Chapter 64
Mathematical Algorithms Supporting the Optimization of Topical Aspects of Project Management

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ABSTRACT

Project management is a highly sophisticated undertaking requiring the synthesis of various interconnected functions, processes, and activities. Numerous risks and uncertainties are inherent to all these inputs. Consequently, successful project management entails the optimization of the complete project as a system. In order to achieve this result, however, the various system subsets to the project must themselves be optimized. Given the current complexity of projects, optimization cannot be adequately undertaken by intuitive judgment alone. Philosophically, optimization is a mathematical concept, and mathematical algorithms are available to identify ideal operating parameters for any given problem. This chapter samples a range of features inherent to project management operations and presents mathematical algorithms that deliver optimal solution sets. The material is collated from literature and adapted to the project management context.

1. INTRODUCTION AND OBJECTIVES

Organizations require investment in systems that monitor their activities in order that goals are achieved and efficiency is maintained. Such systems provide baseline data on operational and project performance. Such data informs of performance status benchmarked against predetermined targets, and in the case of misalignment, ideally offers corrective measures. Given that projects can be immensely complex; both in terms of scale and in the range of interrelated functional activities, such monitoring must be undertaken using scientific algorithms supported by integrated computerized platforms (Amer & Golparvar-Fard; Chaszar; N. Moradi & Shadrokh, 2019; Shi, Tian, Chen, Si, & Jin, 2016). Simply put, world-class project management is now an exercise of identifying and seeking out optimizations for all project-associated functions.

Some of the previous chapters have introduced and examined both basic and evolved methods of optimization of different project management dimensions including cost, quality, and risk. But over the past decade, there have also been advances regarding the approaches taken in the optimization of projects, specifically regarding the optimization of project environments. including construction supply chain network design, accounting for different project management approaches, and temporary location and site management. Some techniques such as ant colony optimization, dynamic programming, duality theory, and modern heuristics are advancements in optimization that have recently been applied to project management. To that end, engineers and mathematicians have developed a comprehensive variety of algorithms that support the various aspects of project processes and operations (Brodach & Shilkin; Kamel, 2019; Safa, Sokolova, Safa, & Weeks, 2019; Sanchez, Rausch, Haas, & Saari, 2020). These provide detailed information to project managers on matters of time, cost, environmental impacts, risk, and safety, to name a few of the many considerations (Abbasianjahromi & Hosseini, 2019; Degraf Miara & Scheer, 2019; Fanaei, 2019; Gan et al., 2019a; Gan et al., 2019b; Jin, Nahangi, Goodrum, & Yuan, 2020; N. Moradi & Shadrokh, 2019; Rivera-Gómez, Pérez-Fenoy, Entrenas-Angulo, López-Aguilar, & Galán-Marín, 2020; Valor, Escudero, Labajo, & Cossent, 2019). Moreover, these solution sets aid in achieving project objectives, including 1) specification to client requirements, 2) robust feasibility assessment, design, and planning, 3) fabrication of a physical product, 4) integration into current systems, 5) testing, debugging and validation, 6) defect free product installation, and 7) ongoing trouble-free maintenance. This chapter examines the techniques and how they can be applied to project environments by offering a review of certain support systems available to project managers. Neither the issues presented nor the support systems described should be taken as comprehensive. Rather, the selection offered is an attempt to draw the reader's attention to the manner in which high-end project management is now conducted. This chapter documents advancements in project management within the construction industry. So, the topics related to these advancements considered in the following sections are construction supply chain networks; location and site management; time, scope, cost, quality, and risk; as well as optimization of different approaches to project management. This chapter has six sections. Following the introduction, the remainder of the paper is organized as follows. Section 2 presents advancements in project management in construction supply chain and network design. Section 3 presents advancements in a temporary location and site management. Section 4 discusses project management advancements for balancing project parameters of time, scope, cost, quality, and risk. Section 5 discusses different project management approaches and their optimization (see Figure 1). Finally, section 6 offers a brief summary and reflection on these topics.

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