Chapter 42
Personnel Rostering Management by ICT Techniques

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ABSTRACT

In this chapter, the authors discuss the technological aspects of solutions and applications in staff rostering by means of ICT techniques. Three different applications are presented related to nurse rostering in a public hospital ward, nurse rostering in a private hospital ward, and physician rostering in a public hospital intensive care unit. For all applications, the use of efficient operations research techniques, models, and related solvers guided by the suggestions of the healthcare staff is introduced. The peculiarity of this work is the combination of mathematical programming techniques and solvers under the classical neighborhood search framework.

INTRODUCTION

Healthcare Services are made up of people with different (not exhaustive nor exclusive) perspectives: patients, relatives, workers, etc. Though patients and their relatives are an obvious major issue from different points of view (organizational, logistical, economical), the same can be said for people working in any health-care structure. Physicians, nurses and support personnel work together typically split into working shifts and the quality of their working life is strongly correlated to the quality of such shifts. Indeed, the management of human capital should be a crucial point in possibly every (not limited to health-care) organization. As medical, particularly in intensive care, and nursing care are often to be met 24/7, the management of personnel roughly means staff rostering which is known to be a central issue in the majority of hospitals. Optimally planning the working shifts of personnel in health-care services, that is health-care staff rostering, is then fundamental in increasing the working life quality of such personnel and correspondingly improving their performances. We remark that staff rostering consists in optimally assigning a working shift or a day off to each worker, on each day of a month, according to several contractual

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and operational requirements. In this chapter, we discuss the technological aspects of solutions and applications in staff rostering by means of ICT techniques. Three different applications are presented related to nurse rostering in a public hospital ward, nurse rostering in a private hospital ward and physicians rostering in a public hospital intensive care unit. For all applications, the use of efficient operations research techniques, models and related solvers guided by the suggestions of the health-care staff is introduced. Peculiarity of this work is the combination of mathematical programming techniques and solvers under the classical neighborhood search framework.

BACKGROUND

All the case studies discussed in this chapter belong to the family of timetabling problems (De Werra, 1985; De Werra, 1997; Nanda & Browner, 1992; Grobner, Wilke & Buttcher, 2003), in particular they belong to the well known class of *Employee Rostering Problems* which deals with personnel assignment to shifts according to contractual and operational requirements (Vanhoucke & Maenhout, 2009; Parr & Thompson, 2007; Bellanti, Carello, Della Croce, & Tadei, 2004). There are at least two ways to cope with workers rostering:

- Manual Rosters Generation
- Automatic Rosters Generation

Despite the fact that in many hospitals the rostering of personnel is made by hand, there exist a number of drawbacks to that practice.

First of all the (sometime huge) time spent in manually generating shifts plans is clearly stolen to other working activities; furthermore, hand-generated rosters can be of poor quality as satisfying all compulsory and contractual requirements is generally a hard tasks to be accomplished just by hand. Notice also that rostering is, actually, not always considered a real time consuming task by hospitals management so that people are expected to accomplish such task, but no clear perception exists of what does it mean in terms of effort spent. On the other hand, advantages of automating the rostering process include the reduction of the planning workload and associated costs (not only economic) and the opportunity to create higher quality and more flexible schedules (Lodree, Geiger, & Jiang, 2009).

Rosters of better quality also reduce fatigue and stress due to overwork and poor scheduling and help to maximize the use of spare time of personnel by satisfying more requests, also complaints about unbalanced plans can be more easily justified and/or avoided.

Optimally planning the working shifts of personnel in health-care services is then fundamental in increasing the working life quality of workforce and correspondingly improving their performances directly increasing quality in the patients care.

Operations Research researchers and practitioners have always been involved in studying and solving such problems that falls into the class of *Combinatorial Optimization Problems* (COPs).

Within the operations research framework, many works have been published on Nurse Rostering Problems (NRPs) since the pioneering works of Warner (1976) and Miller (1976) and the proposed approaches in literature are mainly based on constraint programming, metaheuristic procedures and exact methods (Burke, De Causmaecker, Vanden Berghe & Van Landeghem, 2004; Cheang, Li, Lim & Rodrigues, 2003; Grobner, Wilke & Buttcher, 2003; Beddoe, Petrovic & Li, 2009).

In particular, within the metaheuristic framework, a simple and effective metaheuristic for combinatorial and global optimization, called Variable Neighborhood Search (VNS) has been successfully applied to solve both general Mixed Integer Programming problems (MIPs) (Hansen & Mladenovic, 2001; Mladenovic & Hansen,