



Invited paper

Generic operational models in health service operations management: A systematic review



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ABSTRACT

The area of Health Services Operations Management has received considerable attention in scientific literature over the past decades. Numerous articles have appeared in health services operations management literature in which models of health operations are used. In this paper we review this wide body of literature with the aim of synthesizing evidence on application of generic operational models in health services. A generic operational model is defined as a formal description of operations performed to deliver a health service that is applicable in a wide range of health service delivery settings. The systematic review of the literature which forms the basis of our research synthesis includes peer reviewed publications from business management databases (SCOPUS) as well as medical databases (PubMed). Our search resulted in more than 4000 recent papers of which 116 papers met the inclusion criteria. This paper reports our synthesis from the included papers on four main questions: 1) why are models used? 2) what is modeled? 3) what models are used and how are they developed? 4) what are the achievements? Our systematic review reveals that few papers report achievements which qualify as empirical evidence to guide the application of operational models for health services. Nevertheless, the synthesis leads to an initial framework for operational modeling in health services to guide further research.

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1. Introduction

Over the last centuries health service operations have progressed continuously as medical sciences and technologies have progressed and the health service demands and expectations of populations and individuals changed [1]. Health service operations have become considerably more complex, and so have the corresponding operations management issues for which societies are urgently seeking solutions around the globe [2–4].

Operational models can contribute to adapting and improving health service provisioning in such complex service systems [5]. Operational models form the lingua franca in which problems arising in the design, operation and improvement of health services can be generally formulated and addressed and on which solution methods can be based.

We define an operational model for health services as a formal description of operations performed to deliver a health service and

with the purpose of facilitating operational (as opposed to strategic or tactical) decision making. An operational model describes operations which make use of resources in response to a demand of a patient. The value of the service lies in the health outcomes obtained and the evaluations of the service experiences.

Examples of formal descriptions of operations are process flow charts, care pathways, mathematical models or simulation models. Because the definition requires that the model facilitates operational decision making, the formal description must capture the service operations in all detail required to be taken into consideration for operational decision making. Based on the scientific communities which have considered operational modeling in health services, an initial categorization of such models can be as follows:

- General (service) operations models which are applied in health services such as i) (descriptive models) process flow-charting, service blue printing, activity modeling, business process modeling, simulation models), and ii) (analytical models) queuing model, Markov model, mathematical programming.

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- Models from health services research which include clinical guidelines, clinical pathways, clinical paths, critical paths, care pathways, patient journeys.

We now briefly address genericity. The terms generic and specific models are defined based on common understanding and a prior study by Fletcher et al. [6]. From the perspective of model genericity, we distinguish models into i) specific models which are used to model a single provider within a single disease chain; and ii) generic models which apply across multiple providers within a single disease chain, or across multiple providers in multiple disease chains. More practically, we view a model presented in scientific literature to be specific if it is regards a single case study without presenting results that are valid beyond the case study, e.g. apply to other cases and/or contribute to theory. In this context, we recall that earlier reviews established in various ways that many specific models have been reported in the scientific literature, but with little synthesis and with few papers that present more generic models which are generalizable across multiple diseases or settings [6]. The disease-oriented structuring of the medical profession is a possible driving force underlying applied operations management research, which has its own share in the specific nature of the prevailing literature.

Using these above generic modeling techniques, researchers have actively developed generic health service operational models and solved many commonly encountered problems in health operations management (see Ref. [6]). This has however not silenced the many laymen, professionals, managers and researchers who state that health services are inefficient and/or ineffective [7]. This raises the question whether existing scientific methods and models fall short of enabling practical improvements for today's health service operations challenges or, alternatively, whether practitioners fail to identify and apply these methods and methods? In this paper, we therefore explore if and how scientific contributions to health service operations modeling have contributed to improving the complex health service systems. The aim of our research is to review state of the art scientific literature on generic health service operations models and modeling techniques and to structure existing evidence on the contributions generic models have made to the practice of today's complex health service systems. More specifically we review the evidence on: i) the purposes of modeling ii) the services and service operations which have been modeled iii) the modeling techniques which have been applied iv) the achievements, in particular regarding implementation. Subsequently, we investigate the interrelationships among these topics of interest.

In this review, we chose to adopt an approach to analyzing and presenting research results, which is quite novel to operations management. The novelty relates to the application of the evidence based Healthcare Management paradigm in Health Service Operations Management. There is to our knowledge no such study that synthesizes state of the art scientific literature in health services operations management using the evidence base approach. Our research can therefore be viewed to parallel the development of evidence based research in health services research [8,9]. Our research also answers recent calls for evidence based management [10]. The novelty of our research also relates to the approach that we have adopted to analyze this study results. As the limited number of papers make it not feasible to apply the methodology of evidence based healthcare (e.g. meta-analysis to synthesize evidences), we have developed a pragmatic approach to classify evidences and to conclude evidence bases. We believe that this systematic novel approach has led to new answers and insights. In our view it contributes to understanding and dissemination of existing research and results, and to

strengthen the evidence base for health service operations management. A reflection on the methods and findings is provided in the [Discussion](#) section.

1.1. Study purpose

We have conducted a systematic review using an explorative approach to providing a research synthesis [11]. To provide a starting point for an empirically relevant theoretical structure of generic health service operational models, a research synthesis of a large number of primary articles is conducted through a literature review [12].

In order to define the type of evidences needed for the study objectives we build upon Kovner's work in evidence based management [10] and translate the research objectives into four dimensions:

- 'why models are used' addresses the purpose of study.
- 'what is modeled' addresses the application area of the model (patient group modeled, process modeled, setting modeled, resources included).
- 'How are models developed' addresses model objective, modeling method, and modeling language or software.
- 'What are the achievements' addresses the research findings, and whether they have contributed to practice, e.g. have been implemented, and/or contributed to health service operations management theory.

We start by noticing that studies considering the relationships between these dimensions are limited to one dimension or to a specific set of models [13] or specific settings (e.g. hospitals) [5]. Brailsford et al. [13] investigated the relationship between the functional area of simulation models and the types of model used. In the same vein we investigate relationships among the aforementioned dimensions. By developing an ordinal domain of values for each of the dimensions, we explore relationships between domain values. An example of a most extensive possible relationship for which the synthesis might provide evidence can be read as: 'studies which use model X for purpose Y in patient group Z are more likely to achieve result V in practice'. Notice that this relationship claims generalizability across a wide variety of healthcare settings, and must therefore be based on studies in which models are generic and have external validity [14]. As specific models lack external validity, therefore our research synthesis is restricted to generic models.

1.2. Previous research

Various authors have discussed operational models for health service operations in a general manner prior to our work. These general reviews complement the many applications and case studies which have been reported in literature. Some of these studies will be reported in subsequent sections. Their nature and number have been addressed by most review papers that have been published up to now. Wilson [15] already reports over two hundred simulation case studies in health care. Fone et al. [16] critically review the use of simulation modeling in population health and healthcare delivery and call for further research to assess the value of modeling. Sobolev et al. [17] review the use of computer simulation in modeling patient flow in surgical care. They report limited understanding of value of simulation in healthcare management. Brailsford et al. [13] report more than thousand papers on simulation in the emergency department alone, while Günel et al. [18] report that the number of papers appearing on simulation studies in health care

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