research could focus on understanding the context of construction planning practice and shift the debate from a focus on optimisation to practice.

Originality/Value – An interpretivist approach with a focus on how tools such as planning documents are used on site. Social practice theory may provide a clearer explanation of the place of construction planning within the practice of construction management. This could provide solutions that deal effectively with stakeholder expectations around timely completion of construction projects.

Keywords Delay, Performance, Programme, Schedule, Time, Management, Planning

All papers within this proceedings volume have been peer reviewed by the scientific committee of the 10th Nordic Conference on Construction Economics and Organization (CEO 2019).

1. Introduction

Managing time in construction projects is difficult often because a large range of different people and organizations are involved. While there is much literature on this topic, it tends to focus on tools rather than people. These tools are referred to as schedule, programme or

Emerald Reach Proceedings Series
Vol. 2
pp. 189–194
Emerald Publishing Limited
2516-2853
DOI 10.1108/S2516-285320190000002045

plan, while the associated activity is called scheduling, programming or planning. The choice of terminology varies by country or region. For the purposes of this paper, we adopt the UK convention and refer to them as "programmes" and "programming". A critical review of papers typifying the dominant approach to research in this topic highlights the tool-focused character of much of the literature. This dominant approach focuses particularly on aspects that De Marco (2011) describes as "activity attributes", as well as dealing with the risk inherent in construction activities (Nasir *et al.*, 2003). Focusing on these aspects might be misplaced, because construction programmes are usually improperly done, wrong or working imprecisely (Odeh and Battaineh, 2002). This helps to explain the common recurring complaints that construction projects are usually completed late (Morton and Ross, 2008). In contrast, this paper proposes the use of practice theory to explore the impact and use of construction programmes. A programme may be conceptualised as a display of provisions or allocated resources used to manage the timing and sequence of construction activities (Herroelen and Leus, 2005; Tory *et al.*, 2013). These resources could be time, labour, plant or equipment and, according to De Marco (2011), could be represented as a network diagram, Gantt chart, bar chart, progress curve, task matrix or histogram.

Discussion of construction programmes is common in operations research and construction management literature. One dominant thread assumes that the secret to improving performance is to improve the way that activities are calculated. For example, it is common to examine the relationship between "tightness" of activities and construction performance. Another thread assumes that changes to the way that activity attributes are calculated would improve the capacity of a programme to mitigate disruptions. Researchers often examine a relationship between resilience in construction programmes and the activity attributes in a baseline programme. The term "activity attribute" describes measurable characteristics of an activity that are integral to construction programmes and could represent any of the following: duration, start date, completion date, safety or buffer size or value, float, slack, flexibility, relations, dependency relationships, cycle time, man-hours and rework. What follows is a critical examination of the main assumptions and arguments in these two threads. This is followed by the suggestion of an alternate interpretivist approach that takes people into account and promises to help explain why projects often fail to finish on time.

2. Construction performance

The term "construction performance" generally refers to an outcome of a prearranged construction process. Abuwarda and Hegazy (2016), Nepal *et al.* (2006) and Gurcanli *et al.* (2017) share this assumption and argue that construction programmes influence performance. These authors assume that performance depends on how tightly or loosely activities are set in a programme. Tightness is an attribute that describes relations between activities in a programme network with minimum slack, float and flexibility. For example, Abuwarda and Hegazy (2016) conceptualised construction programmes as activities with flexibility and used a case study to explore ways of representing flexible ranges as overlapping options between any two sequential activities. This conceptual framework was used to produce a programme-crashing model that stimulates construction activities to meet strict deadlines. They claim that construction projects can be optimally accelerated by combining, crashing and overlapping decisions. This claim is not consistent with their evidence because calculating overlapping options that tighten sequential activities in a programme does not necessarily correlate with prompt completion of activities.

Nepal *et al.* (2006) further developed Abuwarda and Hegazy's (2016) argument about the tightness of activities. They conceptualised construction programmes as target decisions with pressures on construction processes and used a questionnaire survey to explore the influence of pressured decisions on the perceived performance of projects in Singapore. This approach measured the influence of pressured decisions on three aspects of performance: perceived productivity, perceived work rate and perceived quality of site work. The influence of four target decisions, representing varying degrees of tightness in construction activities, was tested using levels of agreement with hypothetical statements about pressure on performance. They claimed that large amounts of target pressure can slow down work rates by lowering the quality of the work. However, this claim is not supported by their data, as they failed to test for the causal relationship between pressure decisions, work rates in construction and quality. Moreover, their claim contrasts with Abuwarda and Hegazy's (2016) argument on performance, where work rates do not depend only on levels of pressure.

Decisions in programming can be made after weighing or comparing alternative cycle times. This activity attribute was studied by Gurcanli *et al.* (2017) and assumed to influence construction performance. Cycle time refers to a portion of time that represents repeated occurrences from the start to the end of the same group of activities in a sequence. The authors undertook a case study of truck crews in Turkey to compare the productivity outputs of excavator-loader-dump truck-crews in residential construction. Their results showed divergent effects on the duration of activities in a project. They claim that using past data estimates and simulated techniques can assist in developing accurate estimates for construction programmes. However, on their own, calculations of different simulated outputs cannot be used to make claims about improvements in performance. A major limitation of this approach is that it does not fully explain the way that time estimates are used in negotiating various professional and business interests in the construction project.

Hegazy *et al.* (2011) examined how low-quality construction activities can lead to rework. This activity attribute is assumed to influence construction performance. Rework refers to work that is faulty or defective that must be repeated. Hegazy *et al.* (2011) conceptualised construction programmes in a more dynamic way than other authors because they incorporate repeated activities. This approach applies techniques developed using a computer prototype to correct a construction programme and include rework. Progress made in executing a project was illustrated daily by comparing initial, actual and remaining durations with percentage completions in a construction programme. The results of this comparison produced a corrective action plan using site reports of a case project that reduced a small construction programme from 13 to 11 days. The researchers claim that programming can be more responsive to the specific timing of various progress events.

All of these authors assume that changes to the way activities are calculated can control the timing and sequence of construction activities and assume that the construction programme directly influences construction performance. However, they offer no mechanism or explanation as to how these changes would necessarily correlate with improvements in time performance. They do not engage with construction in its commercial or social context with differing and sometimes conflicting interests of diverse parties. For example, in the UK construction practice, the contractor's programme is a requirement under most standard-form building contracts as it is used for calculating the impact of the kind of delays that would justify an extension of the contract period. Therefore, contrary to the widely held assumptions about the purpose of programmes being to avoid delayed completion, the way that contracts are drafted tells us that the purpose of a programme is to acknowledge that delays occur and to deal with their consequences (see, for example, Ballesteros-Pérez *et al.*, 2017).

3. Construction programmes and resilience

In contrast to authors who assume that the programme itself causes or avoids delayed completion, other scholars explore the way that performance is affected by exogenous and endogenous risks. This is exemplified by Nasir *et al.* (2003), Song *et al.* (2009) and Roghanian *et al.* (2017). These authors assume that knowledge of inherent risks will improve the capacity of project managers to mitigate real time disruption. They argue that the resilience of a construction programme depends on the features of activities in a "baseline" programme, i.e. a programme that provides a plan against which progress can be measured.

Risk is inherent in an activity and can influence an activity's duration. This activity attribute was investigated by Nasir *et al.* (2003) and assumed to influence resilience of construction programmes. Duration refers to the length of time apportioned to an activity in a construction programme. They conceptualised resilience in construction programmes as an evaluation of risk inherent in construction activities and explored how risks related to construction processes could aid in estimating probable time values for an activity. This approach examines case projects and progress reports and produces a risk model for analysing construction programmes. Nasir *et al.* (2003) claim that their programme-risk model can provide a basis to determine the likely extent of delays. However, this argument is not supported by simply evaluating risk in past projects as some activities develop in variance to prescribed sequences of past company projects, delays are not always a function of how activities are calculated and past delays cannot predetermine the timing of future construction events. This approach is prescriptive and based on the idea that the problems in past projects will occur in a similar way in future projects. It is not clear that the proposed approach would account for unforeseen events.

Our knowledge of risk in construction can shape the allocation of resources to activities such as labour. This activity attribute is investigated by Song *et al.* (2009) and assumed to influence the resilience of construction programmes. They conceptualised construction programmes as the use of construction knowledge in the design process and examined the influence of such knowledge inputs on the resilience of construction programmes. This knowledge input at an early stage may also be referred to as contractors' input, experience or involvement. Song *et al.* (2009) developed a baseline simulation model that set out percentage estimates on the frequency of delays for certain elements in a process. Song *et al.* conclude that including a contractor's knowledge in the design will lead to reduced labour use and project duration. However, this argument is not supported by their evidence as they have not compared their findings with a case that did not include early contractor involvement.

Effects of risk in construction activities can be moderated with the size of a buffer. This activity attribute is investigated by Roghanian *et al.* (2017) and assumed to influence the resilience of construction programmes. "Buffer" refers to an amount of cushion or protection embedded in an activity against disruptions and is represented as a portion of time in a baseline programme. Their approach examined a seven-activity case study and aimed at minimising the uncertainty in non-routine construction projects. A model of how construction programmes can be applied with buffer-sizing was developed using fuzzy set theory to overcome programme risk more efficiently. The authors' model set out a proposed buffer size or value. A comparison of the existing buffer value with the proposed buffer value from the model indicated a reduced completion time. Roghanian *et al.* (2017) claim that construction projects can be programmed to neutralise delays and disruptions with buffer values. It is not clear how such a prescriptive approach would help in practice because delays and disruptions in construction processes do not depend on the way buffers are calculated but, rather, in a way that programmes are used in the event of disruptions.

As this brief review suggests, studies on resilience share many of the same assumptions as those on construction time performance. In these papers on resilience, authors assume that changes to the way activity attributes are calculated will improve the capacity of a programme to mitigate disruptions. These approaches focus on the unique attributes of activities in a baseline programme and claim that time in construction can be managed merely by changing the way that activities are calculated. Their research focuses primarily on patterns between time-related variables. However, these approaches do not necessarily correlate with any improvement in construction performance, and evidence of performance improvement is never offered. None of these studies consider the business context and situational use of various parties utilising or interacting with construction programmes.

4. Engaging with construction programmes using a practice theory approach

As an alternative to the approaches discussed above, we propose the use of social practice theory. This is an approach that explores how well-established everyday activities (practices) are maintained and changed. The approach conceptualises practices as made up of three basic elements, namely, objects, practitioners and knowledge or skills (Shove *et al.* 2012).

The proposed research calls for a study of both the ongoing design of the programme (programme practices) and its use in everyday construction activities. For example, in the case of programme practices, relevant objects include a programme or specification; practitioners include builders or construction managers and skills include programming or estimating. Questions about programming practices include: how is the initial programme produced? What skills, experience or information does the person writing it draw upon to define activity and activity duration? Do they consult with anyone else? When and how are programmes revised? What leads to changes? A second stream of research involves exploring how project team members engage with a programme. Who consults it? When? Under what conditions does it influence what the project team do? In what type of situations is it ignored or modified? This approach is distinguished from the focus of earlier studies because there are no fixed assumptions that construction is simply an engineering or mathematical concept. Rather, it involves exploring the practices of putting together a programme and how a programme figures as one of many objects utilised in constructing a building. The focus is on the production of programmes in local construction settings.

This approach promises, among other things, exploration of how various parties engage with construction programmes in highly contextual and uncertain environments. Construction is a business and exploring a business sense of construction programme is useful when there are continuous negotiations, variances in interests, trade-offs between decisions for profit and execution. This context offers a deeper understanding of which practices shape the use of programmes, which parties interact with construction programmes, the actual sequence of events that produce project outcomes and what sense parties make when engaging with a construction programme as a project-based tool. This approach offers a better understanding of why construction projects do not always develop precisely in the way that activities are planned.

Investigations exploring programming practices would involve an ethnographic study. This would contribute to our understanding of how professionals engage with project-based tools. This would explain why performance in construction does not always improve or meet stakeholders' expectations. This would challenge the focus of previous studies by concentrating on a situational engagement with construction programmes. This focus involves considering construction programmes as an object of everyday use in daily judgements and negotiations in business. This aspect posits that construction is about timing, people and judgements, and that the various parties are involved in a project with extended supply chains, multiple contractual relationships and diverse interests. It is worth noting that no matter how sophisticated a programme may be, its usefulness depends on the people who run the project (Morton and Ross, 2008).

We posit that exploring this approach to the subject of construction programmes and programming will provide clearer explanations about why construction planning does not necessarily improve construction performance, despite the many innovations and improvements in construction planning practice. The approach also challenges widely held assumptions that overruns are primarily owing to managerial incompetence.

5. Conclusion

Several authors focus primarily on patterns within and between time-related variables. Past research efforts show that focussing on construction planning techniques alone does not necessarily improve construction time performance. Social practice theory offers an alternative which takes into account the use of programmes, rather than their formal features. This approach offers a contextual understanding on how programmes work. As such it promises to shed light on why projects often fail to deliver on time and how to develop and improve the use, rather than the design, of management tools.

References

Abuwarda, Z., and Hegazy, T. (2016). Flexible activity relations to support optimum schedule acceleration. *Journal of Construction Engineering and Management*, 142(11), 6016004.

Ballesteros-Pérez, P., Rojas-Céspedes, Y. A., Hughes, W., Kabiri, S., Pellicer, E., Mora-Melià, D., and del Campo-Hitschfeld, M. L. (2017). Weather-wise: A weather-aware planning tool for improving construction productivity and dealing with claims. *Automation in construction*, 84, 81–95.

De Marco, A. (2011). *Project management for facility constructions: A guide for engineers and architects*: Springer Science & Business Media, Heidelberg.

Gurcanli, G. E., Turkoglu, H., and Bilir, S. (2017). Heavy equipment scheduling for horizontal construction projects. *Procedia Engineering*, 182, 265–273.

Hegazy, T., Said, M., and Kassab, M. (2011). Incorporating rework into construction schedule analysis. *Automation in construction*, 20(8), 1,051–1,059.

Herroelen, W., and Leus, R. (2005). Project scheduling under uncertainty: Survey and research potentials. *European Journal of Operational Research*, 165(2), 289–306.

Morton, R., and Ross, A. (2008). *Construction UK: Introduction to the industry*: Wiley-Blackwell, London.

Nasir, D., McCabe, B., and Hartono, L. (2003). Evaluating risk in construction-schedule model (ERIC–S): construction schedule risk model. *Journal of Construction Engineering and Management*, 129(5), 518–527.

Nepal, M. P., Park, M., and Son, B. (2006). Effects of schedule pressure on construction performance. *Journal of Construction Engineering and Management*, 132(2), 182–188.

Odeh, A. M., and Battaineh, H. T. (2002). Causes of construction delay: traditional contracts. *International Journal of Project Management*, 20(1), 67–73.

Roghanian, E., Alipour, M., and Rezaei, M. (2017). An improved fuzzy critical chain approach in order to face uncertainty in project scheduling. *International Journal of Construction Management*, 18, 1–13.

Shove, E., Pantzar, M., and Watson, M. (2012). *The dynamics of social practice: Everyday life and how it changes*: Sage, London.

Song, L., Mohamed, Y., and AbouRizk, S. M. (2009). Early contractor involvement in design and its impact on construction schedule performance. *Journal of Management in Engineering*, 25(1), 12–20.

Tory, M., Staub-French, S., Huang, D., Chang, Y-L., Swindells, C., and Pottinger, R. (2013). Comparative visualization of construction schedules. *Automation in Construction*, 29, 68–82.