



Optimization of Nurse Scheduling Problem with a Two-Stage Mathematical Programming Model

Chang-Chun Tsai^{a,*}, Cheng-Jung Lee^b

^a*Department of Business Administration, Trans World University, Taiwan*

^b*Department of Information Management, National Yunlin University of Science and Technology, Taiwan*

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Abstract

This paper constructs a two-stage mathematical programming model to solve the nurse scheduling problem in order to assign nurses to shifts over a scheduling period so that certain constraints (organizational and personal) are satisfied. In the first stage, the nurse optimal vacation schedules are solved by a self-schedule programming that can check for any violation of government regulations, hospital management requirements, and scheduling fairness. In the second stage, the nurse roster schedule is arranged and a Genetic Algorithm (GA) is further adopted to derive the optimal schedule. An empirical case study is performed and the results show that the proposed approach can solve the nurse scheduling problem efficiently. In addition, it can also be easily modified to suit different cases encountered in hospitals.

Keywords: International mathematical programming model, genetic algorithm, self-schedule, nurse scheduling

1. Introduction

Nursing staff scheduling is an essential task in manpower resource management. The scheduling quality directly influences the nursing quality and working moral. Nurse scheduling problems represent a subclass of scheduling problems (Ender, 2005). Typically, personnel scheduling problems are highly constrained and complex optimization problems (Ernst et al., 2004). The need to take into account individual preferences further complicates the process. In recent years, the emergence of larger and more constrained problems has presented a real challenge. Because obtaining good quality solutions can lead to a higher level of personnel satisfaction (Burke et al., 2006). Cheang et al. (2003) added nursing staff's preferences into the factors to be considered when preparing work schedules. In addition, Bard and Purnomo (2007) considered other factors, such as nurse workforce, hospital work and hospital scheduling regulations, to establish a schedule-making decision tree. The constraint conditions for nurse scheduling are broad, and may differ from case to case. Some of the constraint conditions even conflict with each other. For instance, the shift preference of nursing staff may violate the requirement for shift fairness. In practice, the nurse chiefs arrange the schedule based on their subjective experience. To meet the complicated situations with ever-increasing patient demands and a limited nurse workforce, the chiefs may require more time and effort than ever to deal with the scheduling and still fail to be fair to all the staff. Consequently, the nurse scheduling issue remains challenging, and development of a more sophisticated approach to solve the problem deserves further exploration.

Rondeau (1990) and Beltzhoover (1994) maintained that self-scheduling reduces the ratio of shift-changes, increases opportunities for on-the-job training, and increases individual

* Corresponding author. Email: jimtsai@mda.edu.tw