Process improvement in healthcare
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IMPROVING QUALITY IN HEALTHCARE
1.1 Introduction

Cost and quality of healthcare are two critical issues facing the healthcare industry throughout the world. Finding ways to improve quality and reduce costs is therefore one of the most important issues facing the medical profession as well as the public in general. Leaving it to healthcare administrators to worry about costs and the clinical staff to worry about quality is not a recommended approach. The two sides need to collaborate closely to obtain better quality while controlling the spiraling costs of healthcare. In this chapter we discuss the three definitions of quality promoted by quality management pioneer Dr. Joseph M. Juran (Juran, 1989). Conceptually, these definitions may help healthcare professionals — clinicians and administrators — clarify the relationship between cost and quality and explain the seemingly paradoxical idea that we can indeed enhance quality while reducing cost of healthcare.

Furthermore, we discuss in this chapter quality performance indicators. Current indicators appear to be inadequate to inform the public to make the right choices. We propose a framework and an organizational setting in which valid and reliable healthcare information can be produced to inform the general public about healthcare quality.

Finally, the chapter ends with an outline of this thesis.

1.2 Improving quality in healthcare while reducing costs

The term quality has several interpretations. Confusing them may cause problems, some of which may confuse policy discussions, create conflicts between patients, healthcare professionals and hospital management, and impede progress in solving problems with the healthcare system. If the prevailing paradigm is that reducing cost inevitably will compromise the quality of care, the very mindset becomes an obstacle to dealing with some of the most vexing problems of modern healthcare.

The majority of activities in professional organizations are done as routines, and “routinization” (that is, turning something into a process) of activities constitutes the most important form of storage of an organization’s specific operational knowledge. Process management has an analogy with financial management. The latter is carried out through
three managerial processes: financial planning (budgeting), financial control (budget) and financial improvement (cost reduction). It was Juran (1989) who explores this analogy for managing quality. It may seem logical to implement process planning before engaging in process control and process improvement. However, Juran suggested that it is more pragmatic to start with improvement (Bisgaard, 2007).

Perhaps the first association that people make with the topic of healthcare improvement is innovation in medical science, including innovations in treatment protocols, medical equipment, and pharmaceuticals. The first subsections of this chapter, however, focus on the improvement of healthcare by improving its delivery. Healthcare delivery concerns the operating routines in hospitals, including primary patient processes, medical support processes, and nonmedical support processes. Characteristics of these processes, such as their capacity, efficiency, and reliability, determine important performance dimensions of healthcare, such as throughput, patient safety, and waiting times. Ultimately, they have a substantial impact on patient satisfaction, cost, and the quality and timeliness of medical care.

1.2.1 Quality as fitness for use
Juran’s primary definition of quality is “fitness for use” (Juran, 1989). This somewhat peculiar definition implies that more is not necessarily better. Instead, the paramount focus should be patient needs and expectations. Quality as “fitness for use” provides a conceptual guide for caregivers to focus attention on what is “fit” for the patient in his or her current circumstances and helps clinicians clarify what is needed to prevent “overuse”, “underuse” or “misuse” (Becher and Chassin, 2001). For example, patients do not want to undergo large or risky surgical procedures or diagnostic tests unless there is a reasonable probability of benefit to their healthcare condition. It is the healthcare workers’ professional responsibility to judiciously apply the fruits of medical science to that end. Most patients are realistic and do not expect miracles. However, it has been observed that healthcare professionals — possibly out of fear — sometimes prescribe tests, procedures and medications regardless of cost and without sufficient consideration of relevance and effectiveness (Chassin and Galvin, 1998; Schuster, McGlynn and Brook, 1998; Institute of Medicine, 2001, Chapter 8). On the other hand, situations also occur where healthcare administrators or funding agencies try to ration tests, procedures and medications. By establishing actual needs, clinicians should stay true to the principle that the only tests and medical procedures that should be administered, are those that contribute to satisfy these needs.
Juran’s definition of quality as “fitness for use” may offer clinicians a conceptual framework for thinking through how to provide better quality while reducing costs. As an example: more costly procedures do not necessarily imply better quality of life; one cancer patient may desire to live as long as possible and endure the hardships of chemotherapy, radiation therapy, and operative procedures; another cancer patient may wish to receive palliative care and spend the available time at home with the family. Obviously, the cost implications differ significantly. Every possible therapy within medical and ethical standards should be made available, but the final choice should be based on the principle of “fitness for use” for the particular patient.

Although “fitness for use” is the predominant definition, Juran realized a need for further subsidiary definitions, chiefly for economic reasons, and we will cover these in the next two subsections.

1.2.2 Quality as features
Juran further quantifies “fitness for use” in two different categories: quality as “features” and quality as “freedom from deficiencies” (Juran, 1989). Both have important implications for conceptualizing the quality of healthcare and helping to clarify the relationship between quality and cost. Quality as “features of a product or service” implies that more features lead to better quality. However, more features typically cost more. There are, or should at least be, two reasons to add features in healthcare. The first is the patients’ justifiable needs, the likelihood of improved health, and — ultimately — improved quality of life. The second reason is the state of the art of medical knowledge and technology. For example, in the past, coronary artery obstruction was treated with balloon dilatation. Today this procedure usually requires specially coated stents to be implanted as well, which adds significantly to the cost.

In the upper portion of Figure 1.1, we have sketched out the economic relationship between quality interpreted as features, cost, and revenues. In a fee-for-service system (Institute of Medicine, 2001, Chapter 8) and certain other pay systems, added features may have the following financial benefits to the provider: Better healthcare attracts more patients and produces more revenues, provided that the additional features are paid for, and typically, that margins are higher for more expensive features.

The definition of quality as “features of a product or service” forces us to make tradeoffs between quality and costs. Unfortunately, improved quality as “more features” often
is the only definition people implicitly have in mind when they talk about healthcare quality. Such a mindset causes many healthcare professionals, administrators, politicians and the general public to assume that reducing costs inevitably will force us to compromise quality. However, as we will discuss in the next subsection, that is not necessarily so.

1.2.3 Quality as freedom from deficiencies

Juran’s second subsidiary definition of quality as “freedom from deficiencies” has the opposite cost implication (Juran, 1989). Fewer deficiencies cost less! Costs are reduced if we succeed in lowering the number of deficiencies: e.g. fewer medication errors, rejected products, lost paperwork, missing X-rays, rework, delays, fewer hospital acquired infections, and lost materials due to failures and mistakes. The focus of this definition is typically not on the “product or service” as in the “features” definition, but is related primarily to processes, either clinical or administrative.

Figure 1.1: Graphical summary of the main economic relations of quality defined as “features” and “freedom from deficiencies”.

![Graphical summary of the main economic relations of quality defined as “features” and “freedom from deficiencies”](image-url)
As indicated in the lower portion of Figure 1.1, the reduction of deficiencies in healthcare and administrative processes results in many cost reductions at all levels in the organization.

As in manufacturing, efforts intended to improve the “production” process of healthcare services (that is: healthcare delivery) invariably lead to lower costs for the provider. But there is also a crucial difference between manufacturing and healthcare that has further cost implications. For instance, if the number of rejected cars at the end of a production line is reduced from 20 to 2 percent, costs related to rework will be significantly reduced. However, with effective outgoing inspection, the customer will experience only cars that meet given quality standards. In healthcare, if 20 percent of the operations in a hospital are not successful, it directly affects the patients. Failures, defects and rework in healthcare processes, are synonymous with complications, inconvenience, waiting and delays, morbidity and mortality rates. Thus, in healthcare deficiencies not only increase costs but also reduce the quality of care, and always impact the patients adversely. For example: postoperative wound infections result in costly lengthened hospital stays and the risk of death. In healthcare, the patient and the product are one and the same; the customer (i.e. the patient) is intimately involved in the delivery process (Van den Heuvel et al., 2006). Consequently, in healthcare there is a direct loop from improved process quality to improved healthcare product quality.

1.2.4 Examples of improving quality while reducing costs
So how do we improve quality of healthcare while reducing cost? In this subsection we provide already a few concrete examples of the use of Lean Six Sigma, a data-driven scientific approach to quality improvement that has been popular in industry for some time. In the next chapters we will discuss Lean Six Sigma and its impact in healthcare in more detail. Lean Six Sigma’s main focus is on improving quality while reducing cost. Lean Six Sigma has lately also been used with success in healthcare (De Koning et al., 2006). Its main strength is the application of a scientific and data-driven approach to problem solving and its use of a broad spectrum of quality improvement tools and techniques, many of which are statistical. Improvements are achieved by a team based, project-by-project approach involving hospital employees trained in the Lean Six Sigma methodology. From a database of more than 500 successfully completed projects in thirteen medium or large hospitals in the Netherlands a few examples are given. These projects focused on improving processes, clinical as well as administrative, either by reducing the number of deficiencies or by reducing non-value adding
activities. Each project has produced savings of at least €20,000 and some projects saved more than a million euros.

Some examples are:

1. Reducing the length of stay for COPD patients from 10 days to 7.5 days (Bisgaard and Does, 2009)
2. Reducing the number of errors in invoices from 10% to less than 1% (Van den Heuvel et al., 2005)
3. Optimizing the utilization of operating rooms by reducing the delay in start-time by 50% (Does et al., 2009)
4. Increase the availability of infusion pumps in a hospital to 100% while reducing the total number of infusion pumps by 20% (Kemper et al., 2009)
5. Improved staffing of nurses in the maternity ward by aligning the right people to the right job and reducing the number of temporary workers (Wijma et al., 2009)

Money saved in these projects was used either to reduce budget shortfalls, or to reinvest in quality features, innovations or new equipment.

1.3 The challenges of measuring healthcare quality

Quality of healthcare has many facets and can be measured in many ways. Unfortunately, this is done in a non-standardized way by multiple organizations in the Netherlands. A weekly magazine called Elsevier started publishing hospital rankings in 1997, based on expert opinions from general practitioners, physicians, nurses, managers and board members (Hen et al., 1997). The Dutch Healthcare Inspectorate developed an ever-expanding quality performance indicator (PI) list that hospital staff are obliged to measure and report to the inspectorate. The reported results are rarely verified, however, so reliability is dubious. A Dutch newspaper yearly publishes hospital rankings based on selected Healthcare Inspectorate quality PIs, multiplied by the newspaper’s own weighting factor (Geenen and Wessels, 2004). Patient organizations developed their own specific quality PIs related to explicit diseases, such as diabetes, breast cancer, and colon carcinoma (NPCF 2010; Ronde and Smit-Winterink, 2003). Healthcare insurance companies followed with their attempts to measure quality based on quality PIs, i.e. specific indicators developed by patient organizations and the Consumer Quality Index (Stubbe et al., 2007). In 2011 a yearly guide (Dr. Yep) was published for the first time, ranking hospitals based on information provided by staff, the Healthcare Inspectorate PIs, and mystery guest experiences (Dokter et al., 2011).
Another recent attempt from 2010 is the combination of Elsevier’s revised list based on public data such as the Healthcare Inspectorate PIs with treatment admission times.

In this information labyrinth a hospital can get very different scores, depending on the survey. In Figure 1.2 we illustrate this phenomenon by a scatterplot of the rankings from Elsevier and the Dutch newspaper (AD). Since criteria of one survey can also change from year to year, this alone may cause differences in the ranking, even without real changes.

![Figure 1.2: Scatterplot of rankings of two different surveys.](image)

Surveys invariably claim to measure healthcare quality, however, leaving patients confused by inconsistencies and ever changing rankings. Despite this claim, Lingsma (2010, pp.240-242) concludes that the Dutch general public has access to different process and outcome measures, none of which represents quality of care. In this section, we introduce a framework and an organizational setting for measuring healthcare quality that provides standardized, valid and reliable information to the public.
1.3.1 Lessons learned from financial accounting

Pronovost et al. (2008) state that reporting on quality measures in healthcare is like the Wild West, dramatically different from financial reporting. They suggest that healthcare managers could learn from the generally accepted accounting principles in the United States of America (US GAAP) as a model to develop a public healthcare-quality reporting system (Pronovost et al., 2007). Porter and Teisberg (2006, 2007) argue that unbiased and reliable public reporting is the only way to expect a value-based competition on results and in turn affordable high-quality healthcare. To better understand the Pronovost analogy, the GAAP’s purpose is to assure the public that stocks represent the value as stated, and that the information provided by the company can be trusted. GAAP’s role is an external one relative to the stakeholders and the public, and its information pertains to the company’s economic performance reported in the income statement and the balance sheet. To assure that the external financial reporting is trustworthy, the US Financial Accounting Standards Board (FASB) and the European International Accounting Standards Board (IASB) develop standards and rules independently (IASB, 2010). Furthermore, the company is required to hire an outside independent agent, a certified public accountant, to go over the books and verify that the numbers indeed represent reality and performance. This external reporting function is parallel to the quality assurance (QA) function in a quality management system (QMS).

Jayaraman and Rivenson (2008) argue that healthcare is more complex than financial services and that information conveyed in external reports may lack the details required by internal reports and vice-versa. No modern business management team, however, relies on the external financial statement for day-to-day operations. Thus, firms have a parallel internal management accounting system providing detailed information that does not follow GAAP and seldom, if ever, is shared with the public. As in financial management, a QMS incorporates an internal information method that does not necessarily follow any external reporting standards but helps managers to control and to improve quality. To obtain valid and reliable information, we explore the analogy between financial and quality management to organize structure and to provide external reporting on healthcare quality for the public. We provide a brief quality management principles overview as the primary quality-information source. Then we take a closer look at the relationship between quality management and external reporting, known as QA. We provide a framework for measuring healthcare quality and suggest an organization to provide this information to the public.
### 1.3.2 Quality management and measuring quality

According to Juran (1986), the three quality management’s principles are: quality planning; quality control and quality improvement (the Juran Trilogy). We discuss these three principles and look at them as quality information sources to support QA.

**Quality planning:** to improve healthcare, it is not sufficient to eliminate deficiencies, reduce medication errors and eliminate delays, et cetera, by just doing projects. The objective of quality planning (QP) is to design new products, processes and services without deficiencies (Juran, 1988). An example is the introduction of a new computer system for medication prescription and distribution support, to reduce medication errors. QP can be done in a structured manner, by systematically looking at healthcare markets, patient’s demands and present healthcare specifications. The specific path to be followed and the information needed to get to a newly designed healthcare product are unpredictable, which means that the information generated in the quality planning process is specific, time dependent and closely related to unique questions. Therefore, this information is generally not useful for public reporting.

**Quality control:** this is the managerial process that provides stability, to prevent adverse change and to maintain the status quo (Juran and Godfrey, 1999). All employees, from the hospital floor workers to the CEO, exercise control. The only difference is the subject and control exercised by different groups. Healthcare professionals typically control products and processes related to the unit in which they work. Executives control budgets, revenues, costs, et cetera. The information needed to exercise control includes PIs that are well known in every hospital. Performance can be measured from financial, production, efficiency, logistic, personnel, quality and safety perspectives. Complications, postoperative infection rates and pressure sore incidence are popular. It takes effort to design an information system for controlling a specific department. Control of a nursing department, for instance, is different from control of a fully automated production line. Information related to quality control (QC) may be of interest to external stakeholders. Special attention is required when detailed QC information from varying departments is aggregated and simplified to fit public reporting using a single indicator.

**Quality improvement:** this is the most important function to establish an ongoing healthcare organization, which needs to be done via projects. In the Netherlands we have more than ten years experience with implementing Lean Six Sigma in healthcare (Van den Heuvel et al., 2006 and Does et al., 2006). From this experience, we know that information
required for quality improvement (QI) differs from project to project. After closing a project, much of the collected data can be skipped, because different data is required to preserve the improvements and to control the process. Information to perform QI projects is highly specific, costly to gather and only useful for a short period. Therefore, this source is unsuitable for providing healthcare quality information to share with the public.

1.3.3 Quality assurance
Quality assurance (QA) activities provide evidence to establish confidence that quality requirements will be met (Gryna et al., 2007). Juran pointed out that QC and QA have much in common (Juran, 1977). Both evaluate performance and both compare performance to targets. QA’s main purpose is to verify that control is being maintained. Performance is evaluated after operations and resulting information is provided to the operating forces and others needing to know, including senior managers, corporate staff, regulatory bodies and the general public (Juran and Godfrey, 1999). Juran (1977) articulated the need for QA as an external function to complement the Juran Trilogy’s internal management role. He also suggested that the financial function provides a useful managerial model for the quality function to emulate in job description and organization terms.

1.3.3.1 How to report quality information
There are several ways in which quality information can be presented. The first and most obvious are PIs. It is tempting to use PIs because they have a precise and concrete aura. These two supposed virtues will most likely lose their attraction after an aggregation process through different departments and several hierarchical layers. The natural response is to add more and also more detailed indicators. The extra indicators rarely provide more insight; on the contrary they are likely to produce more confusion. Additionally, based on Shewhart’s work, we can demonstrate that hospitals with the same performance levels can produce different PI values owing to common cause variation (Mohammed et al., 2001). Comparing these hospitals in a league table format would, therefore, be meaningless because random variation is the only explanation for different scores.

The second way to present quality information is QMS certification. Compliance with the ISO-9000 standards, for example, provides confidence that hospital managers have a well-functioning QMS (Marquardt, 1999 and Van den Heuvel et al., 2005). Certification, however, does not guarantee healthcare quality.
The third way is accrediting the entire or parts of the healthcare organization. Accrediting a healthcare institute by the Joint Commission in the US or the NIAZ in the Netherlands, for instance, supports QMS’s existence and functioning, and provides guarantees that professional standards are followed. A recent study demonstrated that implementing a surgical safety checklist containing various professional standards in six Dutch hospitals was associated with a significant reduction in surgical complications and mortality (De Vries et al., 2011). So, following standards enhances quality, and demonstrating that standards are met is a strong QA instrument. Certification and accreditation have in common that a third party verifies that an organization meets standards. The conclusion is fairly simple and transparent to the public: the organization does or does not comply with the standards.

1.3.3.2 Different healthcare QA information

Based on the input-process-output model and the quality definitions of Garvin and Juran, we identified five types of quality that can be measured to provide healthcare QA information (Boulding, 1956 and Garvin, 1984).

1. **Input quality** has to do with materials and professionals involved in healthcare processes. Well-trained personnel are expected to deliver better quality and a better hip prosthesis is expected to last longer. Serious quality problems related to prostheses have been described, for instance, in cardiac surgery (Graaf, 1992). Most QMSs pay attention to this type of quality and it can be best made explicit by an ISO certification (Van den Heuvel et al., 1998).

2. **Healthcare process quality** has to do with well-designed healthcare delivery processes and flawless performance. This quality can also be best made explicit by certification or accreditation. Unlike industry, the patient is an active participant in the healthcare production process. Therefore, some process PIs can provide relevant information. Admission and waiting times, rework and medication errors are process PIs that are relevant to future patients (Van den Heuvel et al., 2006). These indicators are not relevant to a person buying a product in industry; he is not interested in the way the production process performs provided that product quality is excellent.

3. **Healthcare product quality** has to do with the situation that exists at the moment healthcare delivery is completed. Has the treatment been performed according to professional standards? Were there adverse events or complications and treatment side effects? Because the patient is part of the healthcare process and the healthcare
product (e.g. owning a new hip), there is some overlap between healthcare process and healthcare product quality. The best way to establish healthcare product quality is to assess the patient’s healthcare status after treatment is completed. Reporting healthcare product quality is best done using PIs. When healthcare product quality items are closely related to the healthcare process (proper medical and nursing procedures have been followed), certification and especially accreditation such as the Joint Commission Accreditation are also appropriate.

4. **Health gain** is quality which can be defined similarly to reliability used in engineering, i.e. the probability that a machine performs, for instance after repair or maintenance, as intended under specified operating conditions for a specified time. Reliability, therefore, is quality over time (Condra, 1993). Similarly, health gain could be defined as the therapy related reduction of complaints and limitations over time. So, if a patient gets a hip arthroplasty then the health gain would be how long and under what kind of limitations the patient lives with the (best possible) prosthesis implanted; the best possible operating procedures were followed and after that the best care was given, until complaints return. The next question would be: what are the scores of the hospital and physician I intend to visit and how do they relate to the best possible result. This would provide an excellent quality PI. Who wouldn’t want to know this before going to a physician? Although highly relevant, this information is hard to collect. It requires ongoing, longitudinal yearly measurements that cost a lot of money. Aggregation is hardly possible because there is no value in averaging an excellent and a poorly performing physician. Furthermore, the information is prone to being outdated after every innovation, such as a new prosthesis or a new surgical procedure. We consider this information the most relevant of all five quality types but, unfortunately, the most difficult to obtain.

5. **Patient/client satisfaction** can be measured using questionnaires or interviews. This information can be obtained at reasonable costs and is especially relevant for improving services for patients/clients as well as for QP. The relevance to QA is limited except to provide service-quality information.
### 1.3.4 Reporting, relevancy and availability

We now provide a framework for reporting the different types of quality information of the previous section. The quality types are shown in the first column of table 1.1. In the second and third columns we show how healthcare quality can be measured and be made explicit for comparison by certification/accreditation and PIs respectively. In the fourth column we estimate the relevance to the public, and in the fifth column we estimate the availability of the healthcare information.

The number of “Xs” in Table 1.1 represents scores. One “X” in the certification/accreditation or PI column means: it is not suitable to measure this type of quality and five “Xs” means: highly suitable. In the relevance and availability columns, one “X” means very low and five “Xs” mean very high.

In subsection 1.3.3.2 we identified five quality types that can provide healthcare quality information. Four are embedded in the QMS and information is available. Health gain is not or seldom part of the QMS and this information is scarce. Unfortunately, health gain information is also the most relevant to (potential) patients. We therefore have to realize that the most relevant quality information for patients is at the same time the least available.

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**Table 1.1:** Reporting different types of quality, relevance and availability (from X = minimum to XXXXX = maximum).

Information tapped from the QMS has to be processed or at least aggregated to become relevant to the public. Two physicians, one excellent and the other poorly performing, demonstrate that aggregation deteriorates the information. Lingsma (2010, p.49) found that apart from differences in quality of care, the larger part of the observed differences between
hospital’s quality PI scores can be attributed to random variation, patient characteristics that were not adjusted, residual confounding owing to imperfect case-mix correction, and registration bias. She concluded, therefore, that no outcome indicators currently used are suitable for ranking hospitals. Given these quality PI imperfections, one could imagine that QMS certification, like ISO-9001:2008 or healthcare system accreditation like the Joint Commission, might provide better transparency and assurance to the public than current quality PIs.

1.3.5 Organizing quality assurance

Developing valid, reliable and relevant information to measure quality is only one QA aspect. The other, also suggested by Pronovost et al., (2007), is to set up an organization to produce this information. We recognize five activities to organize QA:

1. **Determining which quality PIs are required to provide the most reliable and valid healthcare quality picture.** This is a challenge given the current PIs’ poor validity and reliability. So, better PIs have to be developed. Furthermore, the process of inventing new PIs and updating existing ones has to be ongoing.

2. **Determining the rules regarding how each PI has to be measured.** In pressure ulcer cases, one could for instance exclude the child department or measure and report only departments (like the ICU) that are prone to pressure ulcers. Also, schemes for measuring pressure ulcers have to be designed to reduce registration bias. Guidelines are needed to determine which patients have to be included in order to reduce random variation. Finally, strict rules have to relate to case-mix adjustments.

3. **Measuring PIs by healthcare organization staff.** Preferably these measurements are performed and incorporated in the ordinary quality management process. Given the right PI’s and rules, registration bias has to be reduced in this step.

4. **Verifying results and measurements independently comparable with certified public accountants’ work.** A management letter can be produced that gives an impression of the total quality measuring process. This can be added to the final quality information publication.

5. **Aggregating and transforming quality information into an overall hospital score on one or more dimensions.** This process also needs specific guidelines, for instance on weighting factors and external verification otherwise some quality information might look useful but in fact is worthless.
The Dutch Healthcare Inspectorate covers the first two activities. They recommend PIs and guidelines for measuring them. There is debate between the Inspectorate and medical specialists about relevancy and validity, because the indicators are also used to judge physicians and hospitals. To prevent this counterproductive debate, service quality PIs have to be developed and defined by boards of independent experts, like the FASB and the IASB do for accounting rules. Indicators used to evaluate a hospital by the Healthcare Inspectorate will most likely differ from indicators that are valuable for informing the public. So, the ultimate goal producing and publishing an indicator has to be perfectly clear. To deal with the last two activities, verification and aggregation, independent organizations, comparable to accountancy firms in the financial world, are required. When we look at certification and accreditation, the situation is more mature. There are organizations engaged in developing QMS standards and safety management systems and these standards have been customized to healthcare (ISO, 2001). Also there are independent organizations that can execute certification or accreditation and provide specific certificates. Perhaps this situation is an additional and a strong argument for stimulating certification and accreditation as healthcare QA instruments.

1.4 Contributions and outline of the thesis

In the current debate about the escalating healthcare costs, it is typically assumed that there is a tradeoff between quality and cost of healthcare. This misconception is rooted partly in confusion about the definition of quality. Such misconception may impede progress in improving the management of healthcare and paralyze leadership. In section 1.2 we discussed quality management concepts and strategies for improving quality while halting the escalating costs of healthcare. In particular, we discussed how defining quality as “fitness for use” with the two subsidiary definitions of quality as “features” and as “deficiencies” conceptually help us understand the relationship between quality and costs. The “freedom from deficiencies” definition offers an opportunity for clinicians to redirect the focus to initiatives that will increase quality while reducing costs. Agreements on reinvestment priorities can be made before initiating a given project. This will enhance the participation and facilitate input from clinicians, which is essential for success of any project related to healthcare delivery. Section 1.2 is based on a paper, which was published in the Quality Management Forum (Does, Van den Heuvel, De Mast and Niemeijer, 2010).

In section 1.3 we support the view that public reporting on healthcare quality needs major improvements comparable to financial reporting. Information on healthcare quality can
be derived from the quality management system of the institution. Performance indicators related to health gain, which provide the most valuable information on healthcare quality for (potential) patients, have to be developed further. Independent organizations need to develop the right healthcare quality performance indicators and rules to measure them in a standardized way. Also, possibly other, independent organizations, comparable to accountancy agencies, are required to verify and validate the scores of healthcare institutions. It remains intriguing that we invest enormous amounts of money to verify financial information and we do not invest very much in verifying healthcare quality data, despite the fact that worldwide we spend billions on health care. Finally, we believe that certification and accreditation can play a more prominent role in public reporting on healthcare quality. This section is based on a paper, which appeared in the *International Journal of Health Care Quality Assurance* (Van den Heuvel, Niemeijer and Does, 2012).

The twentieth century saw an incredible development of professionalism in organizations. Besides the impact of technological advances, innovations in management structures and methods have resulted in the highly productive organizations of today. When the race for outperforming competitors on quality and efficiency gained momentum, companies started to copy each other’s best practices. Consultants and management gurus quickly jumped in and started giving names to these methods: total quality management, just-in-time, business process reengineering, statistical process control, quality circles, lean manufacturing, continuous improvement, et cetera. Time has singled out the methods, principles, and approaches that really added value. While most approaches have been presented as panaceas at one time or another, time has shown that they are in fact complementary. In this thesis we will use the Lean Six Sigma approach.

Lean Six Sigma is not revolutionary; it is built on principles and methods that have proven themselves over time. It has incorporated the most effective approaches and integrated them into a full program. It offers a management structure for organizing continuous improvement of routine tasks, such as manufacturing, accounting, nursing, sales, and other work that is done routinely. Further, it offers a method and tools for carrying out improvement projects effectively. In an economy that is determined more and more by dynamics than by static advantages, continuous improvement of routine tasks is a crucial driver of competitiveness.
Optimizing healthcare efficiency appears to be an imperative. Healthcare process improvement can produce reductions in costs while increasing quality and thus producing the required efficiency improvements. Lean Six Sigma is a process improvement program developed in industry. However, in recent years it has also been applied by a number of healthcare institutions. Lean Six Sigma is a project oriented problem solving approach that deploys five rigorously followed problem solving phases - Define, Measure, Analyze, Improve, and Control (DMAIC). Program management consist a Lean Six Sigma director, program managers (daily management), and Lean Six Sigma master black belts (knowledge resources). Project management consist a champion (project owner) and a black belt or green belt (project leader), and the team members are experts and shop floor personnel.

The subject of Chapter 2 is to create actionable knowledge, making the definition of process improvement projects in healthcare delivery more effective. The study is based on a retrospective analysis of process improvement projects in hospitals, facilitating a case-based reasoning approach to project definition. Data sources were project documentation and hospital performance statistics of 271 Lean Six Sigma healthcare projects from 2002 to 2009 of general, teaching, and academic hospitals in the Netherlands and Belgium. Objectives and operational definitions of improvement projects in the sample were analyzed and structured in a uniform format and terminology. Extraction of reusable elements of earlier project definitions will be presented in the form of nine templates called generic project definitions. These templates function as exemplars for future process improvement projects, making the selection, definition and operationalization of similar projects more efficient. Each template includes an explicated rationale, an operationalization in the form of metrics, and a prototypical example. Thus, a process of incremental and sustained learning based on case-based reasoning is facilitated. The quality of project definitions is a crucial success factor in pursuits to improve healthcare delivery. By offering nine tried and tested improvement themes, related to patient safety, patient satisfaction, and to the business-economic performance of hospitals, we hope to contribute to this goal. Chapter 2 is based on a paper, which appeared in Quality Management in Health Care (Niemeijer, Does, De Mast, Trip and Van den Heuvel, 2011)

In the next chapters we describe two important generic projects in more detail. The empirical bases for these chapters are our own experiences in a number of hospitals we have worked for. Therefore, we have applied the longitudinal case study research method. This
method can be defined as an empirical study that investigates a contemporary phenomenon (Yin, 2009). Chapter 3 discusses an efficiency improvement project at a level I trauma center in the Netherlands, using measurements of inappropriate hospital stay from 2008 through 2010. The effect of reducing inappropriate hospital stay is to decrease the length of stay (LOS). But in contrast to LOS, inappropriate hospital stay does not depend on the complexity of the patients. The efficiency improvement project was carried out along the lines of the Lean Six Sigma program. The corresponding article appeared in the *Journal of Trauma* (Niemeijer, Trip, Ahaus, Does and Wendt, 2010).

Chapter 4 treats the subject of reducing overuse of diagnostic tests in hospitals. The data are from 2008 through 2011. As a result of the Lean Six Sigma project, the average number of diagnostic tests per treatment decreased significantly, without changing treatment guidelines. Patient’s benefits are less exposure to potential adverse effects from the tests itself. This project has shown that Lean Six Sigma enables physicians to produce systematic and continuous quality improvement by reducing waste and costs. An article on this subject will appear in *Quality Engineering* (Niemeijer, Trip, Ahaus, Wendt and Does, 2012).

In Chapter 5 we study the usefulness of Lean Six Sigma for the development of a multidisciplinary clinical pathway for hip fractures in the elderly, with the aim of improving efficiency of care and reducing the length of stay. The related paper has been submitted to the *Journal of Evaluation in Clinical Practice* (Niemeijer, Flikweert, Trip, Does, Ahaus, Boot, Wendt, 2012).

Finally, in the last chapter we evaluate the results of the implementation of Lean Six Sigma in the second largest hospital in the Netherlands, one of the eight hospitals with a university medical department for education and research. This hospital started the implementation in 2007 and we are able to review the results of a five years’ period. We will also discuss more detailed results obtained in the Department of Traumatology. The corresponding article has been submitted to *Quality Management in Health Care* (Niemeijer, Trip, De Jong, Wendt and Does, 2012).