

A Framework for Health Care Planning and Control

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Abstract

Rising expenditures spur health care organizations to organize their processes more efficiently and effectively. Unfortunately, health care planning and control lags far behind manufacturing planning and control. Successful manufacturing planning and control concepts can not be directly copied, because of the unique nature of health care delivery. We analyze existing planning and control concepts or frameworks for health care operations management, and find that they do not properly address various important planning and control problems. We conclude that they only focus on hospitals, and are too narrow, focusing on a single managerial area, such as resource capacity planning, or ignoring hierarchical levels.

We propose a modern framework for health care planning and control. Our framework integrates all managerial areas involved in health care delivery operations and all hierarchical levels of control, to ensure completeness and coherence of responsibilities for every managerial area. The framework can be used to structure the various planning and control functions, and their interaction. It is applicable broadly, to an individual department, an entire health care organization, and to a complete supply chain of cure and care providers. The framework can be used to identify and position various types of managerial problems, to demarcate the scope of organization interventions, and to facilitate a dialogue between clinical staff and managers. We illustrate the application of the framework with examples.

Keywords: *organizational decision making, integrated planning and control, hierarchical framework, operations management, strategic planning*

1 Introduction

Planning and control in health care has received an increased amount of attention over the last ten years, both in practice and in the literature. This attention is due to an increase in demand for health care and increasing expenditures [28]. As a result, health care organizations are trying to re-organize processes more efficiently and effectively. It is therefore not surprising that the Operations Research/Management Science (OR/MS) research community's interest in health care applications is steadily increasing [4]. In fact, the attendance of the conference of the EURO Working Group on Operational Research Applied to Health Services (ORAHS [29]) has increased from around 50 in 2002 to 150 in 2009, and involves an increasing number of countries. Within these research efforts, planning and control is a key focal area – the subject of more than 35% of the ORAHS publications [5].

Planning and control has a rich tradition in manufacturing. Graves [16] states that "Manufacturing planning and control address decisions on the acquisition, utilization and allocation of production resources to satisfy customer requirements in the most efficient and effective way." Planning and control comprises integrated coordination of resources (staff, equipment and materials) and product flows, in such a way that the organization's objectives are realized [1].

Health care planning and control lags far behind manufacturing planning and control. Common reasons stated in the literature include:

1. Health care organizations are professional organizations which often lack cooperation between, or commitment from, involved parties (doctors, administrators, etc.). These groups have their own, sometimes conflicting, objectives, as is nicely illustrated by Glouberman and Mintzberg in their "four faces of health care" framework [14,15].
2. Due to the state of information systems in health care, crucial information required for planning and control is often not available [8]. Although Diagnosis Related Groups (DRGs) and electronic health record systems have spurred the need for *financial* and *clinical* information management systems, these systems tend to be poorly integrated with *operational* information

systems. This lack of integration is impeding the advance of integrated planning and control in health care, both organization-wide and between organizations. This was recognized already in 1995 by Roth and Van Dierdonck [34], but developments until now have been slow [21].

3. Since large health care providers such as hospitals generally consist of autonomously managed departments, managers tend not to look beyond the border of their department, and planning and control is fragmented [32,34].
4. The Hippocratic Oath taken by doctors forces them to focus on the patient at hand, whereas planning and control addresses the entire patient population, both within and beyond the scope of an individual doctor [26,27].
5. While health care managers are generally dedicated to provide the best possible service, they lack the knowledge and training to make the best use of the available resources [8].
6. As health care managers often feel that investing in better administration diverts funds from direct patient care [8], managerial functions are often ill-defined, overlooked, poorly addressed, or functionally dispersed.

In this paper we propose and demonstrate a hierarchical framework for health care planning and control to help overcome the aforementioned problems. This framework serves as a tool to structure and break down all functions of health care planning and control. In addition, it can be used to identify planning and control problems and to demarcate the scope of organization interventions. It is applicable broadly, from an individual hospital department to an entire hospital, or to a complete supply chain of care providers. The framework facilitates a dialogue between clinical staff and managers to design the planning and control mechanisms. These mechanisms are necessary to translate the organization's objectives into effective and efficient health care delivery processes [13]. It covers all managerial areas involved in health care delivery operations and all levels of control, to ensure completeness and coherence of responsibilities for every managerial area.

We will argue in Section 2 that while frameworks for planning and control do exist in the literature, they mostly focus on one managerial area – in particular resource capacity planning or materials planning – and mostly only focus on hospitals. The contribution of our framework is that it encompasses all

managerial areas, including those typically overlooked by others. In particular, *medical planning* (i.e. decision making by clinicians) and *financial planning* should not be overlooked when health care delivery processes are to be redesigned or optimized. Another contribution of the framework is its hierarchical decomposition of managerial levels, which is an extension of the classical strategic-tactical-operational breakdown [1], often used in manufacturing. Finally, while most frameworks focus on hospitals, our framework can be applied to any type of health care delivery organization.

This paper is organized as follows. Section 2 outlines the literature on frameworks for planning and control. Section 3 presents the generic framework for health care planning and control. Section 4 describes how to identify managerial problems with the framework, and demonstrates its application. Section 5 presents concluding remarks.

2 Literature on frameworks for planning and control

In this section we give an overview of the state-of-the art in the literature of both manufacturing planning and control and health care planning and control. We also discuss the strengths and weaknesses of the existing frameworks.

Almost all well-known frameworks for manufacturing planning and control (MPC) organize planning and control functions hierarchically. It reflects the natural process of increasing disaggregation in decision making as time progresses, and more information becomes available [41]. It also reflects the hierarchical (department) structure of most organizations [2]. Many MPC frameworks use the hierarchical decomposition into a strategic, tactical, and operational level, as first done by Anthony in 1965 [1].

The classical MPC frameworks have a specific orientation on either *production planning* (e.g. hierarchical production planning [19]), or *technological (or process) planning* (e.g. computer aided process planning [25]), or *material planning* (e.g. Material Requirements Planning (MRP) [30]). As argued by Zijm in [41], this myopic orientation to one managerial area is the main cause that these MPC frameworks are inadequate in practice. Modern MPC frameworks integrate these orientations: the frameworks of [41] and [18] are designed for

integrated MPC in highly complex organizations, such as engineer-to-order manufacturers.

Various researchers have proposed frameworks for (hierarchical) planning and control in health care. In the remainder of this section, we give an overview of existing frameworks for health care planning and control.

First introduced in [33], and later expanded on by Roth and Van Dierdonck in [34], two papers propose a hierarchical framework that is based on application of the Manufacturing Resource Planning (MRP-II) concept. This framework considers both resource capacity planning and material planning, and focuses specifically on hospitals. It relies on DRGs which serve as the “bill of materials” in MRP-II to derive the resource and material requirements of patient groups. Roth and Van Dierdonck [34] propose to use DRGs to facilitate integrated hospital-wide planning and control. Vissers and Beech [37] criticize this framework, and argue that although DRGs are an excellent tool to market and finance hospitals, they are not a good basis for logistical control and managing day-to-day operations.

Vissers et al. [38] and De Vries et al. [12] propose a framework for production control in hospitals. The approach assumes the common situation that a hospital is organized in relatively independent business units. It is limited to resource capacity planning, for which it distinguishes five hierarchical levels: *strategic planning*, *patient volumes planning and control*, *resources planning and control*, *patient group planning*, and *patient planning and control*. These levels address “offline” (in advance) decision making. “Online” (reactive) operational control functions such as reactive planning (for example, add-on scheduling upon arrival of an emergency case) and monitoring are not considered in their framework.

Butler et al. [6] emphasize that due to the differing complexity and information requirements of the various decisions, organizational planning processes are commonly hierarchical in nature. The first step, on a strategic level, involves strategy formation, process layout design, and long-term capacity dimensioning. Subsequent steps relate increasingly to operational concerns, with a decreasing planning horizon and increasing information availability. The hierarchical levels

of control are linked: for example long-term capacity dimensioning decisions shape the capacity restrictions for subsequent operational decision making. The performance, which is measured at an operational level, is the result of how well the various hierarchical planning activities are integrated. In another paper, Butler et al. [7] indicate that the literature neglects cooperation between different managerial areas at the strategic level of hospital planning and control. They argue that to attain exceptional operational performance, it is important that the hospital's strategy consistently and coherently integrates operations issues from areas like *Finance, Marketing, Operations, and Human Resources*.

Blake and Carter [3] focus on an operating theatre setting, for which they propose a hierarchical framework for resource planning and appointment scheduling with three hierarchical levels: *strategic, administrative* (tactical), and *operational* planning.

We conclude that all existing frameworks for health care planning and control focus on hospitals, and are hierarchical in nature. However, like many MPC frameworks they also focus on just one managerial area – mostly resource capacity planning. Integration of managerial areas is neglected, as well as the reactive decision functions, which are important given the inherently stochastic nature of health care processes. Modern MPC frameworks [18,41], however, address multiple managerial areas as well as the three well-known hierarchical levels of control. These frameworks were designed for engineer-to-order or manufacture-to-order environments, where uniquely specified products are produced on demand. In this aspect, these environments resemble health care delivery. Therefore, these MPC frameworks offer a sound basis for our framework for health care planning and control. However, for application in health care, they require significant modification. In the following section, we introduce our generic framework.

3 A generic framework for health care planning and control

We propose a four-by-four generic framework for health care planning and control which spans four hierarchical levels of control, and four managerial areas. We first discuss the managerial areas (3.1), and then the hierarchical decomposition (3.2). We then combine these two dimensions to form the

framework for health care planning and control (3.3). Finally, we discuss the context of the framework and how it affects the content (3.4).

3.1 Managerial areas

As outlined in Section 2, most existing frameworks in the literature focus on one managerial area. We propose to include the following managerial areas for health care planning and control: *medical planning*, *resource capacity planning*, *materials planning*, and *financial planning*. We describe these areas in more detail below.

Medical planning

The role of engineers/process planners in manufacturing is performed by clinicians in health care. We refer to health care's version of "technological planning" as *medical planning*. Medical planning comprises decision making by clinicians regarding for example medical protocols, treatments, diagnoses, and triage. It also comprises development of new medical treatments by clinicians. The more complex and unpredictable the health care processes, the more autonomy is required for clinicians. For example, activities in acute care are necessarily planned by clinicians, whereas in elective care (e.g. ambulatory surgery), standardized and predictable activities can be planned centrally by management.

Resource capacity planning

Resource capacity planning addresses the dimensioning, planning, scheduling, monitoring, and control of *renewable* resources. These include equipment and facilities (e.g. MRIs, physical therapy equipment, bed linen, sterile instruments, operating theatres, rehabilitation rooms), as well as staff.

Materials planning

Materials planning addresses the acquisition, storage, distribution and retrieval of all *consumable* resources/materials, such as suture materials, prostheses, blood, bandages, food, etc. Materials planning typically encompasses functions like warehouse design, inventory management and purchasing.

Financial planning

Financial planning addresses how an organization should manage its costs and revenues to achieve its objectives under current and future organizational and economic circumstances. Since health care spending has been increasing steadily [28], market mechanisms are being introduced in many countries as an incentive to encourage cost-efficient health care delivery (see e.g. [40]). An example is the introduction of Diagnosis-Related Groups (DRGs), which enables the comparison of care products and their prices. As health care systems differ per country, so does financial planning in health care organizations. As financial planning heavily influences the way the processes are organized and managed, we include this managerial area in our framework. For example, Wachtel and Dexter [39] argue that in the US, the tactical allocation of temporary expansions in operating theatre capacity should be based on the contribution margin of the involved surgical (sub)specialties. This criterion is not likely to be used in countries with a non-competitive health care system, such as the UK or the Netherlands. Financial planning in health care concerns functions such as investment planning, contracting (with e.g. health care insurers), budget and cost allocation, accounting, cost price calculation, and billing.

We have selected these four managerial areas, as we consider these as relevant in all our research projects that revolve around optimization of health care operations [9].

3.2 Hierarchical decomposition

As argued in Section 2, decision making disaggregates as time progresses and information gradually becomes available. We build upon the “classical” hierarchical decomposition often used in manufacturing planning and control, which discerns *strategic*, *tactical*, and *operational* levels of control [1]. We extend this decomposition by discerning between *offline* and *online* on the *operational level*. This distinction reflects the difference between “in advance” decision making and “reactive” decision making. We explain the resulting four hierarchical levels below, where the tactical level is explained last. The tactical level is often considered less tangible than the strategic and operational levels, as we will further explain in Section 4. Therefore, we explain the more tangible levels first, before addressing the tactical level.

Note that we do not explicitly give the decision horizon length for any of the hierarchical planning levels, since these depend on the specific characteristics of the application. An emergency department for example inherently has shorter planning horizons than a long-stay ward in a nursing home.

Strategic level

Strategic planning addresses structural decision making. These decisions are the bricks and mortar of an organization [24]. It involves defining the organization's mission (i.e. "strategy" or "direction"), and the decision making to translate this mission into the design, dimensioning, and development of the health care delivery process. Inherently, strategic planning has a long planning horizon and is based on highly aggregated information and forecasts. Examples of strategic planning are resource capacity expansions (e.g. acquisition of MRI machines), developing and/or implementing new medical protocols, forming a purchasing consortium, a merger of nursing homes, and contracting with health insurers.

Offline operational level

Operational planning (both "offline" and "online") involves the short-term decision making related to the execution of the health care delivery process. There is low flexibility on this planning level, since many decisions on higher levels have demarcated the scope for the operational level decision making. The adjective "offline" reflects that this planning level concerns the *in advance* planning of operations. It comprises the detailed coordination of the activities regarding current (elective) demand. Examples of offline operational planning are: treatment selection, appointment scheduling, nurse rostering, inventory replenishment ordering, and billing.

Online operational level

The stochastic nature of health care processes demands for *reactive* decision making. "Online" operational planning involves control mechanisms that deal with monitoring the process and reacting to unforeseen or unanticipated events. Examples of online planning functions are: triaging, add-on scheduling of emergencies, replenishing depleted inventories, rush ordering surgery instrument sterilization, handling billing complications.

Tactical level

In between the strategic level, which sets the stage (regarding e.g. location and size), and the operational level, which addresses the execution of the processes, lies the tactical planning level. We explain tactical planning in relation to strategic and operational planning.

While strategic planning addresses structural decision making, tactical planning addresses the organization of the operations / execution of the health care delivery process (i.e. the “what, where, how, when and who”). In this way, it is similar to operational planning, however, decisions are made on a longer planning horizon. The length of this intermediate planning horizon lies somewhere between the strategic planning horizon and operational planning horizon. Following the concept of hierarchical planning, intermediate, tactical planning has more flexibility than operational planning, is less detailed, and has less demand certainty. Conversely, the opposite is true when compared to strategic planning.

For example, while capacity is fixed in operational planning, temporary capacity expansions like overtime or hiring staff are possible in tactical planning. Also, while demand is largely known in operational planning, it has to be (partly) forecasted for tactical planning, based on (seasonal) demand, waiting list information, and the “downstream” demand in care pathways of patients currently under treatment. Due to this demand uncertainty, tactical planning is less detailed than operational planning (consider for example block planning vs. appointment scheduling). Examples of tactical functions are admission planning, block planning, treatment selection, supplier selection and budget allocation.

3.3 Framework for health care planning and control

Integrating the four managerial areas and the four hierarchical levels of control shapes a four-by-four positioning framework for health care planning and control. While the dimensions of the framework are generic, the content depends on the application at hand. The framework can be applied anywhere from the department level (for example to an operating theatre department) to organization-wide, or to a complete supply chain of care providers. Depending on the context, the content of the framework may be very different. Figure 1

shows the content of the framework when applied to a general hospital as a whole. The inserted planning and control functions are examples, and not exclusive.

	Medical planning	Resource capacity planning	Materials planning	Financial planning	
Strategic	Research, development of medical protocols	Case mix planning, capacity dimensioning, workforce planning	Supply chain and warehouse design	Investment plans, contracting with insurance companies	← hierarchical decomposition →
Tactical	Treatment selection, protocol selection	Block planning, staffing, admission planning	Supplier selection, tendering	Budget and cost allocation	
Offline operational	Diagnosis and planning of an individual treatment	Appointment scheduling, workforce scheduling	Materials purchasing, determining order sizes	DRG billing, cash flow analysis	
Online operational	Triage, diagnosing emergencies and complications	Monitoring, emergency coordination	Rush ordering, inventory replenishing	Billing complications and changes	
	← managerial areas →				

Fig. 1 Example application of the framework for health care planning and control to a general hospital

3.4 Context of the framework

As argued in the previous section, the content of the framework should be accommodated to the context of the application. Regarding the context we discern the internal and external environment characteristics.

The *internal* environment characteristics are scoped by the boundaries of the organization. This involves all characteristics that affect planning and control, regarding for example patient demand (e.g. variability, complexity, arrival intensity, medical urgency, recurrence), organizational culture and structure.

The way health care organizations are organized is perhaps most influenced by its *external* environment. For example a “STEEPLED” analysis (an extension of “PESTEL”, see e.g. [20]) can be done to identify external factors that influence health care planning and control, now or in the future. “STEEPLED” is an abbreviation for the following external environment factors:

- Social factors (e.g. education, social mobility, religious attitudes)
- Technology (e.g. medical innovation, transport infrastructure)

- Economic factors (e.g. change in health finance system)
- Environmental factors (e.g. ecological, recycling)
- Political factors (e.g. change of government policy, privatization)
- Legislation / Legal (e.g. business regulations, quality regulations)
- Ethical factors (e.g. business ethics, confidentiality, safety)
- Demographics (e.g. graying population, life expectancy, obesity)

These factors largely explain the differences amongst countries in the management approach of health care organizations. Figure 2 illustrates how the framework can be observed in light of the organization's external environment.

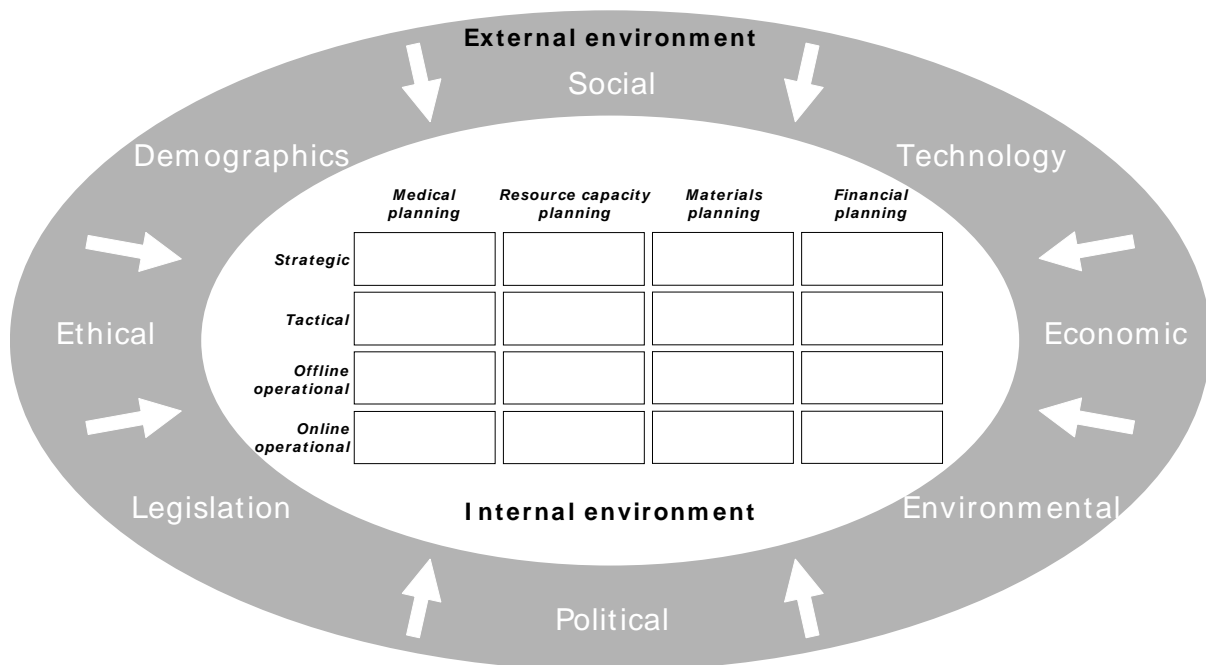


Fig. 2 The framework and the organization's external environment

4 Application of the framework

The primary objective of the framework is to structure the various planning and control functions. In this section, we give examples of how the framework can be applied. Section 4.1 discusses how the framework can be used to identify managerial deficiencies. Section 4.2 gives an example of an application of the framework to an integrated model for primary care outside office hours.

4.1 Identification of managerial deficiencies

Once the content of the framework has been established for a given application, further analysis of this content may identify managerial problems. In the remainder of this section, we discuss examples of four kinds of typical problems:

1. Deficient or lacking planning functions
2. Inappropriate planning approaches
3. Lack of coherence between planning functions
4. Planning functions that have conflicting objectives

Sub 1. Deficient or lacking planning functions

Overlooked or poorly addressed managerial functions can be encountered on all levels of control [8], but are often found on the tactical level of control [34]. In fact, to many, tactical planning is less tangible than operational planning and even strategic planning. Inundated with operational problems, managers are inclined to solve problems *at hand* (i.e., on the operational level). We refer to this phenomenon as the “real-time hype” of managers. A claim for “more capacity” is the universal panacea for many health care managers. It is, however, often overlooked that instead of such drastic strategic measures, tactically allocating and organizing the available resources may be more effective and cheaper. Consider for example a “master schedule” or “block plan”, which is the tactical allocation of blocks of resource time (e.g. operating theatres, or CT-scanners) to specialties and/or patient categories during a week. Such a block plan should be periodically revised to react on variations in supply and demand. However, in practice, it is more often a result of “historical development” than of analytical considerations [36].

An example of a deficient planning function is when autonomy is given to or assumed by the wrong staff member. We illustrate this with two examples. (1) Spurred by the Oath of Hippocrates, clinicians may try to ‘cheat’ the system to advance a patient. Although this may appear suboptimal from a central management point of view, it may be necessary from a medical point of view. The crux is to put the autonomy where it is actually needed. This depends on the application at hand. As argued earlier, the more complex and unpredictable the health care processes, the more autonomy is required for clinicians. Standardized and predictable activities can however be planned centrally by

management, which is advantageous from an economies of scale viewpoint. (2) Intravenous drip pumps are commonly a resource shared by wards. Wards typically hoard them, to ensure immediate availability [11]. This leads to excessive inventory (costs), which may be significantly reduced by centralizing management and storage of this equipment.

Sub 2. Inappropriate planning approaches

There are many logistical paradigms, such as Just-In-Time (JIT), Kanban, Lean, Total Quality Management (TQM), and Six Sigma, all of which have reported success stories. As these paradigms are mostly developed for industry, they generally cannot be simply copied to health care without impunity. “The tendency to uncritically embrace a solution concept, developed for a rather specific manufacturing environment, as the panacea for a variety of other problems in totally different environments has led to many disappointments” [41]. The structure provided by the framework helps to identify whether a planning approach is suitable for a planning function in a particular organizational environment. Planning approaches are only suitable if they fit the internal and external characteristics of the involved application. They have to be adapted to / designed for the characteristics that are unique for health care delivery, such as: (1) patient participation in the service process; (2) simultaneity of production and consumption; (3) perishable capacity; (4) intangibility of health care outputs; and (5) heterogeneity [31].

Sub 3. Lack of coherence between planning functions

The effectiveness and efficiency of health care delivery is not only determined by how the various planning functions are addressed; this is also determined by how they interact. As health care providers such as hospitals are typically formed as a cluster of autonomous departments, planning is also often functionally dispersed. The framework structures planning functions, and provides insight in their horizontal (cross-management) and vertical (hierarchical) interactions. *Horizontal interaction* between managerial areas in the framework provides that required medical information and protocols, and all involved resources and materials, are brought together to enable both effective and efficient health care delivery. *Downward vertical interaction* concerns concretizing higher level objectives and decisions on a shorter planning horizon.

For example, capacity dimensioning decisions on a strategic level (e.g. number of CT scanners) impose hard restrictions on tactical and operational planning and scheduling. *Upward vertical interaction* concerns feedback about the realization of higher level objectives. For example the capacity of MRI machines is determined on the strategic level to attain a certain service level (e.g. access time). Feedback from the tactical and operational level is then needed to observe whether this objective is actually attained, and to advise to what extent the capacity is sufficient.

Sub 4. Planning functions that have conflicting objectives

As argued, the framework structures planning functions and their horizontal and vertical interactions. The framework can thus identify conflicting objectives between planning functions. For example, minimal-invasive surgery generally results in significant reduced length of stay in wards and improved quality of care, but results in higher costs and increased capacity consumption for the operating theatre department. These departments are often managed autonomously and independently, which leads to sub-optimal decision making from both the patient's and the hospital's point of view.

Conflicting objectives also occur between two care providers in an inter-organizational care chain. For example a nursing home's strive to maximize occupation will lead to bed blocking in hospitals. Aligning planning functions between health care organizations may identify and solve such problems.

4.2 Application of the framework to primary care outside office hours

In this section we give an example application of the framework. First we introduce the context: the concept of an integrated organization that provides primary care outside office hours. We then demonstrate how the framework can facilitate the discussion regarding the design of such an organization.

Introduction

The organization of primary care outside office hours, which involves telephone triage, urgent consultations and house calls, has received increasing attention in many countries [17]. In parts of Europe, general practitioners (GPs) are required by law to provide this type of care, and in some countries, GPs cooperate in

primary care cooperatives (PCCs) to jointly provide primary care outside office hours. Within a PCC, the GPs can alternate who is responsible outside office hours. As a result, these GPs do not always have to be available outside office hours. Alternative to the PCC, patients requiring primary care outside office hours can visit the emergency department (ED) of a hospital. Although EDs are intended for complex urgent care, they deal with a relatively large group of patients that could have been served by a GP. For example a study at King's College Hospital in the United Kingdom reports that 41% of patients visiting the ED could have been treated by a GP [10]. Evidently, it is more costly to serve these so-called 'self referrals' at the ED. Therefore, methods are proposed to ensure these patients are served by GPs and do not visit an ED. One of the proposed methods is an integrated model, where the PCC is located in close proximity to the ED, with a joint triage system. Integrated models are effective in the UK [22], and are also favored by the Netherlands as the appropriate system for emergency care [35]. A survey [35] showed that the integrated model significantly decreases the number of self referrals in the ED, since these patients can be referred to the PCC. The integration is thus cost effective from a societal point of view [10,35]. It is, however, under debate whether the integration is cost effective for the EDs and PCCs [35]. For EDs, the integration decreases the number of patient visits, possibly around 50% [17]. This reduces turnover, and all kinds of economies-of-scale advantages. In the Netherlands, the hourly rate for primary care outside office hours for GPs (set by government and paid by health insurers) is considered low and not profitable. Hence, GPs do not welcome the increased workload.

Application of the framework

To successfully implement an integrated ED/PCC, the involved parties must address the aforementioned problems, and discuss how to manage the new organization's planning and control. To facilitate this discussion in a structured way, the framework can be instrumental. We mention some of the key issues per managerial area:

- *Medical planning*: How does the case of joint triage affect the role and responsibilities of the GPs, who before were considered the 'gatekeepers' of health care delivery?

- *Resource capacity planning:* What are the “24/7” resource capacity requirements? Is collaboration of ED and PCC staff possible despite the fact that they work for two independent cost centers – if so, to what extent should they collaborate?
- *Materials planning:* Should the ED and PCC jointly purchase materials? Where should inventories be kept, and who has ownership?
- *Financial planning:* Is an integration of ED and PCC cost effective for hospitals, GPs, insurance companies, society? Is it profitable for the ED to employ general practitioners for self referrals instead of integrating with a PCC? Should hospitals, insurance companies, or the government compensate GPs for the increased workload? Should the ED and PCC be integrated into one cost center?

Based on the outcomes of the discussion around the aforementioned issues, the framework can be used further to design appropriate planning and control on all hierarchical levels and in all managerial areas.

5 Conclusions

The increasing costs of health care and the introduction of (managed) competitive health care have spurred the need for improved health care management. In this paper we propose a reference framework for health care planning and control, which hierarchically structures planning and control functions in multiple managerial areas. It offers a common language for all involved decision makers: clinical staff, managers, and experts on planning and control. This allows coherently formulating and realizing objectives on all levels and in all managerial areas [13]. The framework is widely applicable, to any type of health care provider, or to specific departments within a health care organization. The contents of the framework depend on the application at hand, for example an organizational intervention, a decision making process or a health care delivery process.

The framework facilitates a structural analysis of the planning and control functions and their interaction. Moreover, it helps to identify managerial problems, regarding for example planning functions that are deficient or inappropriate, that lack coherence, or have conflicting objectives. When

managerial deficiencies have been identified, the framework can be used to demarcate the scope of organization interventions. In general, focusing on problems on lower hierarchical levels reduces uncertainty, as inherently the planning horizon is shorter and more information is available. However, flexibility (e.g. regarding resource expansion) is also lower. Focusing on problems on higher hierarchical levels increases the potential impact (e.g. cost savings, waiting time reduction, quality of care), however required investments are usually also higher, and effects of interventions are felt on a longer term. Regardless of the focal point of organization interventions, the framework emphasizes the implications from and for adjacent managerial functions. It can thus be prevented that stake holding decision makers are not involved, and that interventions like “more capacity” (the universal panacea) are not made without considering the possible effects for all underlying and related planning functions. As a result, interventions will have a higher chance of success.

As argued in Section 1, the literature regarding the application of OR/MS in health care is expanding rapidly. This framework can also be instrumental in the design of taxonomies for, for example, literature on outpatient department (appointment) planning, operating theatre planning and scheduling, and inventory management of medical supplies. Scientific papers can be positioned in the framework to illustrate the managerial area(s) they focus on, and the hierarchical level of decision making in the considered problem(s). Similarly, also algorithmic developments can be classified and positioned in the framework.

The framework can easily be extended to include other managerial areas or hierarchical levels. In particular *information management* is a managerial area that should go hand in hand with development of innovative organization-wide planning approaches. "Business-IT Alignment" addresses how companies can apply information technology to formulate and achieve their goals on the various hierarchical levels [23]. Another relevant managerial area that can be included is *quality and safety management*, which is involved in almost all care delivery processes, and can be decomposed hierarchically. The framework can also be expanded in the hierarchical decomposition. There may be different functions on a single hierarchical level within a managerial area, which by themselves have a natural hierarchy. For example decisions regarding the construction of a new

building are of a higher level than decisions regarding the expansion of a ward, while both are strategic decisions.

Acknowledgements

This research is supported by the Dutch Technology Foundation STW, applied science division of NWO and the Technology Program of the Ministry of Economic Affairs.

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