FLEXIBLE SCHEDULING OF MEDICAL STAFF AND RESOURCES

By

Fadwa Ahmed Mohammed Abd Alrahman

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Biomedical Engineering and Systems

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Flexible scheduling of Medical Staff and resources

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Summary:
the last decades, many countries have been looking for systematic ways to For reduce the national healthcare expenditure. As surgeries costs a lot, all hospital administrators aim to deliver the best healthcare with the available limited resources and with the lowest costs. Planning and scheduling the surgeries and medical staff have become a major goal of hospital administrators to optimize the management and utilization of medical resources. In this work, mixed integer-linear programming models have been investigated for the scheduling of listed surgeries at different specialties with two priority grades, scheduling anesthetists over flexible shifts with flexible starting times and shift lengths. We investigated single and multi-objective formulations with criteria of cost, physician's preferences, or their combinations with weighting parameters. We can schedule all the surgeries with priority grade of 1 and more than 57% of the surgeries of a priority grade of 2.We decreased number of anesthetists, achieving more than 43% of anesthetists' preferences for their shift starting times and more than 57% for their preferences for the surgeries.

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Dedication

This thesis is dedicated to:

- The sake of Allah, my Creator and my Master.
- My great teacher and messenger, Mohammed (May Allah bless and grant him), who taught us the purpose of life.
- My supervisors Prof. Dr. Ahmed Badawi and Dr. Muhammmed Rushdi.
- My family and my parents.

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List of Symbols, Abbreviations, and Nomenclature

GDP	Gross Domestic Product; Unit of total income of country
PPP	Purchasing power parity
USD	United States dollars
BM	Blocking model
B&B	Branch-and-bound
LP	Linear programming
MATLAB	MATrix LABoratory, www.mathworks.com
MILP	Mixed integer linear programming
MIP	Mixed integer programming
KRI	Germany – Krankenhaus
IPP	Intel performance primitive

Abstract

National health spending around the world varies between countries: 17 % in the USA and around 10 % in most large European countries and about 5% in Egypt. Hospital budgets account for almost half of all expenditures in most health systems. Surgeries cost more than 40% of total expenditures of a hospital [1].
In the last decades, there have been a lot of efforts in the healthcare field to decrease costs without affecting the performance and quality of healthcare services. In particular, there is an increasing need of good scheduling schemes for medical staff and medical resources to minimize the cost of medical staff and maximize the usage of the limited resources. This is why optimal scheduling of medical personnel (including nurses and physicians) has been receiving growing attention.
In this thesis, we are interested in surgery scheduling and physician scheduling. In our model, we schedule a time horizon (e.g. a week) by dividing this time horizon into equal time intervals. Our model consists of three phases. In the first phase, we schedule the surgeries at different specialties with two priority grades over the predefined work hours for operating rooms for each specialty. In the second phase, we schedule physicians under certain constraints and rules to cover the variable demand of physicians at each time interval over shifts which are flexible in their starting times and lengths (number of time intervals). We have multiple objectives: a cost objective and a preference objective. Here, we are interested in the preferences of physicians to their starting time for shifts without contradicting hospital rules. In the third phase, we assign the available physicians at each time interval from the second phase to the scheduled surgeries of the first phase with the preferences of the physicians to specific surgeries as the objective function.
Our model can reduce the waiting lists to 40 % and perform all the urgent operations. We can cover all the demanded physicians at all the time intervals without any overtime or external physicians. We can achieve the preferences of the physicians for their shift starting times on all days if the preferences don't contradict with the rules. If there is a contradiction, the model reaches to the maximum permitted time that is closest to the physician preferences. We found that we can reduce the number of contracted and external physicians leading to minimum hospital costs.
The efficiency of achieving the preferences of anesthetists for their surgeries at specific operating rooms with average preference satisfaction rate is higher than 50%.