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Shift scheduling with fuzzy logic: an application with an integer programming model

Muhittin Sagnak^a, Yigit Kazancoglu^{a*}

^a*Izmir University of Economics, Sakarya Cad. No:156, 35330, Balçova/IZMIR/TURKEY*

Abstract

The shift scheduling, which is one of the most crucial processes in order to increase efficiency and decrease labor costs, is a common phenomenon in both manufacturing and service organizations such as airlines, security services, fire stations, etc. In order to meet changing demand and keep responsiveness and flexibility, the shift scheduling includes the scheduling of manpower by assigning employees to shifts determined by types, length, and the number of breaks. The types of shifts may present variety such as part time and full time shifts. The breaks also show variety like lunch breaks, short rests, and compulsory reasons based on the occupational health and safety or necessities for maintenance. To overwhelm this complexity, this paper recommends an integer programming model integrated with fuzzy logic due to the vagueness inherited to the nature of decision-making process in order to provide flexibility in shift lengths, and lower the total labor costs.

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1. Introduction

Many companies face difficulties while composing acceptable optimized schedules for employees. These difficulties include contradictory and multiple scheduling restrictions of work environment. As Dahmen and Rezik (2015) stated, schedules should allow employees to be present at needed places in different periods of planning in order to maintain admissible service quality.

* Yigit Kazancoglu. Tel.: +90-232-488-83-46; fax: +90-232-279-26-26.
E-mail address: yigit.kazancoglu@ieu.edu.tr

Effective scheduling of manpower is one of the critical issues that a service system manager comes across daily. In an operating day, the demand for service generally might change in service systems. Shift scheduling can be developed by determining the demand which will after be converted into labor requirements with the help of queuing models. This will help to maintain the desired service level throughout the day. After this, employees are assigned to shifts in a way to meet these requirements. Understaffing might be useful for lowering the total labor cost but on the other hand it might result in degeneration of the service quality so this might also lead to higher total cost. On the other hand, in order to improve the service quality, overstaffing might be the answer but it leads to underutilization of labor and so labor costs also increases. For this reason, in order to minimize the labor cost and ensure desired service level, efficient scheduling is important for organizations (Aykin, 2000).

Efficient personnel scheduling is used by organizations, in order to be competitive among other organizations (Bard et al., 2003). Competitive advantage can be attained by achieving the best staff configuration in terms of time, demand and cost constraints. If workforce scheduling is not appropriate, it may lead to oversupply or undersupply which might result in loss of business. Nevertheless, characteristics and constraints on workforce scheduling show an alteration in different industries and organizations (Kabak et al., 2008).

There are various problems regarding the developing shift schedule. These can be counted as the determination of the employee number that are to work in various shifts, the timing of the shifts and their breaks considering the limitations allowed by legacy, unions, and company requirements. In order to improve the utilization of manpower and decrease labor costs, the flexibility in shift types, start times, duration of shifts and breaks is provided (Aykin, 2000).

The main concern of manpower scheduling is the scheduling of resources in order to meet the requirements of operations while satisfying the goals and policies enforced by the management, labor union and the government. Manpower scheduling is critical in non-stop operating service organizations in which the employees have multiple shifts. Operators in communication companies and workers in airports can be given as examples (Lau, 1996).

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The remainder of the paper is structured as follows. First, in Section 2, the literature related to shift scheduling is presented. Then, in Section 3, the proposed methodology of fuzzy integer programming model explained. Section 4 is conclusion and discussion for future research.

2. Literature Review

Edie (1954) introduced the shift scheduling problem (SSP) in order to schedule toll booth operators. Then, the integer programming model was firstly introduced by Dantzig (1954) for solving SSP problems. With this precursor work, researchers are able to be done on more variations of the model and the solution methods in more realistic way.

A new integer programming model for optimal shift scheduling including various multiple brakes was proposed by Aykin (1996). In his work, a new approach was formed for introducing a set of break variables in order to assign break placements. With this approach, an improved integer programming model which needs constitutively smaller number of variables and computer memory was formed.

In Al-Yakoob and Sherali's (2007) work, a new approach was proposed and this approach's main concern was multiple shifts and work centers included scheduling problems of employees who belong to an organization which has downward substitutability of hierarchies. For example, an employee at a lower-position might not perform the duties of an employee at a higher-position, but vice versa is possible. After all, employees at higher-position get more wage than the ones in lower-position. Demand is constant in weekdays; however, it shows some fluctuations in weekends. There are two objectives which are 1) to schedule workforce with minimum cost to satisfy demand

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