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

TASK-TECHNOLOGY FIT IN THE ADOPTION OF LINEAR SCHEDULING METHOD

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Although the general consensus is that linear scheduling methods (LSMs) are quite powerful, their use in construction has been very limited. The linkage between the characteristics of scheduling methods and the requirements of the tasks performed by schedulers has been an on-going concern in the construction industry. This study proposes a “task-technology fit” model to understand why LSMs are not being used as extensively as expected. The model aims to determine whether the characteristics of LSM (technology) satisfy the duties and obligations of construction schedulers (tasks). By scrutinizing the task-technology fit in LSM applications, deficiencies can be detected which hinder the wider use of these methods in the industry. A questionnaire survey was administered to measure task-technology fit in LSM applications. The target population included schedulers, project managers, construction managers, and other professionals listed in the directory of the Construction Management Association of America (CMAA). The findings indicate that LSM is effective in repetitive projects and is able to provide a smooth and efficient flow of resources by adjusting activities’ rate of production. In addition, research findings point out that LSM effectively shows activity sequences as well as progress. However, the findings also reveal that LSM is not applicable when reliable resource data are not available. It should also be noted that very few software packages that perform LSM scheduling are commercially available on the market.

Keywords: Task-technology fit, Scheduling methods, Linear scheduling, Scheduling tasks, Scheduling software, Visualization.

1 INTRODUCTION

Even though the general consensus is that linear scheduling methods (LSMs) are quite effective in projects composed of activities of repetitive nature, their use in construction has been limited. In order to understand the reasons why these methods are not used as extensively as expected, an attempt is made in this study to analyze the linkage between the characteristics of LSM (technology) and the requirements of the tasks performed by schedulers. By scrutinizing the “task-technology fit” in LSM applications, deficiencies which deter LSM from being used widely in the industry could be found. Thereby, the ways to increase its level of acceptance could be developed.

2 THE PROPOSED TASK-TECHNOLOGY FIT MODEL

The task-technology fit model leads to three general propositions. The first two propositions deal with the characteristics of the scheduling task and the LSM technology, respectively. The third, and most critical proposition, is that task and technology characteristics interact to define a relationship. Such interaction is the essence of what is meant by a "fit" relationship.

2.1 Characteristics of the Tasks

Activities are identified to describe the project in sufficient detail so as to satisfy the schedule objectives (Hartley 1993). According to Chua and Shen (2005), construction can be viewed as a production line flowing through the activities of a project, and being supported by resources.

Many construction operations in building, industrial and civil works are repetitively performed. These repetitive projects consist of a large number of similar or identical units. Thus, maintaining work crew continuity in projects composed of repetitive units is essential in minimizing disruption that makes schedules difficult to develop as well as maintain (El-Rayes and Moselhi 2001).

Construction time and resources should be considered simultaneously for proper project scheduling. Time often takes precedence over resource utilization in construction projects. To be specific, when the interrelationships between project participants and activities are critical to the project or when the time constraints assume contractual significance, time has a higher priority than resource utilization (Hartley 1993). In contrast, optimal resource utilization is recognized as the key to meeting a repetitive construction project schedule (El-Rayes and Moselhi 2001). To be specific, construction managers need to develop a schedule for directing and controlling resources of manpower, machinery, and materials, which play a significant role in making work plans reliable, in a coordinated and timely fashion in order to deliver a project within the limited time available (Halpin and Woodhead 1976). Thus, construction project scheduling should be performed under resource constraints by considering flexibility for time through proper resource leveling.

2.2 Characteristics of the Technology

Technologies can be defined as tools that individuals use in carrying out their tasks (Goodhue and Thompson 1995). In the context of construction scheduling, schedulers utilize LSM to perform their tasks in projects that exhibit repetitive characteristics. LSM is based on a continuous flow of resources. The general consensus in the literature is that LSM is better suited in situations that involve repetitive activities.

2.3 Task-Technology Fit

Task-technology fit can be interpreted as the extent to which a scheduling method is supportive of the tasks generally performed by schedulers. A scheduling system that does not have a good fit is considered failed or unacceptable. Thus, examining the fit between the characteristics of a scheduling method and the tasks usually performed by schedulers may help to identify the barriers to extensive implementation.

3 METHODOLOGY

The methodology of the study is presented in Figure 1. An exhaustive literature review was conducted to understand the characteristics of LSM scheduling. Similarly, technology acceptance theories were reviewed to propose a “task-technology fit” model to investigate the current situation. The questionnaire survey method was chosen for data collection because the unit of analysis is users of LSM. The study was confined to the professionals listed in the directory of the Construction Management Association of America (CMAA). The selection of the respondents was based on their experience in construction scheduling. A cover letter was emailed to the recipients, which emphasizes the intent of the study and acknowledges the confidentiality of the information that is requested. This letter also included a link to the questionnaire.

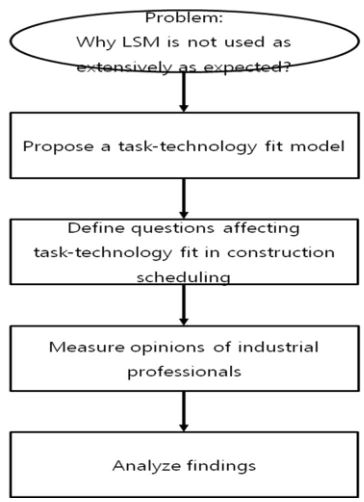

Figure 1. Research methodology.

The eight statements described in the following section were identified as task-technology fit measures that affect the linkage between LSM and the tasks of the staff involved in scheduling and control. The first part of the questionnaire required the respondent to indicate agreement or disagreement with these eight statements 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 type and size of projects in which they were involved and the respondents` years of experience in construction industry.

The online survey was designed on a web-based platform www.SurveyMonkey.com. The reason for selecting an online survey tool was to obtain a wider sample of respondents and to reduce cost and time (Rubin and Babbie 2013).

4 TASK-TECHNOLOGY FIT IN LSM APPLICATIONS

The eight statements presented in Table 1 were designed to measure the relationship between scheduling-related tasks and LSM technology. The statements are inspired from the study of Goodhue and Thompson (1995).

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

Statement	Clarification	Sources
T1. The schedule clearly shows activity sequences in my projects well.	For a schedule to be realistic, the physical relationships that exist among the different construction components must be considered.	Moosavi and Moselhi (2012) Echeverry *et al.* (1991) Tommelein and Ballard (1997) Hartley (1993)
T2. Software exists that does all the tedious calculations instantaneously.	Commercial scheduling software packages are used to extract, read, and analyze the data with accuracy and high speed.	Badiru and Pulat (1995) Lee (2005) Mattila and Bowman (2004)
T3. Activities` rates of production can be adjusted for efficient performance.	Production rates should be updated and adjusted on a regular basis to assure they accurately reflect the site conditions in the construction area, allowing a smooth flow of resources and working continuity.	Hartley (1993) Moosavi and Moselhi (2014)
T4. It is easy to schedule projects that are composed of repetitive activities.	Although most construction projects are dominated by non-repetitive activities, some construction projects such as highways, railways, pipelines, and tunnels are characterized by a series of successive and repetitive activities.	Harris and Ioannou (1998)
T5. A realistic schedule can be developed even if reliable resource data are not available.	Time constraints sometimes have a higher priority than resource constraints. For example, reliable resource data are desirable but not required in network-based scheduling systems.	Zheng *et al.* (2005) Harris and Ioannou (1998)
T6. The schedule provides a smooth and efficient flow of resources.	In order to control the flow of resources smoothly, equipment and labor should be utilized in the most efficient way possible and the total cost of resources should be minimized.	Karaa and Nasr (1986)
T7. The schedule defines all contractual interfaces clearly.	A scheduling method defining all contractual interfaces clearly provides the legal basis for the administration of construction disputes and claims.	Moosavi and Moselhi (2012) Hartley (1993)
T8. The schedule can measure progress compared to a baseline schedule.	A scheduling method that provides progress measurement compared to a baseline schedule ensures the fitness of the schedule.	Moosavi and Moselhi (2014)

5 DATA ANALYSIS AND DISCUSSION

A cover letter including a link to the questionnaire was emailed to the recipients in February/March 2015. The letter included the intent of the study and an acknowledgement of the confidentiality of the information that was requested. A total of 251 completed responses were received for data analysis. Of the 251 respondents, more than half indicated that they had experience in building construction (e.g., commercial, residential, educational, etc.) (68%) and civil works (e.g., roads, bridges, tunnels, etc.) (63%), while fewer had experience in industrial construction (e.g., power plants, refineries, etc.) (33%).

Concerning project size, 71 % of the respondents had been involved in projects 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. Based on their extensive experience in large projects, the respondents appeared to be well qualified to answer the questionnaire administered in this study.

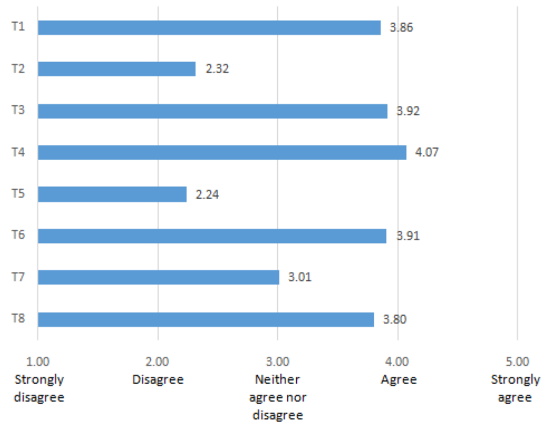

Figure 2. Mean scores of LSM applications.

The results presented in Figure 2 reveal that professionals` view concerning task-technology fit tended to “agree” in five of the eight statements that (1) LSM is effective in repetitive projects (T4); (2) LSM adjusts activities` rate of production efficiently (T3); (3) LSM provides a smooth and efficient flow of resources (T6); (4) LSM shows activity sequences well (T1); and (5) LSM can show progress well (T8).

On the negative side, respondents mostly disagree that (1) LSM is applicable when reliable resource data are not available (T5); (2) Software packages for LSM are not sufficient (T2); and (3) LSM defines all contractual interfaces clearly (T7). There is enough evidence in the literature to support these findings. The LSM scheduling methods’ criticalness is based on time and resources, unlike network scheduling where it is based only on time. To be specific, the LSM diagram can be developed once the number of crews and the expected rate of output have been computed for each activity and then, the number of units to be produced is plotted against time (Arditi *et al.* 2001). Therefore, LSM is indeed not applicable when reliable resource data are not available.

Also, studies such as the one conducted by Jongeling and Olofsson (2007) show that a major reason why the construction industry has been slow to adopt LSM is the lack of supporting software packages that help to produce LSM schedules.

6 CONCLUSION

Despite the obvious strength of LSM, its use in construction has been limited. This study proposed a task-technology fit model to understand why LSM is not used as extensively as expected in construction scheduling. A questionnaire survey was conducted to collect information about LSM applications.

The findings of this study regarding task-technology fit in LSM applications indicate that LSM is superior in repetitive projects by its very nature, and that LSM should not be used if resource data are not available. Also, software packages that help to produce LSM schedules have to be developed for wider acceptance of LSM applications. LSM requires significant expertise and effort to produce but LSM is seldom taught to schedulers at school or at work.

Although this empirical study is limited only to an investigation of task-technology fit, the findings and implications are significant in that the fit between task and technology does affect positively the use of scheduling technology. Future work may involve the examination of additional factors such the level of the schedulers` expertise and their attitude toward an unusual technology such as LSM.

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