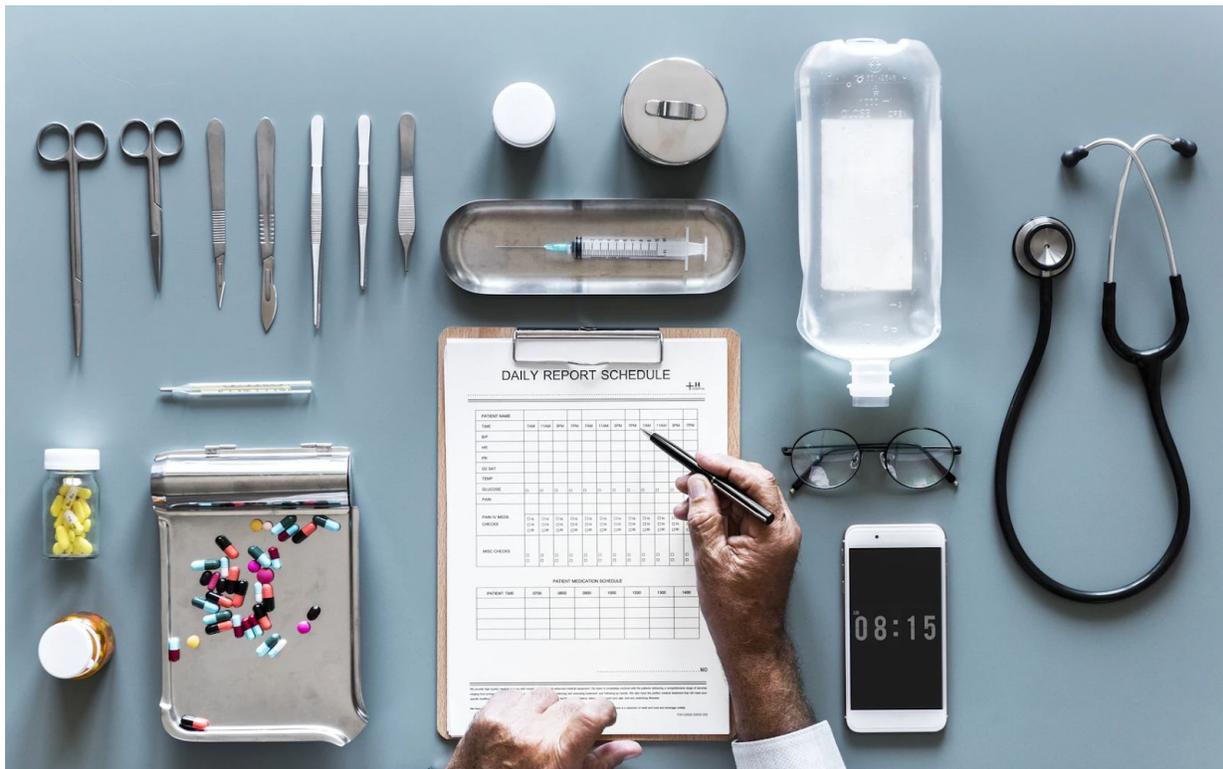


Bachelor Research Report

Capacity Management in Healthcare



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Management Summary

Motivation for this Research

It is necessary to manage health care capacity effectively and efficiently, as it is in the interest of patients, medical practitioners, and health care management. An accurate assessment of capacity management performance is necessary for the improvement of capacity management. Currently, there are no assessment criteria for assessing capacity management performance in health care. Therefore, this research' goal is to propose a framework and performance indicators to assess capacity management performance in health care institutions.

Approach

This research draws its conclusions from a two-part methodology. We conducted an extensive literature review examining 442 articles to arrive at a definition and an overview of the elements of capacity management. Furthermore, 8 experts from health care institutions, consultancy firms, and academia were interviewed to both validate and supplement those findings.

Results

We find that capacity management is the capability to effectively and efficiently acquire and allocate resources (such as facilities, equipment, and workforce) to fulfill demand. Capacity management activity occurs along three dimensions, namely hierarchical, process planning, and managerial domain dimensions.

The hierarchical dimension is closely linked to the value proposition, or *raison d'être* of the health care institution. It is along the lines of hierarchy that a) decision-making disaggregates, b) time passes and thus demand becomes certain, and c) capacity flexibility decreases. The health care institution's strategy is translated down into operational health care delivery and continually improved through feedback that feeds back up. On the strategic level decisions are made on case mix and the capacity of the health care institution, the tactical level concerns patient segments and care pathway capacity, at the offline operational level decision are made on patient groups and department capacity, at the online operational level a match is made between individual patient and practitioner.

In the process planning dimension, the medical profession determines how patient's demand for care should be met by the health care institution's capacity through the organisation of health care activities in care pathways. Standardised treatment protocols are formulated by medical specialists with the goal to improve treatment quality and improve efficiency. Treatment quality and efficiency are improved, because an increased amount standardised treatment limit the variation of treatments, which enables the health care organisation to predict the required capacity more accurately and allows health care institutions to respond to demand using innovative methods such as focussed factories or one-stop shops.

In the managerial domain dimension, the interplay between the medical managerial domain and three facilitating managerial domains concerned with renewable, non-renewable, and financial resources, encompasses the delivery of health care. This consultation bridges the gap between medical decision-making and the medical agenda. As the patients' demand for care becomes more complex, patient-specific, and thus unpredictable, the role of the medical managerial domain becomes relatively larger compared to the other domains.



There is consensus among health care managers, consultants, and academics in The Netherlands that capacity management performance is optimal when organised with an integral view across the hierarchical, process dimension, and managerial domain dimension. This can only be achieved when the activities along the three dimensions are well-aligned, which requires organised interaction among and within the capacity management domains.

The integration of the hierarchical levels is responsible for the health care institution's ability to translate the value proposition into performance, to continually improve and innovate on the long term, and solve problems on the short term. The possibility to escalate and de-escalate decision making, and the organisation of learning in the health care institution are indicators of successful interaction between hierarchical levels.

The process planning activities are integrated when, at every hierarchical level for its relative decision-making scope, care pathways are defined, process performance is structurally measured, and care pathways are optimised. Process performance is frequently measured in terms of quality outcomes, access times, efficiency, and financial outcomes. In optimising care pathways, focus is on the performance of the integral care pathway and not on optimising local steps within the care pathway.

Managerial domain integration determines how well the different managerial domains work together in order to execute the delivery of health care. Primary indicators for the integration of managerial domains the governance of a health care institution and the quality of information on which decisions are made. The experts put forward that integration of managerial domains can be achieved by organising collective decision-making, through dedicated capacity planning meetings, or promoting dual medical and capacity leadership. When assessing the information streams, experts frequently look at the value of information, distinguished in the categories descriptive, diagnostic, predictive, or prescriptive information. Health care institutions that employ high value information can forecast demand and supply fluctuations and react flexibly by allocating capacity in a timely fashion, instead of solely planning based on averages and ignoring the inherent demand and supply variability.

Conclusion

We find that capacity management is the capability to effectively and efficiently acquire and allocate resources (such as facilities, equipment, and workforce) to fulfill demand. Capacity management activity occurs along the hierarchical, process planning, and managerial domain dimensions. There is consensus among health care managers, consultants, and academics in The Netherlands that capacity management performance is optimal when organised with an integral view across the three dimensions. This can only be achieved when the activities along the three dimensions are well-aligned, which requires organised interaction among and within the capacity management dimensions.

Outlook

We have developed promising areas of study for future research to examine, concerning capacity management in general, this research' methodology, and indicators measuring integration. Trade offs between the interests of stakeholders play a large role in capacity management, but remain difficult to properly address. These trade offs occur between the health care system, health care institutions, and individual practitioners and patient. Studies reviewing these trade offs systematically in the context of capacity management frameworks can contribute greatly to achieving balance. The chosen expert interview sample could include medical expertise to broaden the view on capacity management within health care institutions and strengthen the validity of the research. For the hierarchical, process planning and managerial domain integration, more specific indicators can be hypothesised and empirically tested. These can be found in the role of policy and regulation, the significance of roles, competencies and responsibilities of people within capacity management functions.



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1 Introduction

It is necessary to manage health care capacity effectively and efficiently as it is in the interest of patients, medical practitioners, and health care management. Patients are negatively impacted by capacity mismanagement in both their physical and mental health. Numerous studies have shown that waiting can hamper the recovery of patients and negatively influences their treatment satisfaction (Moskop et al., 2009; Becker and Douglass, 2006). In addition, the uncertainty surrounding the timing of medical interventions takes a toll on the mental state of patients. For health care professionals, capacity mismanagement means being confronted with unstable workloads, frequent overtime, and long hours' work. Health care administrators are concerned with the ever-increasing cost side. Resources, such as physicians, staff, facilities, and equipment that determine a health care institution's capacity constitute the largest portion of effort incurred in providing care (Porter 2010). The Dutch Ministry of Health Care (2012) outlines that capacity mismanagement explains the rising health care costs to a large extent.

Matching demand for care with a health care institution's capacity becomes increasingly complex. Recent advancements in medical science require an increasing number of specialised medical staff and technology to cater to patient's demand for health care (Lee, 2010). Furthermore, their specialisation becomes increasingly narrow (Chandra et al., 2012). Compared to times where personnel, facilities, and materials were more generic, a loss of commonality necessitates a greater planning effort.

The necessity to manage capacity effectively and efficiently was apparent longer in manufacturing, however its lessons cannot easily be applied to the health care context. The term capacity originated as a term used to denote the number of goods produced, output for short, per time unit. In fulfilling demand, the manufacturing organisation relies on supply: inventory, and production capacity. Services, unlike goods cannot be stocked, which means that service providers can only satisfy demand with capacity. Vissers (2005) outlines other reasons why lessons learned in manufacturing cannot be copied to the health care environment: Capacity management frameworks from the manufacturing context assume that the specifications of both products and their delivery are complete and explicit. In health care, upfront specification of care outcomes and health care delivery is generally subjective and vague. As opposed to manufacturing organisations, health care organisations host complex lines of command characterised by different involved groups whose interests are carefully balanced, such as health care administrators, medical practitioners, and health care insurers, each with their own perception on what constitutes good organisational performance. The highly trained medical practitioners are the key operators in health care's primary process, who not only deliver care, but also generate the requests for care through i.e. diagnosis and treatment protocol design. This sets medical practitioners apart from key operators in the process of manufacturing dedicated to one task.

Several frameworks and models exist that do describe capacity management in health care, yet none have worked out how to assess and thus improve performance of capacity management. Simultaneously, health care capacity managers and consultants are beginning to design frameworks and maturity models for capacity management. An exploration of the work on capacity management in both academic and health care contexts is therefore warranted.



1.2 Problem Statement

An accurate assessment of capacity management performance is necessary for the improvement of performance. Currently, there are no assessment criteria for assessing capacity management performance in health care.

1.3 Research Objective

The research objective is to propose a framework, and performance indicators to assess capacity management performance in health care institutions. These should contribute to establishing a maturity model for Integral Capacity Management.

1.4 Scope

- Focus on the individual institution (meso-level), not health care systems (macro-level)
- Focus on the management of health care institution not patient or medical staff
- Focus on health care institutions in The Netherlands

1.5 Research Questions

Research Question 1: What is capacity management in health care?

- 1.1 What are definitions of capacity management in other academic/applied fields?
- 1.2 How does capacity management in health care differ from the manufacturing context?
- 1.3 How is capacity management in health care described in the literature?
- 1.4 What do capacity management experts interpret as capacity management in health care institutions?

Research Question 2: How to measure health care capacity management performance?

- 2.2 By which criteria is capacity management measured in other academic/applied fields?
- 2.3 By which criteria do capacity management experts assess capacity management in health care institutions?

2 Methodology

In this chapter we present the two-part methodology through which we answer the research questions. We first discuss the systematic literature review (2.1), then the expert interviews (2.2). Lastly, we present an analysis of the validity and reliability (2.3).

2.1 Systematic Literature Review

We follow a systematic literature review methodology originally proposed by Tranfield et al. (2003), because of the methodology's commonness in the health care setting, and its preferability over other less structured methods. Less structured methods, are less reproducible, and are more difficult to control against bias, reliability or validity issues (Davies & Crombie, 1998).

Highly-cited 'staple' articles in the field of health care operations management served as the basis from which we identified key terms for use in the literature review search string that are found in table 1. From Butler (1996), Laffel (1989) and Vissers (2001) we identified the terms: management science, operations management, capacity management, material resource planning, manufacturing resource planning, resource capacity planning, manufacturing planning and control, manufacturing planning & control, production control, and planning framework. The terms health care (and healthcare), and hospital(s) were chosen to narrow the search down to our required context. During the search, no other must-have search strings emerged. An article eligible for review should have a combination of Operations Research/Management Science (OR/MS) and health care-related keywords in either the title, abstract or keyword register. We chose to narrow down the search by requiring that either a OR/MS or health care-related keyword should be present in the title while the other may be found in title, abstract or keyword register.

Table 1: Key Terms for Search Strings

Capacity-related	Capacity-related	health care-related
capacity management	planning & control	hospital
material resource planning	planning and control	hospitals
manufacturing resource planning	planning framework	health care
resource capacity planning	management science	healthcare
production control	operations management	

We build search strings for the bibliographic databases Web of Science and Scopus and used them on 29-05-18 with the following results:

Web of Science with 233 hits, Scopus with 280 hits, unique hits numbered 442 and included the previously identified 'staple' articles.

The aggregate of articles collected in this way has to comply with a set of inclusion criteria, and will be filtered using a set of exclusion criteria found in table 2. Only documents complying fully with the inclusion criteria, and none of the exclusion criteria are taken into account.

Table 2: Article Exclusion Criteria

No.	Exclusion Criteria	Rationale
1	Articles written with a sole focus on health care systems	Too broad for the chosen scope; often focus on supply chain issues (Smith-Daniels, 1988).
2	Articles limited to financial or economic aspects	Financial topics are seldomly connected to operations topics (Li and Benton 1996).
3	Articles limited to information technology, computer science or ERP-databases	Often focus on specific tools; too narrow for our scope (Jack and Powers, 2009).
4	Articles limited to medical or clinical aspects	Rarely address capacity management. (Litvak and Long, 2000)
5	Conference proceedings	Proved limited in providing information

For the purpose of efficiency at this point only abstracts are reviewed. Of the included studies we gather the full articles. After review of the abstracts, 242 remained. After considering their discussions, 37 papers were selected for full reading. The filtering process is summarised in table 3.

Table 3: Overview of Filtering Steps

	No. of Articles
Unique hits	442
After title review	242
After abstracts and discussion	37

2.2 Expert Interview

At this point in the research we have identified elements that are part of the capacity management concept, which we can test and supplement through expert interviews. The goal of conducting expert interviews is eliciting a) a definition for capacity management, b) assessment criteria c) what constitutes good, and bad performance, and d) an intended purpose for using assessment.

McGraw & Harbison-Grigg (1989) propose a method for defining concepts and their interrelations through semi-structured interviews. First they recommend identifying and defining concepts by using a structured brainstorm based on the aforementioned research questions, then they recommend working towards a taxonomy detailing concept interrelations. In order to identify measures for capacity management performance we asked experts for descriptions of successful and unsuccessful performance of capacity management. We used a less structured approach for eliciting what demands, and wishes experts have for the assessment framework, because these can be adequately probed with questions.

From the recruitment effort to find participants, eight interviewees emerged. Three interviewees are in management functions in health care institutions, four are consultants active in health care capacity management and one professor of operations management with a focus on health care.

The interviews were recorded and afterwards transcribed. Transcriptions are analysed to see whether concepts or elements have emerged, but not explicitly mentioned.

2.3 Validity and Reliability Check

Table 4: Overview of Factors Influencing Validity. From Cooper and Schindler (2014):

Validity	Rationale
Content	In order to assure that the specific items under study adequately represent all relevant items under study, we base search strings on highly-cited articles and invite interviewees from different backgrounds.
Construct	Construct validity is guarded for by employing strict exclusion criteria in the literature review and strict inclusion criteria in the interviews

Table 5: Overview of Factors Influencing Reliability. From Cooper and Schindler (2014):

Reliability	Rationale
Stability	Stability of our research' findings is improved by having a two-part methodology, consisting of literature review and interviews.
Equivalence	We prevent errors that influence equivalence reliability by having one literature reviewer and interviewer .
Internal Consistency	In order to control the internal consistency of our findings we compare and contrast findings arising from the literature review and expert interviews.

3 A Framework of Capacity Management

3.1. Capacity Management in the Literature

Capacity management and demand management are the two management activities under the planning and control umbrella in the Operations Research/Management Science (OR/MS) domain. Planning and control spans the activities that coordinate a) the demands of the market and b) the ability of the operation's resources to deliver (Slack, 2013). In the health care context, demand management is the process of identifying patient's demand in terms of type, amount, location, and timing and developing the best methods of curtailing or creating demand (Heineke, 1995; Jack and Powers, 2009). From the literature review, two generally-accepted definitions of capacity management emerge. Smith-Daniels et al. (1988) argue that in the health-care context capacity management involves decisions related to the acquisition and allocation of key resources such as facilities, equipment, and workforce. According to Ridge (1998), capacity management is concerned primarily with ensuring that the organization has the capability to respond to the level of demand experienced. We conclude the following definition:

Capacity management is the capability to effectively and efficiently acquire and allocate resources (such as facilities, equipment, and workforce) to fulfill demand.

For capacity management in health care, existing frameworks are limited in their scope. Smith-Daniels et al. (1988) solely focus on operations research models for the acquisition and allocation of facility and workforce resources. They distinguish temporal difference through the distinction of acquisition and allocation decisions. They reflect on their review by stating that framework integration of different capacity-related subjects is the major challenge for future research. Butler et al. (1996), not only affirm this finding, but further stress that links with strategic, financial, and human resource management need to be made in high-level research. Jack and Powers (2009) elaborate in their review of health care capacity management that a wealth of knowledge exists on specific subjects, such as capacity planning models, workforce management, subcontracting, and information technology. They outline that future research can be done to comprehensively describe how to balance demand and capacity as they note the lack of frameworks that address all capacity management activities.

Zijm (2000) signalled the same need for an integral framework in manufacturing-oriented planning and control literature and combined insights from OR/MS subjects into such a framework. He also alluded differences in temporal or hierarchical scope, however did not explicate them in the framework. The work presents consolidations of dispersed literature on technical, capacity resource and materials management. In the technical domain, engineers through product designs and process planning heavily influence the need for capacity to manufacture products. Furthermore, the paper separates resources that define manufacturing capacity, such as machines and manpower from single-use materials.

Vissers et al. (2001) identified that capacity management in healthcare is separated in hierarchical levels and alluded to managerial domains that comprise capacity management. The framework is an outline for hospitals of “what to do, and not about how to do it.” Each hierarchical level, displays a different levels of demand uncertainty, temporal horizons, a narrow scope of decision making, and restrictions in capacity flexibility. Anthony (1965) first identified three dimensions of strategic, tactical, and operational management outlined by to be applicable to the health care context. Vissers et al. (2001) reflects on capacity management practices found within hospitals by outlining hierarchical levels pertaining to strategic issues, patient volume, resource allocation, patient groups, individual patient patients. As time progresses, the decision-making process moves down the hierarchical levels. Successive levels are confronted with a) decreasing levels of demand uncertainty as a result of time progressing, and b) decreasing capacity flexibility as a result of previously allocated capacity bounds. Hierarchical levels are connected upwards through feedback loops that ensure demand and capacity can be adequately matched despite increasing restrictions.

The framework of Hans et al. (2011) synthesise Zijm’s (2000) insight to consolidate managerial domains and the hierarchical dimensions found in Vissers et al. (2001). The framework provides an overview of four hierarchical, or temporal, levels and four managerial domains. The hierarchical levels are strategic, tactical and operational. The operational level is subdivided in offline and online decision making, where offline reflects the in advance decision making and online the direct decision making in response of unexpected events. The four managerial domains are: medical planning, resource capacity planning, materials planning, and financial planning. Medical planning comprises decision making by clinicians regarding medical protocols, treatments, diagnoses, and triage. Resource capacity planning addresses the dimensioning, planning, scheduling, monitoring and control of renewable, reusable resources. Materials planning addresses the acquisition, storage, distribution and disposal of consumable resources, such as suture materials, blood, bandages, food, etc. Financial planning addresses how an organization should manage its costs and revenues to achieve its goals under current and future organizational and economic circumstances. The framework’s graphical representation is given in figure 1.

	Medical	Resource Capacity	Material	Financial
Strategic Planning				
Tactical Planning				
Offline Operational Planning				
Online Operational Planning				

Figure 1: A Framework for Health Care Planning and Control (Hans et al., 2011)

From the frameworks emerges that capacity management activities can be characterised by their relative hierarchical and managerial position within the health care organisation. In the hierarchical dimension decision making disaggregates as time progresses, following the availability of information. The managerial area’s are distinguished by the scope of decision-making, whether medical or more facilitating in terms of resource capacity, materials or financial resources. The literature suggests that interaction exists between the levels in the hierarchical dimension in terms of feedforward and feedback. It remains an open question if other dimensions are at play in capacity management. Furthermore, current frameworks have yet to identify if similar feedback and forward interactions are present between the managerial areas.

3.2. Expert Opinion Capacity Management

In this section we present the outcomes of interviews held with the expert group consisting of capacity managers, consultants, and academics on health care capacity management.

Section 3.2.1 presents experts' hierarchical dimensioning of capacity management. Section 3.2.2 presents experts' view of the process planning as part of capacity management. Section 3.2.3 summarizes experts' view on managerial domains involved in capacity management.

3.2.1. Hierarchical Dimension

For the experts, the hierarchical dimension of capacity management is closely linked to the value proposition, or *raison d'être* of the health care institution. It is along the lines of hierarchy that a) decisions travel through the institution, b) time passes and thus demand becomes certain, c) capacity flexibility decreases. The experts reflected upon the hierarchical dimension implicitly using the hierarchical axis described by Hans et al. (2011).

The capacity related decision-making processes become more dispersed throughout the institution as the scope of decisions decreases going down the health care institution's hierarchy. The largest scope of capacity related decision making pertains to the value proposition of the institution. Several health care managers and consultants state that on the strategic level the choice is made on which range of services or product groups to offer and in which (regional) markets to operate. From this strategic choice follows a certain case mix of patients that has to be matched by the capacity of the health care institution as a whole. On an aggregate level this demand is compared to the capacity available in terms of workforce, facilities and materials in underlying care pathways and departments. If necessary, capacity can be adjusted with allocation or acquisition decisions. A consultant formulated that: "The resulting strategic capacity plan provides the bounds for underlying levels to operate in." On the next level, care pathways of specific patient groups are matched with capacities in specific care pathways or departments. In the last planning phase, the offline operational level, individual patients are allocated in plans to individual practitioners. The goals of the plans made by dispersed decision-makers have to be a reflection of the goals decided upon centrally on the strategic level. Plans made in the offline operational phase largely determine whether patient's demand for health care is met, at the right place on the right time, with the correct amount of care capacity. On the lowest hierarchical level, rubber meets the road. In spite of careful planning, natural and artificial variation in the specific demands of patients and the specific characteristics of capacity can be source of capacity problems. For this level it is instrumental to signal that in time and to come up with an adequate response.

At all hierarchical levels, capacity management is confronted with uncertainty, or variation that only stabilises as time progresses. Health care institutions employ 2 strategies along their hierarchical lines to plan effectively and efficiently in the face of uncertainty, at every level plans are made on highest possible level of detail and capacity flexibility is reduced at every step. At the highest level the degree of uncertainty is also the highest. While predictions can be made on e.g. historical data, sudden trends in patient demand may only surface later in time. Even without sudden rises in patient demand, variability will occur naturally. It is therefore unwanted to produce detailed plans at this level. Rather, by making aggregated plans with patient care pathways, broader time frames and more general practitioner categories, capacity managers can 'pool' together the various types of variation. This is a common strategy to deal with variation, especially among the experts with a background in supply chain management, known as risk pooling.

Because of the high degree of uncertainty and the need to comply to the value proposition, the need for flexibility is also the highest. Decisions at this level are of a structural nature, that are workable for operations, but also financially feasible. One level down the hierarchy, demand has become more certain. Trends and hick-ups, such as epidemics emerge for the different patient groups and have to be reacted to. In principle, temporary phenomena have to be matched with temporary solutions. It is thus necessary to temporarily reallocate capacity among the different care pathways as a result. Capacity management decisions are thus restricted to temporary decisions within previously determined structural bounds. The logic extends to the operational planning, where incidental phenomena emerge over time. An example of such an incident might be a MRI malfunctioning at a neighbouring health care institution leading to an incidental increase in demand for MRI scans. Again, incidents are matched with incidental capacity decisions. In the operation itself demand is at its most certain. Schedules are fixed and there is practically no room to redistribute capacity.

A summary of the characteristics of the different hierarchical levels according to the views of experts, as discussed above, is given in table 6.

Table 6: Overview of the Characteristics of Hierarchical Levels

Hierarchical Level	Scope of decision-making	Time Horizon and uncertainty	Capacity Flexibility
Strategic	Case mix and health care institution	Long, large uncertainty	Structural Capacity Flexibility
Tactical	Patient segments and care pathways	Middle, considerable uncertainty	Temporal Capacity Flexibility
Offline Operational	Patients and departments	Short, minor uncertainty	Incidental Capacity Flexibility
Online Operational	Individual Patient and Practitioner	Present, no uncertainty	No Capacity Flexibility

3.2.2. Process Planning Dimension

The medical profession determines how patient demand should be met by the health care institution's capacity, primarily through the organisation of health care activities in care pathways. In the process planning dimension, standardised treatment protocols are formulated by medical specialists with the goal to improve treatment quality and improve efficiency. Treatment quality and efficiency are improved, because an increased amount of standardised treatment limits the variation of treatments, which enables the health care organisation to predict the required capacity more accurately and allows health care institutions to respond to demand using innovative methods such as focussed factories or one-stop shops.

Every patient goes through a number of steps from diagnosis to the last health care activity and spends an amount of time in the health care process, in what is called a care pathway. The formulation of the care pathway either emerges ad hoc, or can be planned in advance for a different number of patients at different hierarchical decision-making scopes. The ad hoc emerging of care pathways happens when practitioners at the online operational level formulate treatment plans for individual patients. Conversely, it is also possible to plan treatment protocols for groups of patients within a speciality, patient segments to be treated by a multitude of medical specialities, or even the health care institution's case mix. These levels of decision-making scopes follow directly from the hierarchical level at which the decision-making occurs, as described in table 6. The possibility to design and plan treatment protocols for broader scopes, thus for larger groups of patients, is dependent on the predictability of the medical conditions treatment process. In treating rare disorders and patient groups exhibiting comorbidity, the process planning dimension may be forced to have care pathways emerge ad hoc, while for types of illness with less variation, such as cataract in the eye care domain, treatment protocols can be developed at the scope of multiple medical specialities.

The ad hoc emerging of care pathways leads to suboptimal capacity management. Take the following example of implicit care pathway design in hospital care. A hospital common path typically contains a diagnosis step followed by a treatment step and is concluded by a period of monitoring. This can be a reactive process, where the different clinicians at the different steps can decide which next step should be taken. At every step patients are informed what step to take next and are given a date for this step to occur. It is clear that this will most likely not result in e.g. optimal waiting times for the patient or optimal organisation of capacity for the health care institution.

Ideally, the care pathway is defined with at the highest possible level of capacity decision-making scope. When a health care institution structurally plans care pathways in advance for the largest possible decision-making scopes, then the capacity demand uncertainty decreases, leading to increased effective and efficient capacity management. Detailed descriptions of care pathways help to more accurately predict demand at hierarchical levels that have flexibility in capacity allocation, which makes it easier to anticipate and react to demand effectively and efficiently. In case of minimal impact, capacity demand uncertainty will decrease at the corresponding hierarchical level, which means planners can more accurately assess the capacity necessity and can adjust bounds accordingly. In higher impact cases, the explicit definition leads to the set-up of 'focused factories' or *zorgstraten* in Dutch. One example of this is the establishment of a 'slip and slide' clinic providing care to an elderly whom sustained injury from a fall. This themed clinic, staffed with dedicated nurses, orthopaedic surgeons, and geriatricians, has led to an increase in quality of care and ease of access, while reducing costs.



3.2.3. Managerial Domain Dimension

Experts broadly distinguish four different managerial domains in terms of medical, renewable, non-renewable and financial resource categories that together constitute the actual delivery of health care. As these domains are comparable to the managerial domains outlined by Hans et al. (2011) in all but name, and have earlier been described in detail, this section will focus on the elaboration of experts on the framework.

The terms 'renewable' and 'non-renewable' resources are preferred by experts over 'resource capacity' and 'materials', because of their added clarity. The term renewable demarks the type of resources that can be used repeatedly, whereas non-renewable resources are the resources that need replenishment after use. Renewable resources the challenge is the allocation of workforce, shared critical facilities and equipment, such as medical specialists, operating theatres and beds on nursing wards. With non-renewable resources the challenge is to procure cheaply, yet adequately, keep sufficient inventory and coordinate the flow of goods. Financial capacity is the focus of financing and accounting divisions within hospitals.

According to the experts, the interplay between the medical managerial domain and the three facilitating managerial domains encompasses the delivery of health care. As mentioned in the previous section, the medical managerial domain outlines how demand for health care translates in a sequenced demand for capacity to the health care institution. The medical, renewable, non-renewable and financial managerial domains, through the determination of a treatment plan, formulate what mix of activities and resources have to come together at what time in order to facilitate the delivery of health care. This consultation bridges the gap between medical decision-making and the medical agenda. As the patients' demand for care becomes more complex, patient-specific, and thus unpredictable, the role of the medical managerial domain becomes relatively larger compared to the other domains.

4 Performance Indicators for Capacity Management

There is consensus among health care managers, consultants, and academics in The Netherlands that capacity management performance is optimal when organised with an integral view across the hierarchical, process dimension, and managerial domain dimension. Capacity is managed integrally when capacity decision-making activities are present and integrated along the hierarchical, process and managerial dimensions. This can only be achieved when the activities along the three dimensions are well-aligned. This requires organised interaction among and between the capacity management domains. From the interviews a set of criteria emerge that give indication for the performance of capacity management.

4.1. Hierarchical Integration

The interaction between the hierarchical levels is responsible for the health care institution's ability to translate the value proposition into performance, to continually improve and innovate on the long term and solve problems on the short term. The possibility to escalate and de-escalate decision making, and the organisation of learning in the health care institution are indicators of successful interaction between hierarchical levels.

Without insight into the problems faced at lower hierarchical levels due to higher-level capacity management decisions, higher hierarchical level cannot improve decision making. This is because higher level decision-making relies on information regarding the performance of operations as a basis for future capacity decisions. Organising the flow of information up from the large number of widely dispersed units is therefore a necessary part in improving performance. The hierarchical dimension describes how as planning horizon draws near, demand becomes apparent, and flexibility is increasingly limited. In practice, the health care organisation can find that the boundaries set at higher levels are too restrictive and thus pose a problem. This is the case especially when demand peaks have not been anticipated by higher levels, but lower levels do not have the ability to adjust capacity accordingly. When it is not possible to reactively influence allocation decisions at higher hierarchical levels, or in other words when escalation possibilities are not present, health care institutions are faced with serious consequences. Experts indicate that these institutions most commonly lack capacity management on the tactical level. When demand peaks, capacity management on the operational levels is occupied with 'firefighting', solving immediate problems without outlook of taking back control. On the strategic level capacity management 'burns money', because when word reaches of uncontrolled operational capacity problems, management is forced to provide a level of capacity on par with the peak experienced. "Forced", because if the strategic level fails to provide this level of capacity this might result in decreased quality of care, increased patient waiting times, and large amounts of staff overtime. A common way in which expert validate their suspicion of a lacking tactical level is by checking whether the current capacity level is as high as the last demand peak. If so, this has occurred because of the dynamic described above. Instead, when possibilities for escalation have been formulated, the organisation becomes responsive.



The way in which problems are solved is crucial for the health care institution to continually improve performance and innovate. While first order problem solving, such as quick fixes and workarounds provide a solution in the present, only more in-depth strategies, such as second order problem solving such as root cause analysis provide structural improvement and prevent recurrences. Yet, in the health care context, the majority of problem solving behaviours consists of workarounds instead of systematic problem solving.

4.2. Process Integration

The integration of process planning dimension outlines how the patients demand for care translates to a demand for capacity to the health care institution. The integration of the process planning directly influences this flow of patients through the health care institution.

Patients, after their last treatment, always have a care pathway, a process of a number of steps taken at a certain speed. In some examples, the formulation of the care pathway happens ad hoc at the online operational level through interaction of individual patients and practitioners. This ad hoc care pathway planning happens dispersed throughout the health care organisation and with a short time horizon, which leads to an unpredictable patient care pathway and thus unpredictable capacity demand. Ideally however, the care pathway is defined in advance and concerns patients' complete care pathway at the highest possible level of capacity decision-making scope. As result of the standardisation of specific care pathway treatment protocols, the variability in demand for capacity decreases and becomes more predictable, which leads to increased effective and efficient capacity management.

The process planning activities are integrated when at every hierarchical level for its relative decision-making scope, care pathways are defined, process performance is structurally measured, and care pathways are optimised. In order to define care pathways, experts refer to *Het Zorgpadenboek*, The Care Pathway Guide by Huiskes and Schrijvers (2011) for a detailed description of a care pathway. According to the authors, a care pathway has the objectives and major elements of planned care defined upfront based on evidence, best practice, and patients' expectations and characteristics. It outlines an organisation of the information flow among the medical team and patients. It provides the coordination of the care process by coordinating the roles and sequencing the activities of the multidisciplinary care team, patients and their relatives. It provides for the central documentation, monitoring, and evaluation of variances and outcomes. The identification of the necessary resources involved in the care pathway follow from the description of clinical activities and their sequence. Health care managers frequently express the difficulty of providing a detailed care pathway planning for broader decision-making scopes at higher hierarchical levels, due to uncertainty and variation in patient condition, treatment procedure and the range of process outcomes. Consultants, on the other hand, frequently stress that even high-level process maps can lead to improved capacity management.

After defining care pathways, experts from academia and consultancy suggest to measure care pathway process performance. Performance measurement is considered to a prerequisite for improving the performance of the care pathway. The different measures that are used by consultants and in the literature are summarised in table 7. The measures show a large amount of congruity and refer to performance in terms of quality outcomes, access times, efficiency, and financial outcomes. Notable is the choice of one consultant to focus indicators around the stakeholders, patients, employees, and the hospital, because planning constitutes balancing interests through tradeoffs. The measures make these tradeoffs transparent and controllable.

Table 7: Indicators for Process Performance

Authors	Performance Indicators
Consultant A	Quality, Access, Financial
Consultant B	Patient, Employees, Hospital (Adherence to protocol, Efficient Staffing, Productivity)
Li & Benton 1996	Quality-of-Care outcomes, Efficiency, Financial Performance
Jack & Powers 2008	(Continually developing) Quality-of-Care outcomes, Efficiency, Financial Performance
Smith-Daniels 1988	Productivity, Cost Efficiency, Clinical Quality, Patient Satisfaction, Employee Attitudes & Behaviour, Financial Outcomes
Porter 2010	Quality-of-care (Speed, Extent and Sustainability of recovery) & Cost of Care at the patient-level

Lastly, for the integral management of the process planning dimension, care pathways are to be optimised in terms of their measured performance throughout the care pathway and not only for its individual steps. In order to illustrate why it is important to manage steps in the care pathway integrally, one consultant took the simplified example of a general care pathway that requires a form of surgery. Patient in such a care pathway typically move from an outpatient clinic, through the operating theatre, to the nursing ward for overnight stay. The outpatient clinic planning determines when a certain speciality can see patients for diagnosis, treatment, referral for surgery, therefore influences how patients arrive in the queue for this speciality's surgery. The operating theater planning influences how patients are drawn from this queue for treatment and consequently how patients arrive in the nursing wards for overnight stay. When the schedules for these capacities are not integrally managed, situations might arise where patients are delayed or capacity becomes underutilised because of mismatch between outpatient and operating theatre planning. Furthermore, healthcare managers and consultants tell of situations where surgery was canceled because of capacity constraints downstream at the nursing ward. These examples demonstrate how focus on individual steps in a care pathway, instead of an integral view can lead to decreased capacity management performance.

4.3. Managerial Domain Integration

Managerial domain integration determines how well the different managerial domains work together in order to execute the delivery of health care. Primary indicators for the integration of managerial domains the governance of a health care institution and the quality of information on which decisions are made.

When assessing the governance structure of the health care institution experts focus on answering two questions: 1) Is decision making present at all hierarchical levels within each of the managerial domains?, and 2) Are there decision making activities across each of the managerial domains? The first question checks whether hierarchical integration is organised, as a prerequisite for subsequent integration of

managerial domains. According to the experts, a lack of integration in the hierarchical dimension, for example through lacking a tactical decision-making level is to be addressed simultaneously with a lack of integration in managerial areas. On a similar note, the integration of process planning has to be organised, before managerial domain integration perform optimally. When through process planning, integration groups of patients have been identified that approximately follow prespecified care pathways, then the facilitating managerial domains can formulate the most efficient way to cater to the demand for capacity, because the predicted demand is more accurate at levels where capacity allocation flexibility is high.

With hierarchical and process integration or interaction in place it becomes easier to anticipate and react to demand effectively and efficiently, which means that the facilitating managerial domains are no longer constrained to traditional modes of organising the health care delivery. Instead, alternative, innovative means of health care delivery can be put forward, such as integrated practice units, one-stop shops or telemedicine initiatives. An integrated practice unit is an organisational unit around a specified medical condition, or well-defined patient segments. The unit comprises a dedicated, multidisciplinary team of clinicians and non-clinicians, who become condition specialists. One-stop shops are initiatives to have large patient segments take multiple steps on their care pathway in a single day. Telemedicine initiatives deliver care through patient’s computers or mobile phones as way to provide increased access to health care by decreasing logistical burden posed by face-to-face health care delivery.

The experts put forward that integration of managerial domains can be achieved by organising collective decision-making, through dedicated capacity planning meetings, or promoting dual medical and capacity leadership. Many of the experts work on establishing capacity planning meetings comprised of the four managerial domains that have mandates for allocating shared resources among the medical specialisations in the health care institution. The exact form of which can differ according to the hierarchical level on which the decision making occurs. Generally, the meetings follow the scope of decision making and the time horizon of the given hierarchical level.

Collective bodies of decision making can only perform optimally if aided by the right *intelligence*, availability and analysis of appropriate information. Experts note that in underperforming health care institutions the only source of quantitative intelligence is from the financial managerial domain, while to achieve integration scope must be expanded to include logistical indicators as well. Multiple experts refer to the Gartner Data Analytics Maturity Model (figure 2) as a means to describe the quality of information flowing from business intelligence tools to decision making. The scope of information moves from hindsight to insight to foresight. Health care institutions that employ high value information can forecast demand and supply fluctuations and react flexibly by allocating capacity in a timely fashion, instead of solely planning based on averages and ignoring the inherent demand and supply variability.

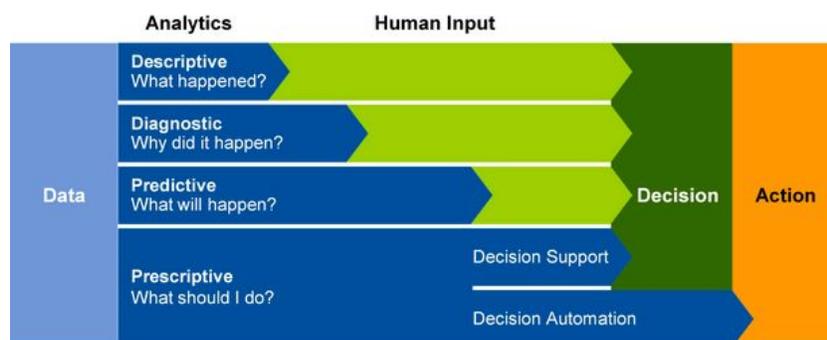


Figure 2: The Gartner (2014) Data Analytics Maturity Model

5 Conclusion

In this chapter we present our conclusion to the research questions asked in section 5.1 and we have developed recommendations for future research in the area of capacity management in section 5.2.

5.1. Conclusion

This research set out to propose a framework, and performance indicators to assess capacity management performance in health care institutions. This research develops a framework with criteria for capacity management performance through answering two main research questions. Research question 1 is “What is capacity management in health care?” and research question 2 is “How to measure health care capacity management performance?”.

Research Question 1: What is capacity management in health care?

Based on earlier reviews on capacity management in health care, we propose to define capacity management as the capability to effectively and efficiently acquire and allocate resources (such as facilities, equipment, and workforce) to fulfill demand. Three dimension of capacity management were identified, through review of literature on the subject and interviews held with expert from health care institutions, academia and consultancy. The dimensions are the hierarchical, process planning, and managerial domain dimensions.

The hierarchical dimension is closely linked to the value proposition, or *raison d'être* of the health care institution. It is along the lines of hierarchy that a) decision-making disaggregates, b) time passes and thus demand becomes certain, c) capacity flexibility decreases. The health care institution's strategy is translated down into operational health care delivery and continually improved through feedback that feeds back up. On the strategic level decisions are made on case mix and the capacity of the health care institution, the tactical level concerns patient segments and care pathway capacity, at the offline operational level decision are made on patient groups and department capacity, at the online operational level a match is made between individual patient and practitioner.

In the process planning dimension, the medical profession determines how patient's demand for care should met by the health care institution's capacity through the organisation of health care activities in care pathways. Standardised treatment protocols are formulated by medical specialists with the goal to improve treatment quality and improve efficiency. The treatment quality and efficiency are improved, because an increased amount standardised treatment limits the variation of treatments, which enables the health care organisation to predict the required capacity more accurately and allows health care institutions to respond to demand using innovative methods such as focussed factories or one-stop shops.

In the managerial domain dimension, the interplay between the medical managerial domain and three facilitating managerial domains concerned with renewable, non-renewable and financial resources, encompasses the delivery of (health) care. This consultation bridges the gap between medical decision-making and the medical agenda. As the patients' demand for care becomes more complex, patient-specific, and thus unpredictable, the role of the medical managerial domain becomes relatively larger compared to the other domains.



Research Question 2: How to measure health care capacity management performance?

There is consensus among health care managers, consultants, and academics in The Netherlands that capacity management performance is optimal when organised with an integral view across the hierarchical, process dimension, and managerial domain dimension. This can only be achieved when the activities along the three dimensions are well-aligned, which requires organised interaction among and within the capacity management domains.

The integration of the hierarchical levels is responsible for the health care institution's ability to translate the value proposition into performance, to continually improve and innovate on the long term, and solve problems on the short term. The possibility to escalate and de-escalate decision making, and the organisation of learning in the health care institution are indicators of successful interaction between hierarchical levels.

The process planning activities are integrated when, at every hierarchical level for its relative decision-making scope, care pathways are defined, process performance is structurally measured, and care pathways are optimised. Process performance is frequently measured in terms of quality outcomes, access times, efficiency, and financial outcomes. In optimising care pathways, focus is on the performance of the integral care pathway and not on optimising local steps within the care pathway.

Managerial domain integration determines how well the different managerial domains work together in order to execute the delivery of health care. Primary indicators for the integration of managerial domains the governance of a health care institution and the quality of information on which decisions are made. The experts put forward that integration of managerial domains can be achieved by organising collective decision-making, through dedicated capacity planning meetings, or promoting dual medical and capacity leadership. When assessing the information streams, experts frequently look at the value of information, distinguished in the categories descriptive, diagnostic, predictive or prescriptive information. Health care institution that employ high value information can forecast demand and supply fluctuations and react flexibly by allocating capacity in a timely fashion, instead of solely planning based on averages and ignoring the inherent demand and supply variability.

5.2. Outlook

Various areas of study were deemed out of scope for this research, due to the exploratory nature of this work and due to time constraints. We have developed promising areas of study for future research to examine, concerning capacity management in general, this research' methodology, and indicators measuring integration.

Trade offs between the interests of stakeholders play a large role in capacity management, but remain difficult to properly address. These trade offs occur between the health care system, health care institutions, and individual practitioners and patient. On the one hand medical technology allows for health recovery previously unimaginable, but it does so at great costs. There is a tradeoff 24/7 need for care from patients and the health care institution's office hours. Academic hospital want to dedicate their costly resources to the most complex health care demanda, but find it difficult or even impossible to turn away a patient in need, for example because of capacity constraint elsewhere. Studies reviewing these trade offs systematically in the context of capacity management frameworks can contribute greatly to achieving balance.



The research could be repeated with an adjusted methodology in order to broaden the view on capacity management within health care institutions and strengthen the validity of the research. The interviews sample could be extended to include medical expertise with an interest in operations management and capacity management experts in non-hospital health care institutions, such as primary care, community health organisations, and elderly care.

For the hierarchical, process planning and managerial domain integration, more specific indicators can be hypothesised and empirically tested. Research that concretely outlines indicators in a detailed fashion contributes to the improvement of capacity management in health care institutions. This research did not focus on the role of policy and regulation in health care institutions while there may be further indicators for integration of hierarchical dimension there. For managerial domain integration, research can, for example, examine integration from an organisational sociological perspective and elaborate on the significance of roles, competencies and responsibilities of people within capacity management functions.

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