Interaction between Theory and Practice in Civil Engineering and Construction
Edited by Komurlu, R., Gurgun, A. P., Singh, A., and Yazdani, S.

ISBN: 978-0-9960437-2-4

STAFF COMPETENCY ISSUES IN LINEAR SCHEDULING APPLICATIONS

JUNESEOK YANG and DAVID ARDITI

Dept of Civil, Architectural, and Environmental Engineering, Illinois Institute of Technology, Chicago, USA

Linear scheduling method (LSM) is a scheduling method that is based on achieving a continuous flow of resources as well as precedence requirements. Although LSMs have recognized strengths in dealing with resource-intensive projects that are composed of repetitive activities, LSMs are not used extensively. This study proposes a staff-technology fit model that aims to measure the extent to which the features provided by LSM match scheduling staff experience, know-how and capabilities. The aim is to understand why LSM is not used as extensively as expected in construction scheduling. A questionnaire survey was administered to professionals listed in the directory of the Construction Management Association of America (CMAA) to measure staffing-technology fit in LSM applications. Research findings indicate that LSM applications satisfy user requirements in construction scheduling by (1) providing information that is useful to project participants depending on their position and function in the project organizations, (2) presenting graphics that are easy to understand, and (3) providing ease in communication. Research findings also reveal that LSM is not only a scheduling tool but also a control tool. However, the findings also point out that (1) LSM schedules require much time and effort to produce, (2) there are only very few commercially available software programs capable of running LSM schedules, and (3) there are not enough training opportunities for project managers and their staff to learn how to use LSM.

Keywords: Staff-technology fit, Scheduling methods, Linear scheduling, Scheduler competencies, Scheduling software, Visualization.

1 INTRODUCTION

The critical path method (CPM) is by far the most popular method used in larger construction projects. Alternative techniques to CPM were developed in the last 40 years under the generic term, linear scheduling methods (LSMs). However, while the general consensus is that LSMs are well suited to projects composed of activities of a repetitive nature, their usage is not widely accepted (Arditi *et al.* 2002).

Can the fit between the scheduling staff's expertise and the characteristics of LSM explain the reason why LSM is not used as extensively as expected? The objective of this study is to identify the barriers which prevent LSM from being used widely in the industry.

2 THE PROPOSED STAFFING-TECHNOLOGY FIT MODEL

The staffing-technology fit model shown in Figure 1 leads to three general propositions. The first two propositions deal with the technical capabilities of the scheduler and the characteristics of the LSM technology, respectively. The third one is a "fit" relationship between the capabilities of the scheduler and the characteristics of the LSM technology.

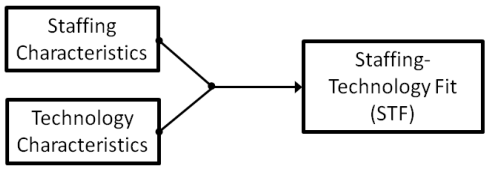

Figure 1. Staffing-technology fit model.

2.1 Characteristics of Staffing

The characteristics of the staff could affect how easily and well schedulers utilize a scheduling method. The difficulty of scheduling may vary depending on the competence of a scheduler. Schedulers, who are more competent, well trained, or quite familiar with a particular scheduling system will be better able to successfully manage their work.

2.2 Characteristics of the Technology

Technologies can be defined as tools that individuals use in carrying out their tasks (Goodhue and Thompson 1995). Scheduling and control can be achieved by using LSM that offers advantages such as maintaining continuity of resources, conciseness, and vividness in linear and repetitive projects.

2.3 Staffing-Technology Fit

Staffing-technology fit can be defined as the degree to which technology functionally matches the individual abilities of schedulers and managers. To be specific, an experienced scheduler can select an optimum level of detail, whereas insufficient knowledge of the scheduler may lead to poor schedule development. Thus, by examining to what degree the LSM scheduling system fits the capabilities of schedulers, the scheduling system can be judged to be acceptable or not.

3 METHODOLOGY

The methodology of the study involved an online survey that was designed by means of a survey tool provided by www.SurveyMonkey.com. The study was targeted to the professionals listed in the directory of the Construction Management Association of America (CMAA).

The first part of the questionnaire required the respondent to indicate agreement or disagreement with eight statements described in the following section on a scale of 1–5 (1=strongly disagree and 5=strongly agree). The second part of the questionnaire

included three questions that inquired about demographic characteristics such as the experience of the respondents, and the type and characteristics of projects in which they were involved.

4 STAFFING-TECHNOLOGY FIT IN LSM APPLICATIONS

Eight statements presented in Table 1 were identified as staffing-technology fit measures that affect the linkage between LSM and the capabilities of the staff involved in scheduling and control. They were inspired from the study of Goodhue and Thompson (1995).

Table 1. Statements for measuring staffing-technology fit in LSM applications.

Statement	Clarification	Sources
S1. The schedule provides information that is useful to all project participants.	Participants in the construction project require information that is useful to them depending on their position and function in the project organization.	Galloway (2006)
S2. The schedule generates graphics that are easy to understand by all parties in the project.	The graphical format enables all parties in the project to better visualize the plan of action and to more easily communicate the plan to the group involved with the project.	Duffy *et al.* (2010)
S3. The degree of detail that the schedule provides coincides with the needs of the project manager.	The level of detail varies from low density (e.g., executive summary) for construction owners to high density (e.g., detailed schedule) for contractors.	Ceran and Dorman (1995) Hartley (1993)
S4. Schedulers are familiar with and have access to a software package.	Software packages allow schedulers to define many phases and tasks, and then to assign the labor, materials and resources required to complete each task and phase.	Hartley (1993)
S5. The schedule requires little time and effort to produce.	If a scheduling method is easy to use and user-friendly, the schedule requires less time and effort to produce.	Badiru and Pulat (1995)
S6. There is enough training for project managers and their staff on how to use the system.	Training on how to use the scheduling system improves the productivity of project participants.	Birrell (1980) Martin (1988) Benjamin *et al.* (1990)
S7. Project participants can effectively communicate with each other on the basis of the schedule.	Communicating on the basis of the schedule makes project participants understand the day to day objectives of the project, and, reduce uncertainty and disagreement.	Orlikowski and Yates (1994) Walker (1995) Jergeas and Hartman (1994) Coble and Snow (1996) Mackanzie *et al.* (1999)
S8. Project managers can respond to schedule-related issues promptly.	Project managers should respond promptly to the schedule-related issues such as contractual compliance, reasonability of job logic, and activity durations.	Goodwin (1993) Moosavi and Moselhi (2012) Hartley (1993)

5 DATA ANALYSIS AND DISCUSSION

The questionnaire was designed for response over a web link emailed to the potential respondents in February/March 2015. A total of 251 completed responses were received for data analysis. Of the 251 respondents, 68% indicated that they had experience in building construction (e.g., commercial, residential, educational, etc.), 63% in civil works (e.g., roads, bridges, tunnels, etc.), and 33% in industrial construction (e.g., power plants, refineries, etc.).

Concerning project size, 71% of the respondents had been involved in projects worth over $50 million. Also, the average number of their years of experience in the construction industry was 24.4 years. All respondents stated that they were familiar with LSM. Given their extensive experience, especially in large projects, the respondents appeared to be well qualified to answer the questionnaire administered in this study.

According to the results presented in Figure 2 respondents mostly agree that (1) LSM satisfies the requirements of all project participants who need information that is useful to them depending on their position and function in the project organization(S1); (2) LSM is not only a scheduling tool but also a control tool (S8); (3) LSM allows a good degree of detail in the schedule (S3); (4) LSM provides ease in communication between project participants (S7); and (5) LSM presents graphics that can be of great value to users (S2).

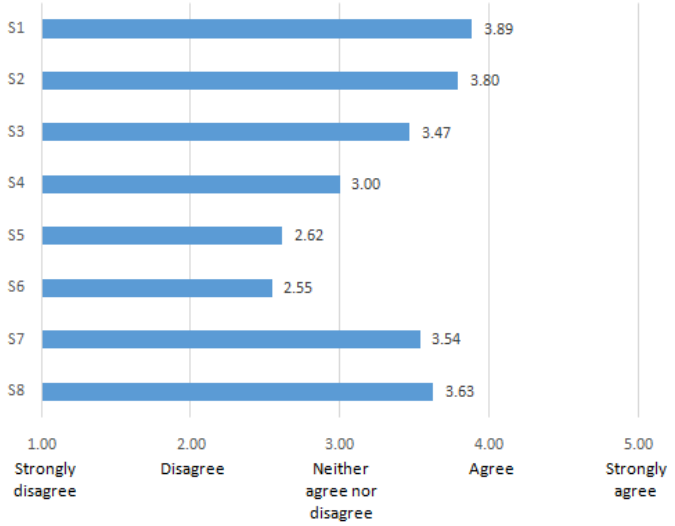

Figure 2. Mean scores of LSM applications.

On the negative side, respondents mostly agree that (1) there are not enough training opportunities for project managers and their staff to learn how to use LSM (S6); (2) LSM schedules require much time and effort to produce (S5); and (3) several well-designed software packages are not commercially available for schedulers' use (S4).

The literature supports these findings. A study conducted by Jongeling and Olofsson (2007) shows that a major reason why the construction industry has been slow to adopt LSM is the lack of supporting software that is user-friendly and easy to use so that the schedule requires less time and effort to produce. In addition, Tavakoli and Riachi`s (1990) work indicated that the main reason behind unsuccessful LSM applications was the lack of support from employees who were presumably not knowledgeable enough about LSM. To accomplish a successful implementation of LSM, all levels of users should be trained well. According to Nageeb and Johnson (2009), most of the limitations and disadvantages are due to limited training opportunities for LSM methods and software because scheduling theory is often lacking at the university level and is usually taught as a two-week seminar.

6 CONCLUSION

This study proposed a staffing-technology fit model to understand why the use of LSM is limited in construction. A questionnaire survey was conducted to collect information about LSM applications. The staffing-technology fit model was used to find out respondents` perceptions of how their capabilities fit the requirements of LSM. Professionals` opinions regarding staffing-technology fit show that respondents mostly agree that LSM requires significant effort to produce and that LSM is not taught at school or at work. Also, schedulers are not familiar with and have not enough access to a software package. Thus, these reasons seem to hinder LSM from being accepted in the industry.

This empirical study considers only the theory of staffing-technology fit. However, LSM use can also be explained by theories of attitudes and behavior. In addition, the fit between LSM and the task performed by schedulers can also help to understand LSM implementation. Although the study has limitations, the findings and implications are significant in that the fit between the technical capabilities of the staff involved in scheduling and control and the characteristics of LSM technology does affect the extent to which LSM is used in the construction industry.

The findings of this study indicate that the performance of LSM is likely to be enhanced if all project participants are cognizant of scheduling-related matters.

- For owners, LSM should monitor work progress. Indeed, LSM applications provide production diagrams that are easier to understand than CPM networks.
- For contractors, LSM should create opportunities to meet deadlines because contractors have to pay liquidated damages for contractor-caused delays. Thus, a scheduling method that can predict bottlenecks that may result in delays will allow contractors to complete the project in the shortest possible time.
- For construction managers, LSM should allow managers to coordinate the activities over the entire project, communicate with other participants, and respond to schedule-related matters.

Future work may involve the examination of other factors than staffing-technology fit, such as task-technology fit, expected consequences of utilization, social norms, habit, and facilitating conditions. Also factor analysis can be used to group the variables for further quantitative analysis.

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