SECOND EDITION

OPERATIONS MANAGEMENT FOR HEALTHCARE

Jan Vissers, Sylvia Elkhuizen
and Nathan Proudlove

ROUTLEDGE

Operations Management for Healthcare

This fully updated edition of the bestselling textbook on Health Services Operations Management provides an invaluable reference for students and researchers in the fields of healthcare management, operations management and patient flow logistics. Featuring theoretical frameworks and a comprehensive set of practical case studies, this book also covers subjects such as hospital planning and supply chain management in healthcare, quality assurance and performance management. Healthcare managers work together with healthcare professionals in a multitude of challenging scenarios. Trade-offs have to be made between waiting times for customers and efficient use of scarce resources, between quality of care and quality of services, between the perspective of a single pathway and the total system, and between the perspective of a single provider and that of a network of providers working together in the chain of primary care, hospitals, nursing homes and homecare. This book guides healthcare students and professionals through a set of practical tools and resources, ranging from simple queueing models to more complicated analytical models, to help address these issues. The book can be used at an undergraduate level by introducing concepts, definitions and approaches, and at a postgraduate level through the application of approaches to operations management problems in healthcare practice. It will serve as a primary textbook for a health service operations management course module in a Master's programme in healthcare management.

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Operations Management for Healthcare

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Routledge
Taylor & Francis Group
LONDON AND NEW YORK

Designed cover image: @ Getty images

2nd edition published 2023
by Routledge
4 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

and by Routledge
605 Third Avenue, New York, NY 10158

Routledge is an imprint of the Taylor & Francis Group, an informa business

First edition published by Willan 2005

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data
A catalog record has been requested for this book

ISBN: 978-0-367-89594-5 (hbk)
ISBN: 978-0-367-89595-2 (pbk)
ISBN: 978-1-003-02001-1 (ebk)

DOI: 10.4324/9781003020011

Typeset in Bembo
by Deanta Global Publishing Services, Chennai, India

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Preface

Health Services Operations Management constitutes a fairly new area of research that has developed rapidly during recent years and has become an important component of studies in healthcare management.

Operations Management for Healthcare is an update and a follow-up to the book *Health Operations Management – Patient Flow Logistics in Health Care* edited by Jan Vissers and Roger Beech, and published in 2005 by Routledge, as part of a Routledge series on Health Management. The introductory chapters introduced many operations management (OM) concepts in healthcare for an audience that is interested in healthcare management, but not familiar with management science. From the feedback received from readers this content filled a need that still exists today. However, the applications were predominantly focused on hospitals. Little attention was given to OM of healthcare chains crossing the boundaries of healthcare providers.

Since then, much has happened. OM in healthcare became very popular, with much interest in the topic from healthcare managers and practitioners as well as researchers. The service features of healthcare, as opposed to the product environment of manufacturing industries, required closing the gap with Health Services Management. This resulted in better profiling the new field of research: Health Services Operations Management (HSOM). Also, the popularity of improvement approaches such as Lean Management, Six Sigma and Theory of Constraints, made it necessary to include them in a new textbook for this field of research.

The new textbook on Health Services Operations Management again has a theory part, in which terminology and concepts are introduced, but also an overview of the field of research is provided along with developments in approaches. The link is made with value-based healthcare, as this has implications for the need for OM research and quantitative approaches. Furthermore, techniques that are used in HSOM are described and illustrated. In the practical part of the book, case studies are presented to illustrate the theory and to reflect the richness of the research field. There is more attention on process chain applications crossing the borders of provider organisations and on comparative research into OM of regional networks. Some of the concepts used in this book are based on an EU project in which we had the opportunity to elaborate our ideas on a HSOM approach in combination with value-based healthcare for healthcare delivery for diabetes, stroke and hip osteoarthritis patients in regional networks in six European countries.

Throughout the book we pay special attention to two features of HSOM: studies in HSOM often make use of a quantitative model of health services and follow a design approach. A model is a formal representation of an object of study such as a hospital unit or a chain of care delivery. The model allows one to experiment with solutions and, moreover, provides evidence for the predicted outcomes of performance improvement changes before implementing solutions. The design approach offers a framework for analysis of a problem and design of a solution to that problem, making use of an evidence-based methodology. The case studies are preceded by chapters in which the design approach and model support are elaborated for three important areas of OM improvement: units, process chains and networks. In this way students can develop their insight into the use of quantitative models for analysing problems and solving them.

October 2022
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Part I

Theory and concepts

1 Introduction

Jan Vissers, Sylvia Elkhuizen and Nathan Proudlove

1.1 Defining Health Services Operations Management

The term 'operations management' (OM) refers to the planning and control of the processes that transform inputs into outputs. This definition also applies to Health Services Operations Management (HSOM). Consider the individual doctor/patient consultation. The input to the consultation process is a patient with a request for healthcare. The output of the consultation process might be that the patient is diagnosed, referred to a further service, or cured. The resources that must be managed to transform inputs into outputs are those associated with the care provided by the individual doctor: for example, their time and any diagnostic or therapeutic services that they use.

In this illustration, the role of the HSOM process is to ensure that adequate resources are in place on time to provide a service for the patient without them having to wait too long. Hence, HSOM focuses on the individual provider that produces a health service and on the tasks involved to produce this service in such a way that service standards are met, whilst also avoiding wasteful provision of excessive resources.

In the above illustration, the individual provider is a doctor. However, the 'individual' provider may be, for example, a hospital department (e.g., a radiology department), a hospital or a network of hospitals and community-based services (e.g., services for the acute care and then rehabilitation of patients who have suffered a stroke). At each different level both the scale and scope of the processes and resources to be planned and controlled increase, as does the complexity of the OM task.

Figure 1.1 presents an example of an HSOM view of an individual hospital provider, adapted from a meta-process model of a healthcare delivery system described by Roth (1993).

The central function of the care provider is to provide patient care. Hence, patient demand for care is the key input which influences the planning and control of the resources required to transform inputs into outputs. However, as Figure 1.1 illustrates, other 'inputs' influence both the types and levels of patient demand and the ways in which the hospital delivers care. These other 'inputs' include the overall level of finance available to provide care, the availability of goods from suppliers and the nature and actions of other hospitals.

DOI: 10.4324/9781003020011-2

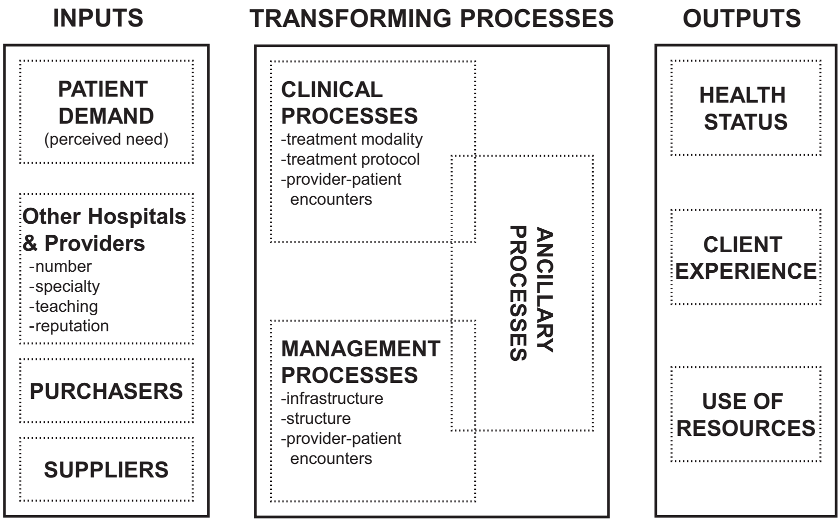

Figure 1.1 Meta-process model of a healthcare delivery system (adapted from Roth (1993)).

Figure 1.1 highlights three generic processes for transforming inputs into outputs: clinical, management and ancillary. Clinical processes are the most important as these are the primary processes in which the transformations take place. The clinical processes are supported by management processes that take care of the planning and control of resources required for the diagnosis and treatment of patients. At the operational level, individual patients are scheduled for appointments or an admission requiring outpatient clinic resources or operating theatre resources and a bed in a ward. At the tactical level, availability of resources for the coming weeks is checked and at the strategic level, checks are made on the amounts of resources required for the longer term. Therefore, management processes are needed to support the clinical processes. Finally, ancillary processes are needed to support the general functioning of the hospital. These processes include the organisation of services for cleaning hospital wards and departments and for maintaining hospital equipment.

The resources to be planned and controlled within each of these processes include staff (e.g., doctors, nurses), materials (e.g., drugs, prostheses) and equipment (e.g., X-ray machines, buildings). Inadequate planning and control of resources within any of the processes can have an impact on the others. For example, deficiencies in the management processes for ordering materials may affect the quality of care that can be delivered by the clinical processes (e.g., a shortage of equipment to support care at home may lead to delays in patient discharge from hospital). Similarly, if services for the cleaning of hospital wards are inadequate, the potential for hospital-acquired infections will be increased, as will the likelihood of subsequent ward closures.

Hence, when planning and controlling the resources that they use, an 'individual' provider must also consider the ways in which their actions might impinge upon other 'individual' providers: for example, other hospital or community-based departments. In this sense, their actions represent 'inputs' to other processes for transforming inputs into outputs.

Finally, Figure 1.1 illustrates the outputs of the OM processes that must be monitored. Health status markers (e.g., mortality rates, levels of morbidity and disability) are important metrics of the success with which clinical processes are transforming inputs into outputs, as are metrics of client experience, where the client is the patient and/or their family. In addition, the client of a process might also be a hospital doctor who requires a service from a diagnostic department, or a hospital manager who requires details of patient activity levels from doctors. Similarly, 'resource' performance output metrics are relevant to all three generic processes as they are needed to monitor the efficiency (e.g., patient lengths of stay, response times of ancillary support services, resource utilisation) and effectiveness (e.g., use of 'appropriate' or 'modern' procedures) with which resources have been used to transform inputs into outputs.

Again, there are relationships and potential conflicts between the different types of output. For example, measures to increase patient satisfaction by reducing patient waiting times might require additional investment and mean that the hospital is unable to achieve its budgetary targets. Similarly, budgetary pressures may mean that a hospital is unable to invest in all of those services that are known to be effective in improving health status: examples might include expensive treatments for rare conditions. Hence, in its attempts to ensure that there is effective and efficient organisation of the delivery of services, the role of HSOM is to achieve an 'acceptable' balance between different types of output.

Up to now we have described the traditional way to define OM in a healthcare setting with a focus on the provider's perspective on primary processes. However, the development of the value-based healthcare perspective has added another dimension to HSOM thinking. As value-based healthcare relates the value for customers to the costs of delivering services, the patient process is put in the foreground, i.e., the journey of the patient along with the services to answer the patient demand in the form of a diagnosis and treatment. So instead of a focus on individual encounters as indicated in Figure 1.1, the focus of hospital management today is on the total process of the patient, leading to output and outcomes. Therefore, when in this book we refer to a process we generally mean the total process from the perspective of the user.

Having illustrated the nature of HSOM it is now possible to offer a definition, i.e.:

> Health Services Operations Management can be defined as the analysis, design, planning, and control of all of the steps necessary to provide services for patients in such a way that their needs are met, that service standards are met, and resources are used efficiently.

1.2 Context of Health Services Operations Management

This section discusses the context of HSOM decision making: drivers for change and factors which influence decision making. The previous section demonstrated that the system of 'inputs', 'transforming processes' and 'outputs' is subject to its own internal dynamics and influences. Efforts to improve the outputs from one process might have an impact on the inputs and outputs of others. Here, we will discuss some of the key 'external' factors, and additional 'internal' factors, which influence HSOM decision making. Again, for the purposes of illustration, we will take the perspective of an individual healthcare provider, e.g., a hospital.

Probably the main external factor which affects the behaviour of individual providers is the overall healthcare system setting in which they function: for example, market and for profit, national health system or government regulated. In a for-profit setting, the emphasis for providers is on profit maximisation. As a result, providers will want to maximise the number of patients that they can treat at 'acceptable' standards of quality but at 'minimum' costs per case. The market environment, therefore, creates the incentives for providers to ensure that the processes for transforming inputs into outputs are functioning in an effective and efficient way. Providers must continually review and invest in their transforming processes as a means of maintaining their market share, attracting new patients, or reducing costs. For example, the market creates the incentives for providers to invest in new healthcare technologies in order to either attract more patients or reduce costs per case.

In a national health system or government-regulated system, providers are budgeted by the contracts annually arranged with purchasers (government-related bodies or insurance organisations). In such a system, the main incentive for providers is to ensure that budgetary targets are not exceeded. Hence, providers need to invest in mechanisms for monitoring the use of key resource areas such as the use of beds and theatres. Beyond the need to ensure that 'cost' performance targets are achieved, providers in public health services probably have lower incentives to continually review and update transforming processes or to ensure that other 'output' measures, such as client perception are 'satisfactory'.

However, this situation is changing, and in the absence of market incentives, regulation is being used as a vehicle for change. For example, in the National Health Service (NHS) of the United Kingdom (UK), National Service Frameworks have been developed for key disease areas (e.g., cancer, diabetes) or specific target groups of patients (e.g., older people with health problems). These frameworks specify the types of services that should be available for patient care: hence, they have a direct influence on clinical processes. The English NHS has also introduced performance or 'output' targets for providers: for example, maximum waiting times for an outpatient appointment or an elective procedure (Department of Health and Social Care, 2021) and use of resources (through national tariffs for reimbursement) (NHS England, 2021). Similarly, in the Netherlands (NL), the Ministry of Health and the associations of healthcare providers have agreed on the 'Treeknormen' standards for acceptable waiting times for, among others, General Practitioner practices, hospitals, mental healthcare providers and nursing homes (Nederlandse Zorgautoriteit, 2017).[1] Again, to ensure that such targets are met, providers will need to review and modify their processes for transforming inputs into outputs.

In Europe, government-regulated healthcare systems are still dominant but gradually more market incentives are being introduced. In the USA, although healthcare is shaped as a market system, the level of regulation has been increasing through developments such as ObamaCare.

Irrespective of the health system in use, all systems seem to adopt a value-based healthcare perspective (Porter and Teisberg, 2006) in which the value of a health service for the customer is key and value is defined as health per dollar or benefits for the customer versus costs (Van de Klundert, 2009). This adoption of a value-based perspective offers many challenges to healthcare providers. Firstly, value needs to be defined more precisely. What is value for the customer, how can we measure it and how can we use it to improve our delivery systems? Next, the value chain from the perspective of the customer may require collaboration with other providers. How can these developing chains of care be managed and how does this relate to the internal management of processes of the individual providers? It must be clear that in value-based health, knowledge of clinical processes and use of resources – so OM – becomes very important, and that at the same time the value perspective gives other opportunities for optimising healthcare delivery systems.

Beyond the healthcare system and the actions of governments, other external factors are affecting the context in which HSOM decisions are made. For example, most Western countries are experiencing changes in the demographic mix of their populations, in particular there is an increasing proportion of older people. Both the scale and nature of hospital resources (and those in other settings) will need to be adjusted to meet this demographic change. For example, the UK NHS is expanding its services for home-based care as an alternative to hospital care.

In addition, advances in medical technology (for example, new drugs and other forms of treatment) are either changing or expanding the options that are available for patient care. Providers will need to decide whether and how they should respond to these advances. Again, government regulation is likely to be used as a vehicle for change.

Finally, via the internet and other media outlets, patient knowledge of healthcare treatments, and so their expectations of healthcare providers, are

1 For instance: first visit hospital (80% within three weeks, maximum four weeks); ambulatory treatment (80% within four weeks, maximum six weeks); admission hospital (80% within five weeks, maximum seven weeks).

increasing. Providers are having to adjust their care processes to address this change in consumer expectations. For instance, more time in consultations might be required for implementing shared decision making.

Up until now, this discussion of the context of HSOM has focused on external factors which affect the environment in which decisions are made. In comparison to other service or manufacturing organisations, the internal environment for decision making is in itself unusual.

Often, the roles and responsibilities of those involved in decision making are either not very clearly defined or are overlapping. Healthcare management often takes the form of dual management, in which clinical professionals share management responsibilities with administrative staff and business managers. There are commonly parallel hierarchies of different staff groups. Finding out who is actually managing the system at different levels can therefore be a real issue in healthcare organisations.

In addition, healthcare management decision making often takes the form of finding consensus among the different actors involved: managers, medical professionals, nursing staff, paramedical disciplines, administrative staff. These actors often have different interests and priorities across the metrics and trade-offs of quality versus costs or effectiveness versus efficiency. As public healthcare does not have the possibility of defining profit as an overall objective, it is often difficult to find the appropriate trade-off between these two perspectives of managing organisations.

Hence, there is a range of ‘external’ and ‘internal’ factors and challenges which influence HSOM decision making. This book presents a scientific body of knowledge and reflection to support the planning and control of healthcare processes.

1.3 Modelling and design cycle

Most HSOM studies make use of a quantitative model of the system under study and follow the steps of a design cycle. Therefore, we will elaborate these two topics a bit further as part of the introduction.

A model is a formal description of a system or a part of a system under study. A system is a collection of elements that are distinguished from the environment, due to a common perspective, and that have a mutual relationship. Within a system one can distinguish subsystems (grouping of elements) and aspect systems (grouping of relationships). For example, a hospital consists of several departments (subsystems). If we are studying the throughput times of radiology requests, we are only interested in the relationships between the timing of operations of the referring physician and the timing of operations of the radiology department. We can now describe how we move from the real world to a system under study and a model (see Figure 1.2).

For example, in the case of an analysis of problematically long throughput times of radiology requests in a hospital, we could demarcate the system under study from its wider context by only considering the referring physicians and

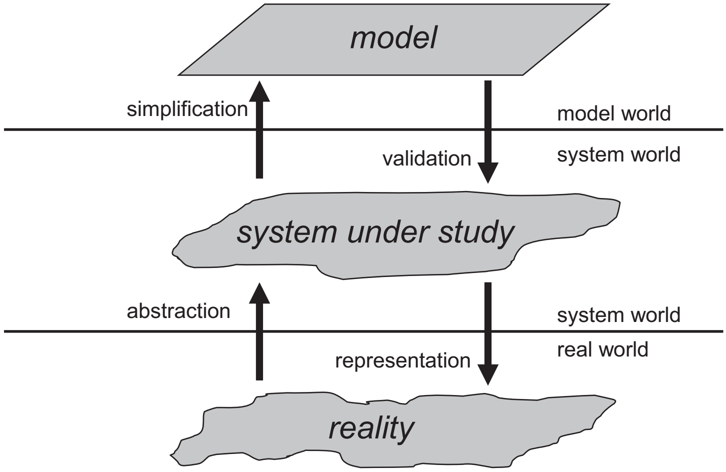

Figure 1.2 Reality – system – model.

the radiology department and by only looking at the timing of referral requests, the handling of the requests by the radiology department, the timing of radiology examinations and the timing of the reporting back to the physician. The abstraction takes place by selecting the relevant subsystems and aspect systems. Then we make a model of the system under study by simplification. A model can be a process description (according to a standardised method), an Excel spreadsheet, a mathematical formulation or a simulation model, etc. In the model we simplify the system under study to a number of relations between the elements, in this case, the difference between the timing of the referral, the timing of the appointment, the timing of the arrival of the patient for the examination, the start and end of the examination and the timing of the reporting back to the physician. This would be sufficient for the analysis of throughput times of requests. If we were also interested in the workload generated by the requests, we must include these aspects in the system description and in the model. We must check carefully whether the system under study truly can be seen as a representation of the real world. If there is much variation in the number of requests and availability of staff, this might lead to a decision to study the throughput times over several weeks.

Then, we use the model to test alternative options to reduce the throughput times, for instance by increasing radiology capacity or by introducing a walk-in system for certain types of requests in the radiology department. The model can then provide the expected performance of the system under study. Before we can do this, we first must validate the model as a true and reliable representation of the system under study. This validation can be done in a number of ways. Comparing the model results with performance data in reality, sensitivity analysis (e.g., manipulating the variables in the model one by one and checking whether the results are as expected, 'face-validity' checking of the results with experts). Then, as a last step, we have to interpret the results in terms of their meaning for the real system.

The design cycle (see Figure 1.3) refers to a five-step approach developed by Van Aken et al. (2012). This approach can be used in studies in which one wants to solve a problem encountered in (the operations of) an organisation and design a solution for the problem. In all the steps, academic (and maybe practitioner) literature is used to develop an evidence-based approach to analyse the problem, to design a solution for the problem and to analyse the performance of the new design.

The problem is approached as a problem 'mess', and each step adds knowledge about the problem. The first step is to define the problem by describing it more precisely and checking how the different stakeholders perceive the problem. Then the problem is demarcated in terms of what is going to be included in the study. In the second step, a diagnosis of the problem is provided by analysing the performance of the current design, and the problem and its causes, using quantitative and qualitative research methods.

The third step is to design a solution for the problem, by first formulating the requirements for a solution. Van Aken et al. distinguish four categories of design requirements: functional requirements (the performance targets for the new design), user requirements (the preferences of the users involved), boundary conditions (conditions which must be met unconditionally) and design restrictions (restrictions on the design formulated by the organisation). Then a few potential solutions for the problem are elaborated, based on evidence reported in the literature for the type of problem investigated, and the solution with the best expected performance is suggested for implementation, and further elaborated into a solution design.

In the full problem-solving cycle, in the fourth step the solution is implemented and in the fifth step the new design is evaluated. In case of a student project there is often no time for a full implementation and an evaluation based on actual performance of the system under study. In that case, the solution is

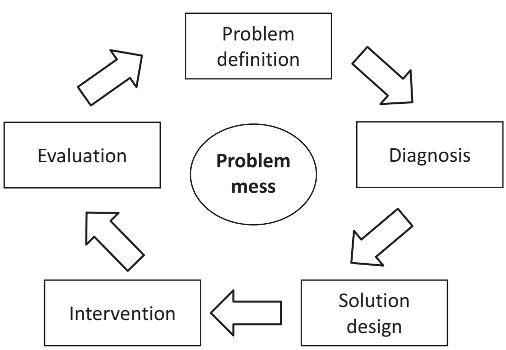

Figure 1.3 Design cycle.

often implemented in a model of the system under study and the evaluation is based on the performance of the solution in the model environment. In cases of a full implementation, an intervention takes place in the form of an implementation of the new design. As the last step the new design is evaluated on its performance in reality. If the problem is not solved satisfactorily, a new cycle can start.

As an illustration of the above approach, we can use an example of the problem of long waiting times for first access in an outpatient orthopaedic clinic. Suppose a Masters' student in healthcare management is asked by the management of the hospital to investigate the problem (how long are the waiting times actually, what are the causes, what are possible solutions?), and to develop an implementable solution for the main cause, including an underpinning of its expected performance.

For defining the problem, in the first step of the cycle, the system studied is demarcated (orthopaedics outpatient clinic/operating theatre department/orthopaedics ward), literature on waiting times in hospitals is studied, interviews are held with the most important stakeholders and patients (for instance managers/team leaders responsible for planning of orthopaedic patients, orthopaedic surgeons/nurses, outpatient clinic staff, operating theatre management), and available information on waiting times is studied. Based on the literature on waiting times in hospitals, a cause-and-effect diagram is created with the most important possible causes (demand too high, insufficient resources, inefficient use of resources, inadequate planning and scheduling of patients, etc.). The interviews provide information on the actual size of the problem, and on the perspectives of the stakeholders on the problem and its causes. The available information on waiting times helps to check whether perceptions of stakeholders and measurements of waiting times create a coherent picture of the problem. Using for instance the 'Treeknormen' as a yardstick helps to check whether the size of the waiting times is really problematic. Suppose this initial analysis leads to a more focused problem statement that inadequate planning and scheduling of patients for orthopaedics is seen as the main cause for the long waiting times, then the further investigation can concentrate on this direction.

The next step is a further diagnosis of the problem. The student studies literature on planning and scheduling of patients in hospitals and develops an approach for the analysis of the current way of planning and scheduling patients for orthopaedics. A precise description of the current design is provided with input from stakeholders responsible for planning and scheduling, and data are gathered which are used to quantify the available resources, the use of resources and the performance of the 'production system' of orthopaedics. Interviews with patients are held to analyse the performance of the current system from the perspective of the ultimate user, and to understand what improvements can create value for customers. Suppose the diagnosis is that the throughput time for orthopaedic patients is too long, especially for hip or knee surgery, due to extra visits for pre-operative screening and inadequate planning and scheduling leading to avoidable waiting times, and that more value for customers can be created by a new design for the total patient journey for patients with hip or knee problems.

In the third step a new design for the patient journey is developed, based on requirements for the design and evidence from literature on effective solutions for waiting times. Suppose effective solutions reported in literature are to use a one-stop outpatient visit (X-ray, visit to orthopaedic surgeon, pre-operative screening), operating theatre sessions dedicated to knee and hip surgery and follow-up visits by an orthopaedic surgeon or orthopaedic nurse. Functional requirements can be based on 'Treeknormen' or specific targets for waiting and throughput times. User requirements can be based on interviews with stakeholders on the importance and expected effect of suggested solutions on waiting times (supported, for instance, by a scoring system for these dimensions). Boundary restrictions are, for instance, that the solutions should accord with the responsibilities of health professionals, and the restriction imposed on solutions by hospital management is that the solution should be cost-effective. Suppose it is decided to include all three elements in a proposed redesign of the patient journey. For this potential solution, plans are made to adapt the processes to see what is necessary to implement the new patient journey. To guide development of this solution, a focus group is created, consisting of key stakeholders and perhaps one or two patients.

In the fourth step, the new solution should be implemented but, due to the limited time available to students for thesis work, it is decided to implement the solution only in a model of the system in this timeframe. The new way of planning and scheduling is elaborated, and checks are made that all procedures for patient planning and scheduling are adapted. To allow for the calculation of the expected effects on waiting and throughput times, and use of resources, a spreadsheet model of the new patient journey is developed. This allows for what-if scenarios for each of the solution elements separately and combined. Key stakeholders, and perhaps also patients, are asked to score the redesign on effectiveness, implementability and expected performance gain. Based on the information from the model calculations and the assessment of the key stakeholders, we now have a well-developed view of the expected performance of the redesign and its benefits.

Instead of using the spreadsheet model and what-if analysis, it would also have been possible to develop a simulation model of the system. This would have offered more possibilities for analysis of the impacts of the solution but would require more time and effort. If variation (stochastics) does not play an important role in this example, a 'simple' spreadsheet model is adequate.

1.4 Outline

In this chapter we introduced a number of features of HSOM that play an important role in our book. In the remaining chapters of the theory part, we elaborate HSOM further. Chapter 2 defines and illustrates a number of concepts of HSOM, such as operations and resources, and the distinction between operations management of units, process chains and networks. Chapter 3 on models and data presents an overview of different ways of modelling OM problems in a health services context. In Chapter 4 we focus on the OM of units, within a health services provider, having to deal with the trade-off between the service level and the efficient use of resources. In Chapter 5 we focus on the OM of process chains, having to deal with the trade-offs between an ideal patient journey, outcomes and costs. Chapter 6 provides an overview of different improvement approaches that can be used in an OM study, such as Lean Management, Six Sigma and the Theory of Constraints. In Chapter 7, we provide a conceptual framework to relate operations to outcomes, and we illustrate this approach with a study on using demand segments for describing and analysing the performance of type 2 diabetes care in a regional setting.

The Practice part of the book starts with three chapters (8–10) on how to improve the OM of units, process chains and networks, making use of a design approach and model support. Then in Chapters 11–17 case studies are presented on OM approaches to improve the performance of healthcare providers in delivering services to patients, that create value and avoid waste.

1.5 Questions and exercises

What are the main differences between a national healthcare system or government-regulated system versus a market-regulated or for-profit healthcare system, and what is the impact on OM of the healthcare provider?

Given the decision-making process on managerial issues in a hospital, what will be important aims for HSOM?

Why is it important to approach an OM problem in healthcare as a 'problem mess'?

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2 Health Service Operations Management concepts

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2.1 Introduction

The concept of Health Service Operations Management originates from the two parent domains of knowledge: (Health) Service Management and (Health) Operations Management. Service management is a multidisciplinary approach to designing, delivering and evaluating services for customers that add value for the customer. Service industries are nowadays responsible for a large growth in jobs and GDP. Important characteristics of services, as opposed to goods, are (Bordoloi, Fitzsimmons and Fitzsimmons, 2019):

- The customer participates in the process.
- Services are simultaneously created and consumed.
- Services are perishable and can therefore not be stored.
- Services are intangible.
- Services can vary greatly from customer to customer because of their heterogeneous nature.
- Services cannot be transferred between patients.

Operations management (OM) is an area of management concerned with designing and controlling the process of production of goods or services. As health services constitute an important service industry, Health Service Management and Health Service Operations Management have developed as more specific knowledge domains. In the definition of Health Service Operations Management (HSOM), we combine the service management approach and the OM approach. This provides us with the opportunity to make use of concepts from both areas of knowledge.

Important concepts used from the domain of Service Management are the service package, the service strategy, the service blueprint and the service modularisation. We make use of these and other methodologies often used in service management later for description, analysis and evaluation of services. We, of course, also make use of the many concepts and methodologies from OM for description and analysis of operations to deliver the services. As we proceed, we observe that there is overlap between the two approaches, and that some

DOI: 10.4324/9781003020011-3

settings make more use of one or the other approach. This illustrates that the research field of HSOM is fairly young and that insights are still developing.

2.2 Patients, clients and customers

A variety of terms is used to identify the persons who are in need of a service or are receiving a service. In general practitioner (GP), paramedic and hospital settings we tend to talk about 'patients'; in homecare/community healthcare, mental healthcare and rehabilitation we often use 'clients' or 'service users' and in services we use 'customers'. We will use these terms interchangeably.

Patients can be identified in many ways. General demographic characteristics include age, sex, marital status and home address. Relevant health-related characteristics might include weight, smoking, alcohol consumption and amount of physical exercise taken. Variables that measure health status could be blood pressure, cholesterol, glucose level, functional disabilities and personal satisfaction with their own health. Therefore, there are many ways in which clients can be grouped for designing and analysing services. This depends on the purpose of the grouping. Table 2.1 provides a number of alternative ways to group clients in health services.

Most ways of grouping clients speak for themselves. One way of grouping that needs illustration is using demand segments. A demand segment is a group of clients that have the same or similar demand characteristics for a service. This concept – from Service Management and Service Marketing – can help to organise the chain of care by forecasting the demand for a specific service. Type 2 diabetes patients, for example, do not represent a homogeneous group. As diabetes is a chronic disease, a patient can have different needs depending on their stage of the condition: in the diagnosis phase there is a need for lifestyle change;

Table 2.1 Alternative ways of grouping clients in health services

Grouping	*Setting*	*Purpose*
Clinical specialty being treated by	Hospital	Analysis of bed use, theatre use
Diagnosis	Hospital	Planning of care pathway
Treatment mode: inpatient, outpatient, day treatment/day case	Hospital	Analysis of use of resources
Urgency level	Emergency department	Determining priority of treatment
Routine/urgent/home visit **General/specific issue**	GP practice	Determining priority of seeing Planning of general versus dedicated clinics
Dependency level	Nursing home	Assessing nursing workload
Demand segment	All	Demand and care chain management
Process, product or product-process	Hospital	Focused factory

the treatment phase is based on medication and, later-on, insulin injection; and in advanced phases the emphasis is on treatment of consecutive complications. To organise services for type 2 diabetes patients, it is important to know the numbers at each phase, i.e., the size of these distinct demand segments. The last example in Table 2.1, refers to the grouping of patients according to the process, product or combination. For instance, if patients follow the same process, even though perhaps arriving on the pathway via different diagnoses, they can then be grouped for the purpose of planning the processes on the pathway. For example, hip and knee surgery patients follow the same process. If a pathway has a high volume of patients, it may be possible to purpose-design a streamlined process with dedicated resources for them – a 'hospital-within-a-hospital' using the general OM idea of the 'focused factory' (Bredenhoff et al., 2010).

2.3 Services and operations

In this textbook on Health Services Operations Management, we use the term 'services' as well as 'operations'. There are, however, some important differences in terminology and definitions, which we elaborate in this section.

Service Management makes use of the concept of '*service package*' to describe the content of a service. The service package is defined as a bundle of services and goods with information that is provided in a particular environment (Bordoloi et al., 2019) and consists of five features:

- Explicit services: the immediate benefits of intrinsic features of the service (e.g., absence of pain after surgery).
- Implicit services: psychological benefits of extrinsic features of the service (e.g., the security of the hospital environment).
- Information: information from the service provider about the service (e.g., the health status before and after surgery).
- Facilitating goods: medical supplies used during the service, leaflets for follow-up care.
- Supporting facilities: physical resources that need to be in place for a service (e.g., hospital facilities).

All these features can be experienced by the customer and contribute to a service experience.

Services can be defined as *value-adding transactions*, in which – in principle – no physical goods are transferred from the provider to the consumer. In healthcare, services are generally delivered by healthcare professionals. The services mainly consist of human labour, and goods play a facilitating role. Examples are a consultation of a medical specialist in an outpatient clinic, and a home visit by a GP. An exception to this rule is surgical procedures involving a prosthesis, which becomes an integral part of the service.

An *operation* can be defined as a *value-adding transformation* of input to output. An example of an operation in manufacturing is, for instance, the painting of a car body on an assembly line. Though the use of 'transformation' in the definition as opposed to 'transaction' makes one think of a physical transformation, a service can also be regarded as a specific type of operation in which the customer is an input to the process and the product delivered is mainly or completely intangible.

In HSOM, we can think of a diffuse dividing line between a service and an operation. A surgical procedure, for instance, shows more operation-like features than a consultation with a healthcare professional; the surgery can lead to a transformation of the human body and also involve transfer of a physical good such as an artificial hip or cardiac pacemaker. The fact that the patient is part of the process, and the core activity is transformation using the knowledge and skills of a surgeon, makes it clear that we label surgery predominantly as a service. Therefore, operations in healthcare can generally be classified as services. In Table 2.2 we provide some definitions related to services and operations, to illustrate the differences and overlaps.

In Figure 2.1 we see an example of a user service journey and in Figure 2.2 an example of a process.

We see in Figure 2.1 a user service journey of a patient who visits a health centre, an acute hospital, a nursing home, a homecare provider and the health centre again. This might represent, for instance, a journey of a patient with a stroke: first contact via the GP, by ambulance to the hospital and diagnosis and treatment in the hospital, rehabilitation in a nursing home and final stay at home with support from homecare and the health centre. We see that within each provider, different service elements are included in the service.

In Figure 2.2 we see an OM description of the process of diagnosis and treatment in a hospital setting for a patient who is referred for hip surgery by a GP.

Table 2.2 Definitions of services and operations

Services perspective		*Operations perspective*	
Item	*Definition*	*Item*	*Definition*
Service	Value-adding transaction between provider and consumer	Operation	Value-adding transformation of inputs to output
Service element	Description of the smallest unit within a service	Activity	Description of the smallest unit within an operation
Service journey	Description of the order in which service elements are delivered to the customer for a service	(Included in definition of operation)	Description of the order in which activities are performed for an operation
User service journey	Description of the order in which services are used by the customer to answer a demand	Process or chain	Description of the set of operations that is performed in a certain order to create a product or a service

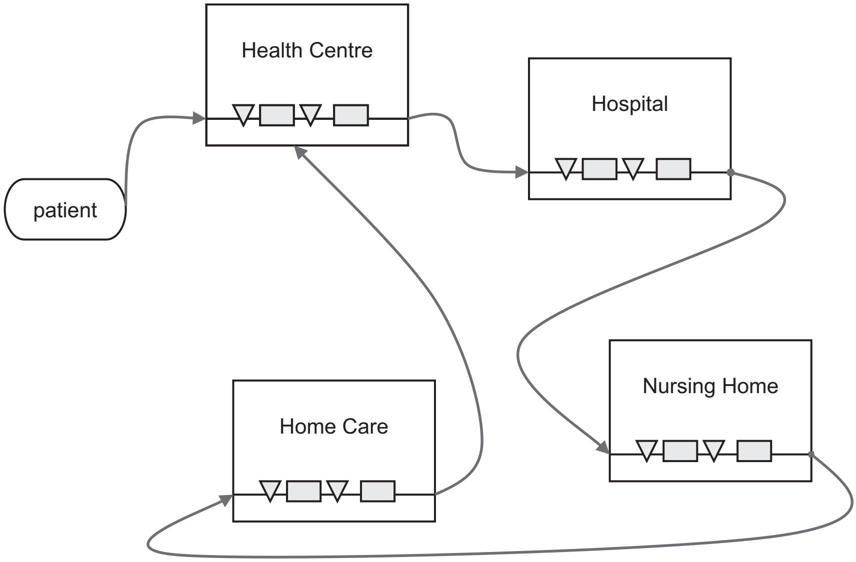

Figure 2.1 Example of user service journey.

In Figure 2.2 we see that the patient's trajectory includes different operations: a consultation in the outpatient department, an examination in the radiology department, a second visit to the orthopaedic surgeon, pre-operative screening before surgery, surgery in the operating theatre department, a stay in the inpatient ward after surgery and a follow-up visit after discharge. For each of the operations the patient interacts with different healthcare professionals and makes use of various other resources. Notice that the description is at the level of operations from the perspective of the total trajectory. Each operation could be expanded or unpacked as a sub-process, with similar symbols detailing the next level (activities). A surgery, for instance, can be seen as a very complex operation that includes many activities: arrive and receive pre-operative preparation, movement to the operating room, administration of anaesthesia, surgery, movement to a post-operative area and recovery and monitoring until taken to an inpatient or discharge ward. If the focus of a study is on the OM of the operating theatre department, then surgery can be seen as a process, including a number of operations.

If we compare the user service journey description (Figure 2.1) and the process description (Figure 2.2), we can make a number of observations:

- The two methods of description show considerable overlap. In principle, both methods could have been applied to both examples.
- The choice of which method to use depends on the problem considered and its potential solution. If, for example, the problem regards

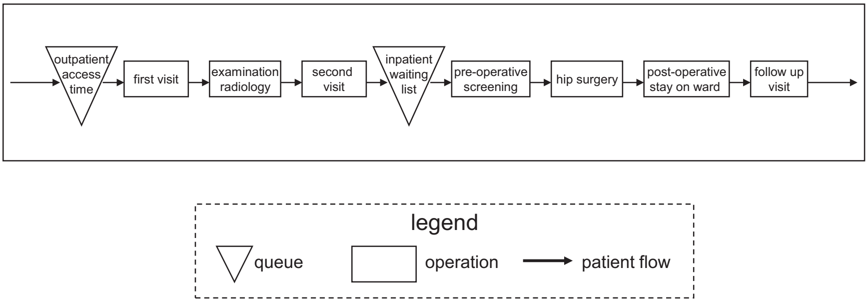

Figure 2.2 Process flowchart of a pathway/trajectory for patients with hip osteoarthritis.

capacity planning in a chain of care including several different providers, a description of the user service journey could be preferred. This provides an overall picture of the problem and does not go into the details within each provider's internal trajectory. This could be sufficient for determining the capacity required for each of the steps in the chain of care. If a problem regards scheduling at a more detailed level, an OM description might be preferred as it provides more insight into the interaction between different processes and resources.

Therefore, we can expect more use of service management descriptions in problems regarding health centres, nursing homes and homecare, and more OM descriptions in problems regarding hospitals.

If we consider the literature in health service management and HSOM in a broader sense, we can further notice that service management terminology is more used in the early stages of the product cycle (development of a new service, redesign of a service, evaluation of a service) and the OM terminology more in the later stages (running a service, improvement of performance of a service).

2.4 Operation types, resources and units

Consider the patient requiring a hip replacement as shown in Figure 2.2. Key operations involved in delivering this service for the patient include visits to the surgeon, examination procedures to diagnose the problem, surgical procedures to replace the hip and physiotherapy sessions to facilitate the rehabilitation of the patient. Each of these operations adds value and each generates an individual output. However, the cumulative effect of these individual products is a patient 'successfully' treated with a hip replacement. Hence, the first stage in the management of this health operation ('the analysis, design, planning, and control of all of the steps necessary to provide a service for patients') is to identify the key operations that are required to deliver that service.

Let us consider the operation ´hip surgery´ as an input-output transformation. See Figure 2.3.

We see that the operation ´hip surgery´ has as inputs the patient diagnosed with a hip problem and also some materials such as a hip prosthesis and wound dressing material. These inputs are – as facilitating goods – consumed during the operation or become part of the output. Other types of input are resources, such as the operating theatre room (with its equipment), the nurses who are monitoring the patient or are assisting the physicians during the procedure and the physicians involved in the surgery. A *resource* is an input for the operation that is used for the transformation of inputs to outputs. Also inputs for the operation are the protocols used to perform the surgical procedure according to clinical guidelines.

Note that an operation can also imply a group of activities that together constitute the operation. A surgical procedure, for instance, consists of activities by the surgeon, the anaesthetist and the supporting personnel. An *activity* in itself, again, involves different tasks. For instance, the activity 'surgical procedure' for the surgeon implies the following tasks: preparing for the procedure, starting the procedure, performing the procedure, ending the procedure and washing. From this example we can see that tasks constitute an activity, and activities constitute an operation. We regard the surgical procedure as an operation, because at this level of activity the added value (to the patient following the surgical procedure) becomes obvious. Note also that there is little

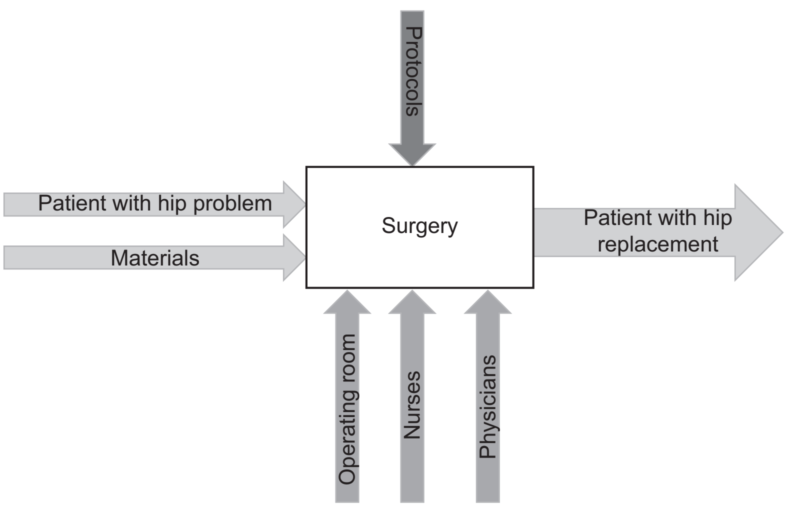

Figure 2.3 Hip surgery as input-output transformation.

or no freedom in the relative timing of tasks or activities, as they all are to contribute to the operation. Operations are, therefore, the basic elements in an OM approach.

Operations can be grouped into *operation types*. An operation type is a group of operations using the same resources, though the amounts of resources used may differ. A *resource* is an input for an operation that is used for the transformation into outputs but can be used again for another operation. This as opposed to *material inputs* that become part of the output (e.g., prosthesis), or are consumed (e.g., swabs). So, operating theatres, operating theatre personnel and operating theatre equipment are resources, but the prosthesis that is placed in a patient during an orthopaedic surgical procedure is a material input for the process that becomes part of the service.

A *unit* is a department in a health system that performs operations of the same operation type: for example, the X-ray unit, as part of the radiology department undertakes X-ray procedures. A unit also has access to the key resources (staff, capital equipment and materials) required to undertake operations of the same type.

For example, a radiology department contains the specialist staff and equipment required (resources) to carry out X-ray procedures, but the films are materials that become part of the output of the process (patient with diagnostic information). Table 2.3 gives an example overview of units, resources and operation types in different healthcare settings.

In the general OM literature, *operations* are classified under the following types: alteration, transportation, storage and inspection. In HSOM we tend to include alteration (e.g., a surgical procedure in an operating theatre), transportation (e.g., the transport of the patient from the ward and vice versa) and inspection (e.g., inspection of the wound) into one operation (e.g., the surgical procedure). Storage of intermediate products in OM compares to waiting for operations in HSOM. Not all waiting in healthcare systems is unproductive. Waiting for an administered drug to become effective, or for recovery in a ward after an operation are examples of productive waits. This can also be the reason to include them in the operation or define them as an operation. Non-productive waits (e.g., waiting in an acute bed when medically fit for discharge, being on a waiting list for a hip replacement) are important forms of 'waste' from the viewpoint of the patient. However, waiting times in healthcare also function as a form of 'buffer', to handle fluctuations in demand or capacity. So, for effective unit management we have to accept some amount of waiting. Chapter 4, 'Operations management of units', elaborates the use of buffers in healthcare operations.

If the identification of key operations represents the first stage in 'the analysis, design, planning and control of all of the steps necessary to provide a service for patients', the second stage is to understand the ways in which operations use and consume resources. Operations can be characterised by their duration (i.e., time taken to undertake the operation) and by the workload required from

Table 2.3 Unit, resources and operation types in hospital and nursing home setting

Setting	*Unit*	*Resources*	*Operation types*
Hospital	Emergency department	Treatment rooms, nursing staff, physicians	First aid (minor injuries) Acute aid (major injuries) Trauma
	Outpatient department	Diagnostic and treatment rooms, administrative and nursing staff, physicians	First and follow-up visits Minor procedures
	Diagnostic and therapy departments (e.g., radiology, pathology, physiotherapy)	Diagnostic and therapy rooms, equipment, paramedical staff, physicians	Diagnostic tests Therapies
	Operating theatre department	Operating rooms, assisting operating personnel, physicians, anaesthetists	Surgical procedures
	Intensive care	Beds, equipment, nursing staff, physicians	Monitoring Acute interventions
	Wards	Beds, nursing staff, physicians	Recovery Cure and care Monitoring
Nursing home	Wards	Rooms/beds, nursing and support staff	Care activities Medication Feeding
	Therapy departments	Rooms, staff	Different therapies

the resources for the operation (e.g., number and types of staff required for the operation). A basic philosophy of OM is that these duration and workload characteristics of operations (and of processes as the constellation of operations to produce a service) determine the way operations (and processes) can be planned and controlled.

Figure 2.4 shows a distribution of the length of stay for patients admitted to general surgery wards. Such data inform decisions about the number of beds (resources) that are required to accommodate a particular volume of admissions (e.g., a schedule of planned admissions).

As can be seen, this distribution of length of stay has a peak at two days and a long tail to the right. The average length of stay is 5.4 days, while the standard deviation is large (6.5 days) due to the long tail. This is typical for many service distributions in healthcare. In Chapter 3 models are presented that can be used to fit a theoretical distribution, such as Erlang, to arrive at a good fit for these data.

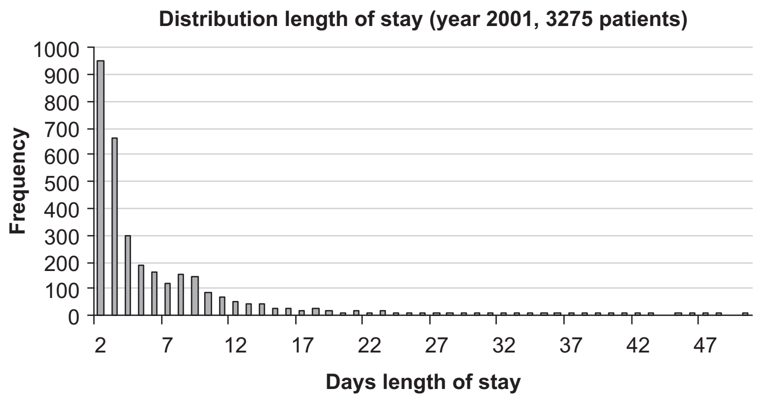

Figure 2.4 Distribution of length of stay for general surgery (n = 3275 patients).

It is important that an HSOM practitioner questions the data and asks themself whether the data shown can be used for taking decisions. For instance:

- Is the aggregation level correct (all general surgery patients) or should the analysis be applied separately to different patient groups within general surgery?
- Does the small peak around eight/nine days suggest there are different distributions aggregated here which would be better understood separately, for instance surgical oncology patients with longer average length of stay?
- Are the patients with a very long length of stay to be accepted as random statistical variation or are there explanations of another kind affecting a subset of patients (e.g., some patients waiting for an empty bed in a nursing home)? This additional stay might be something to analyse separately and take different actions on.

These issues in data analysis are discussed further in Chapter 3.

The first two concerns are relevant to the earlier discussion of product definitions. Here, any decision to reclassify products would be driven by a need to identify a level of aggregation that usefully supports the HSOM task.

Figure 2.5 shows the average daily demands for nursing care for general surgery patients, expressed as Full Time Equivalent (FTE) nursing staff per day. In this illustration, the maximum length of stay of general surgery patients is seven days and they have a surgical procedure on their second day.

As can be seen, the nursing workload is less on the day of admission, rises on the day of the surgical procedure and on the day after, returns to the initial level for the following two days and is low on the days before the discharge. The operations manager needs to be aware of such fluctuation in demand when scheduling nursing resources to support ward-based operations.

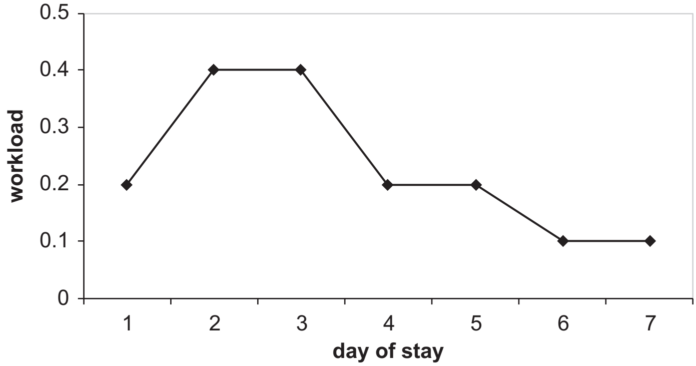

Figure 2.5 Workload for general surgery for nursing staff (expressed as FTE nurses to perform the nursing requirements on that day).

2.5 Process or chain

As indicated earlier, operations represent the building blocks which, when added together, generate the overall set of transforming the processes required to deliver a product or service for a client. Having identified these individual building blocks, and the resources that they use, an operations manager needs to identify the ways in which they should be linked to produce a particular service. This chain of operations (or overall delivery process) may include both productive activities and productive periods of waiting (e.g., waiting for a drug to become effective). A *process chain* can therefore be defined as the chain of operations that needs to be performed to produce a particular service.

Each process has a customer, whether this is an internal customer for a process that focuses on a part of a chain (for instance a specialist that orders a test from pathology), or it is an ultimate consumer of the service, i.e., a patient. Each process should also have a process owner, that is responsible for managing the process. This is, of course, a weak point in many healthcare organisations, as customer processes are often not well managed. This is due to the fact that many healthcare providers are still functionally organised based on the type of work or are in a transition to use the value-creating processes as the basis for organising the work.

Customer processes in healthcare are often only dealing with services provided by a single provider, i.e., a hospital, a general practice, a nursing home or a homecare provider. However, many patients face situations in which different providers each provide a part of the total (end-to-end) process as experienced by the patient. The process of a patient with a cerebral vascular accident (CVA, or a stroke), for example, combines ambulance services, emergency services in an emergency department, medical and nursing care at a stroke unit, recovery and therapy in a neurological ward, and then rehabilitation services at home, a nursing home or a rehabilitation centre.

To distinguish between a single provider process and process involving more providers, we refer to the latter case as a *care chain* (see Figure 2.6). If we want to refer to both, we use '*process chain*'.

It may be clear that the planning and coordination efforts of a care chain create new challenges for OM. The chain of care resembles a supply chain as used in manufacturing industries in which different companies collaborate in the manufacture of products. This opens a window for the use of supply chain techniques (Meredith and Shafer, 2002) to manage the chain of services in healthcare chains.

An analysis of existing chains may also reveal non-productive operations and periods of waiting. A knowledge of these non-productive operations helps to expose areas where the performance of health processes might be improved. In Chapter 6 we provide an overview of different approaches to analyse the performance of systems and suggest areas for improvement such as Lean Management, Theory of Constraints and Six Sigma.

In addition to having awareness of the 'links' in the chain of operations which generate healthcare processes, an OM approach requires reflection on other key characteristics of processes. This additional understanding helps the OM manager to establish appropriate control systems and it informs decisions about the allocation of resources.

Table 2.4 presents an overview of the most important *characteristics of processes* from an OM point of view. These characteristics are illustrated by considering those processes required to deliver services for different patient groups within the specialty of general surgery.

An important distinction in healthcare processes is whether access to resources can be scheduled. ***Emergency*** processes, such as many aspects of care for trauma patients, cannot be scheduled so the resources to undertake operations need to be readily available. This reduces flexibility in resource allocation decisions and potentially means that 'spare' capacity might need to be available. For ***elective*** patients, access to resources can be scheduled (and delayed) in an attempt to maximise efficiency.

Regardless of whether the chain of operations is classified as emergency or elective, along the chain judgements are required about the ***level of***

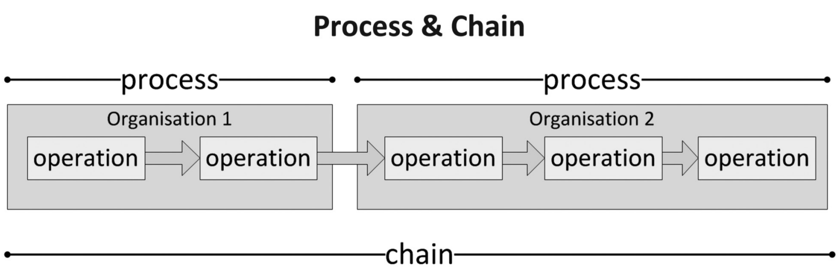

Figure 2.6 Process and chain.