Quality Engineering, 21:222–228, 2009

ISSN: 0898-2112 print/1532-4222 online
DOI: 10.1080/08982110902740325

Taylor & Francis
Taylor & Francis Group

Quality Quandaries*: Efficiency Improvement in a Nursing Department

Jeanet Wijma[1], Albert Trip[1], Ronald J. M. M. Does[2], Søren Bisgaard[2,3]

[1]University Medical Center Groningen, The Netherlands
[2]Institute for Business and Industrial Statistics, University of Amsterdam, The Netherlands
[3]Eugene M. Isenberg School of Management, University of Massachusetts, Amherst

INTRODUCTION

In The Netherlands, pressure to improve efficiency in health care has increased year by year. Historically, hospitals and other care providers could easily compensate for financial losses simply by requesting more money from the government and insurance companies. However, these parties are no longer as generous as they used to be. Additional costs of health care are directly paid via taxes and insurance premiums, so the citizens directly experience the burden. Furthermore, as many other countries in the Western world, the Dutch population is ageing! They require more and longer care. New medical treatments have become available for more diseases, and new equipment and medicines have been developed, leading to ever increasing costs. These, and related developments, have forced health care professionals, administrators, and government officials to think differently, to change drastically, and to adopt proven business practices from industrial and service organizations.

In the past years, a few hospitals in The Netherlands have adopted Lean Six Sigma (LSS), not only for quality improvement, and not just to deal with clinical and medical issues, but more generally for business improvement and in all areas of operations (Does et al., 2009). The documented success of these early adopters has motivated the University Medical Center in Groningen (UMCG) to use LSS as the approach to quality improvement and cost reduction. All university medical centers (UMCs) in The Netherlands have been mandated by the government to render top medical care. The UMCG is the only UMC in the northern part of The Netherlands, a relative large area with a population of nearly 2 million people. With 1,300 beds, 115,000 out-patient clinic visits per year, an annual budget of €750 million, and approximately 10,000 employees, the UMCG is the largest employer in northern Netherlands.

In 2007, the UMCG started to implement LSS. In the first wave, 22 LSS projects were selected, and 12 Black Belts (BBs) and 16 Green Belts (GBs) were trained. In 2008, a second wave of 7 BBs and 39 GBs enrolled in the program. In total, approximately 90 projects were initiated during the first $1\frac{1}{2}$ years of the implementation. Typical LSS projects in a hospital focus on length of stay, appropriate use of medication, better use of operating rooms, and nursing efficiency (Does et al., 2006). However, improving the administrative infrastructure also provides rich opportunities for effective

*Edited by Søren Bisgaard

Address correspondence to Søren Bisgaard, Eugene M. Isenberg School of Management, 121 Presidents Drive, Amherst, MA 01003. E-mail: Bisgaard@som.umass.edu

LSS projects; for example, distribution, purchasing, use of energy, use of information and communication technology, administrative and financial processes, etc. The LSS projects conducted at UMCG were selected from all parts of the organization; nothing was spared.

THE LSS APPROACH

One of the key reasons LSS has been so successful is not the use of sophisticated statistical tools. It is the management and organizational framework; see De Koning et al. (2006). Therefore, it is important to understand how LSS works from an organizational point of view. As a summary of the LSS approach adopted by UMCG, we briefly outline a few core principles. All LSS projects are strictly required to follow the same structure (George, 2003). The five phases of a project are the DMAIC steps:

- Define: Specify project objectives.
- Measure: Define and validate the measurements.
- Analyze: Analyze the problem and identify influence factors.
- Improve: Establish effects of influence factors and define improvement actions.
- Control: Implement improvements, assure quality, and close the project.

Projects are carefully scoped so that the estimated lead time of a project will be no more than 4–6 months. In this time frame, the control phase is often excluded; the actual implementation may generally require activities or decisions beyond the control span of the BB or GB team. In other words, the team remains responsible for the entire implementation and transfer to operations, but it would be counterproductive to hold it responsible to a short and rigid time schedule for the implementation, checking, and working out the kinks. Sometimes new software or investments are required. The implementation may even require a culture change to be fully effective—something that takes time. As an aside, LSS does not directly seek culture change. Such an approach is often doomed. Rather, we seek to make tangible operational changes, and culture changes then naturally follow.

The champion of a project is the "problem owner"; i.e., the person within the organization with responsibility and accountability for the problem. The formal structure is that the champion "hires" a BB or GB team to diagnose the problem and develop effective solutions that, when implemented, will improve the process. After the improve phase, the champion decides how to continue. Implementation, or the control phase of the project, can only start after a formal approval from the champion.

The LSS organization established at UMCG is sponsored by the board of management; see Figure 1. The director of human resources is the LSS program director at the UMCG. She reports directly to the board and is assisted by a Master Black Belt (MBB). The role of the program director is to evaluate and select new BBs/GBs and new projects and supervise the day-to-day management of LSS programs throughout the organization. The day-to-day administration, and especially coaching of the BB and GB teams, is the main responsibilities of the MBB. An external consulting firm, in this case the Institute for Business and Industrial Statistics (IBIS UvA) affiliated with the University of Amsterdam, is responsible for the training of new Belts and for formal project reviews. As a general rule, BBs spend most of their time on LSS; they are primarily selected from the staff. BB projects are, as a general rule, of larger scope, may span across departmental barriers, and often require the involvement of multiple units. The expected annual threshold savings target for initiating a BB project is €100,000, and for a GB project it is €50,000. GBs are selected from the line (doctors, nurses, and managers); they often spend 1–2 days per week on a project. GB projects are, typically, of more local scope and often

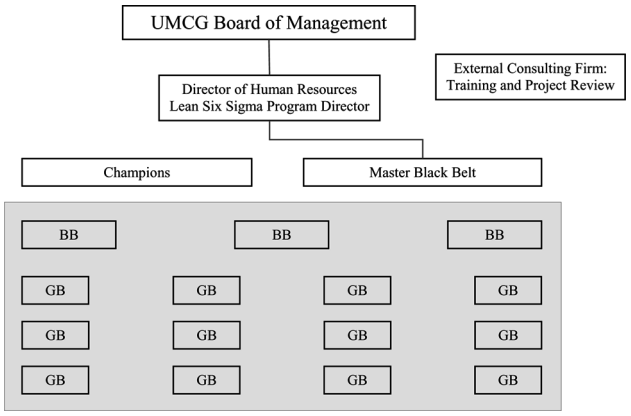


FIGURE 1 **The Lean Six Sigma organization at the University Medical Center in Groningen, The Netherlands.**

involve the teams own process. Line management is responsible for selecting GBs, team members, and their projects.

NURSING EFFICIENCY

As indicated in the introduction, the ageing population in The Netherlands is a primary driver of the growing demand for health care. However, as a related effect, there is, at the same time, a reduced supply of nurses, the health care professionals who primarily deliver health care services to an ageing population. This constitutes a serious dilemma! Hospitals have to compete with other sectors of the economy in a shrinking labor market. It is feared that there will not be enough nurses in the future.

Meanwhile, the UMCG management had, for some time, suspected an imbalance of supply and demand of nurses in the current staffing of nursing departments. After careful debate and based on the core principle of carefully selecting projects that are clearly aligned with organizational strategy, management selected nursing efficiency in the maternity ward as a pilot project for the first wave of the LSS rollout. The manager of the Women's Hospital was made the champion of the project. To prepare her for the task, she received a half-day champion training before the project started. The BB selected for this project was a senior nurse. She conducted the project as part of her BB training, which lasted from August 2007 through January 2008.

In the following sections we briefly summarize the steps taken in the case of improving the efficiency of the nursing at the UMCG using the five stages of define, measure, analyze, improve and control framework.

DMAIC STEP-BY-STEP: THE NURSING EFFICIENCY PROJECT

Define

The summary in Figure 2 provides the objectives of the nursing project.

To develop an overview of the process, the team used an SIPOC analysis (supplier-input-process-output-client); see Figure 3.

The primary focus of the maternity ward is the treatment and care of the mother and her baby, before, during, and after birth. The management

Project description:	Develop a design for the organization of the Nursing Department K3, in which personnel's activities are aligned with education, job category and function.
Main benefit:	• Efficient use of personnel. • Reduction of labor cost.
Additional benefits:	• Reduce the problem of requiting and retaining qualified nurses. • Better motivated personnel.
Financial savings:	More than €100,000 through reduced labor cost.
Champion:	Mrs. R. Landeweerd, manager of the Women's Hospital.

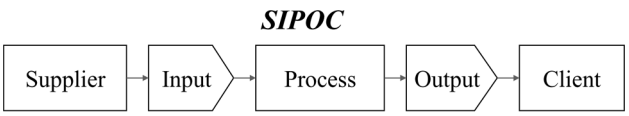
FIGURE 2 **Nursing efficiency project summary.**

and personnel of the department are the main stakeholders. As a precondition for conducting the project, it was agreed that any turmoil caused by this project should be handled with extreme care. The champion took this very seriously. She also handled "political issues," resource problems, and any other interfering issues so that the BB was allowed to concentrate on completing her project. The champion thoroughly informed the department, before, during, and after the project was completed and explicitly asked for everyone's cooperation and assistance.

The define phase concluded with the definition of a few critical-to-quality (CTQ) metrics, the LSS term for results-oriented measurement that describes the problem most adequately. The CTQ flow-down (De Koning and De Mast, 2007) is a useful tool to translate business objectives into measurements. See Figure 4 for the CTQ flow-down used in this project.

Measure

The operational definition of the CTQ is the critical link between theory and practice. For this project, it was decided that the primary CTQ was "activities



Suppliers:	General Practitioner, Midwife, Gynecologist
Input:	Woman in childbed
Process:	Nursing of mother and baby
Output:	Healthy mother and baby
Clients:	Mother, baby and supplier

FIGURE 3 **SIPOC analysis.**

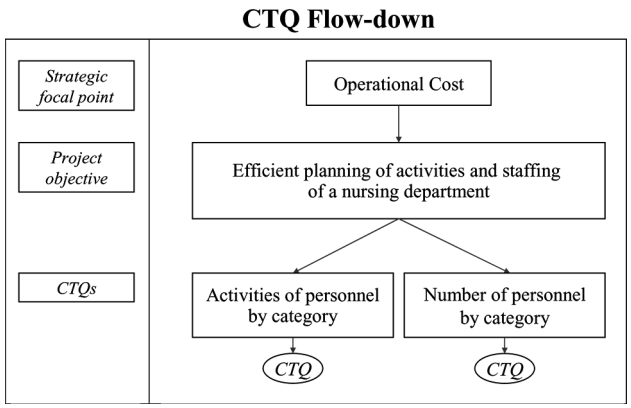


FIGURE 4 **CTQ flow-down for nursing efficiency project.**

of personnel" measured per shift. The BB defined approximately 10 different activities for each functional group and devised a simple measurement form (i.e., a data recording sheet). During a pilot period of 3 weeks, the form was filled out by samples of the personnel from different functional groups. A second CTQ, the "number of personnel," was also recorded per shift. This was done by simply counting the number of people present by category.

To guarantee valid data, the BB took a number of precautionary measures. Most important among these were

- Activities were defined jointly with the people concerned.
- A test was done to judge whether activities were well-defined and unambiguous.
- The first measurements were done by the BB; later samples were checked by either the BB or her substitute.
- The BB (or a substitute) was always available to answer questions.
- The extra work to fill out the measurement forms was limited to a minimum; it was sufficient to record the time that a new activity began. The BB performed the calculations.
- Monitors received a clipboard with a pen, instructions, and a digital watch.
- The measurement forms for different functions were color-coded.

Analyze

The data from a 3-week observational period are summarized in pie and bar charts showing the distribution of the total time for the different activities. The BB checked the variation between measurements within functional groups. It turned out that, for the most part, the variation was small. An example of the results is provided in Figures 5 and 6, showing a pie chart and a Pareto chart, respectively, of nursing activities.

Most noticeable, the plots show that nearly half of the nurse's time is spent on care, especially instruction and attendance, postpartum observation, and baby care. But more troubling, about half of a nurse's time is not spent in direct contact with patients (mothers and babies). In particular, administration and meetings take a significant amount of the time. In the terminology of Lean, such activities would, for the most part, be considered "waste" (see Liker, 2004); the added value for patients is not immediately clear.

Similar analyses were made for all functional groups at the department:

- Senior Nursing Officer
- Senior Nurse
- Nurse
- Nurse Assistant
- Nutrition Assistant
- Secretary

The second CTQ, the number of personnel present at any time, was easier to monitor. Combined with the above analyses, these data give a relatively complete picture of the activities in the department.

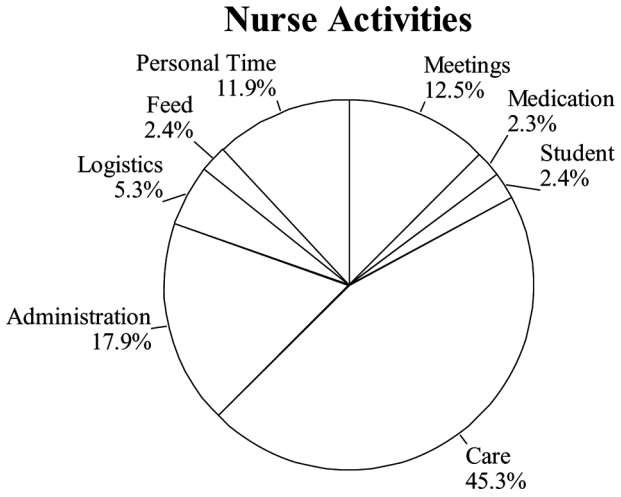


FIGURE 5 **Pie chart of the distribution of nurse activities.**

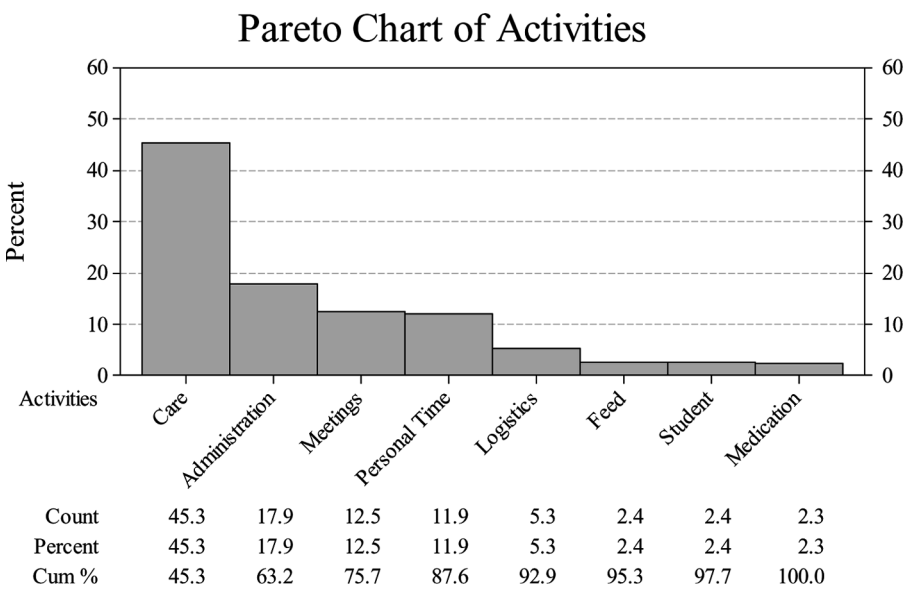


FIGURE 6 **Pareto chart of the distribution of nurse activities.**

Knowing these facts, the objectives of the project became more focused.

The analyze phase of the project was concluded with the identification of potential influence factors: all factors potentially influencing the CTQs. Some examples were shift (morning, afternoon, or night), day of the week, number of patients, experience of nurses, and planning. The team subsequently used one-way analysis of variance (ANOVA) and regression analysis to establish possible relationships. Factors within the control of the organization (e.g., personnel planning) can be used to improve the process. Noise factors (e.g., number of patients) are variables that are difficult to influence. The final category of influence factors are disturbances, which have a disruptive effect on the process (e.g., breakdown of the computer system). For disturbances the risks were evaluated with a failure mode and effect analysis (FMEA).

Improve

In this phase, the effects of control factors were investigated, to select the most important ones for improvements. The analysis of activities performed by the nurses showed that more than 30% of their time was used for administrative tasks and meetings (see Figures 5 and 6). For a more detailed picture, the BB focused in on these activities. Lack of structure in formal and informal meetings was identified as one major reason for wasted time. Another was the use of several forms for related information causing unnecessary and often frustrating redundancy. The improvements the BB proposed were to bring more structure to meetings, redesigning and streamlining the paperwork to remove redundancy. A "soft benefit," greatly appreciated by the nurses, was that time was freed up that allowed for professional development such as training, medical-ethical discussions, etc.

In line with expectations, better personnel planning also turned out to provide a major contribution for improved CTQs. It was agreed that a significant amount of administrative work previously performed by nurses could be done as well by administrators. These were activities that did not require the education and skills of registered nurses (RNs); in fact, they were done much better by administrators. Other activities could be shifted to nurse assistants (NAs); the department could be run by fewer senior nurses as certain nursing tasks were transferred to regular nurses. This better and more rational alignment of work and labor supply turned out to be much cheaper for the department. Furthermore, and not unexpectedly, it also provided much better job satisfaction for the nurses. The yearly costs of the nursing department were estimated to be reduced by €147,000 after implementation. The study also showed that further

cost reductions of €53,000 were possible if temporary workers were used only if necessary.

Control

Often, in pre-Six Sigma time, organizational changes were suggested and implemented because someone in authority thought it would be a good idea. Such ideas may be well thought out. However, suggestions for improvements that emanate from a carefully conducted Lean Six Sigma study are different. They are not just frivolous suggestions but underpinned by solid data and sound analysis. Moreover, as in this case, the champion was directly responsible and accountable for the department's budget and therefore had a direct interest in aiding a successful and effective implementation.

After the successful Lean Six Sigma project in the maternity ward, the manager of the Women's Hospital decided to apply the same method to other nursing departments throughout the UMCG. In the second round, four new GBs were trained to clone the project throughout other departments under supervision of the BB. For example, the surgery department at the UMCG decided to clone the project at one of their nursing departments and sent a new GB to the training. Note that at the UMCG there are about 40 different nursing departments. With a potential savings per department of more than €100,000, this means very significant cost reductions and quality improvements.

CONCLUSION

LSS is a structured way of solving complex operational problems and stimulating organizational innovations. However, to be effective within an organization, LSS requires an organizational framework, with specific roles for champions and BBs/GBs and methods from project management to monitor progress and schedules. Core principles of the LSS approach are the strict use of the DMAIC roadmap, a scientific approach to diagnosing problems, finding effective solutions based on data, not just hypothesis, and deliberate analysis. The nursing efficiency case discussed above shows how LSS was employed in a potentially threatening situation involving many delicate human elements for patients and nurses alike. The BB, with careful consideration of the human aspects, potential fear of change, and many political traps, carefully used the LSS approach to collect objective measurements about the activities of the employees, basing the analysis on facts and data not just opinions while involving all in the process. Rather than deleting jobs, she deleted redundant and wasteful activities—activities that did not provide value to the patients, all of which, of course, is much easier to accept. The case shows that LSS can be used as an intelligent way of economizing while improving quality, patient care, and job satisfaction.

Health care professionals may have understandable hesitations about applying LSS to health care. Health care is a delicate business involving human health and lives, not just nuts and bolts. Many health care professionals may also have had prior and often traumatic experiences with statistics. The very word *statistics* sounds frightening. Just imagine your own reaction if you were told that your work will be monitored and your job changed by using statistics! However, appropriately applied and with careful consideration of the human element, resources wasted on redundant work, poor quality, unnecessary rework, etc., are resources that are not put to good use serving the needs of the patients and providing better, more affordable, health care. Moreover, in regards to statistical methods, it should be kept in mind that improving health care quality and reducing costs does not necessarily involve very sophisticated statistics. As illustrated with this case, it is in fact often relatively simple. The most important aspect of LSS is not the particular statistical method, test or analysis tool, but to get the data, plot them, and apply common sense. Data are like a catalyst for clear thinking and often greatly diminish the influence of the politics. Most importantly, as illustrated with this case, to be successful requires a certain minimum of rigor and discipline in the management of the projects.

ACKNOWLEDGMENTS

Søren Bisgaard's work was supported by the Isenberg Program for Technology Management, the Isenberg School of Management, University of Massachusetts Amherst. The work by Ronald Does was sponsored by the Institute for Business and Industrial Statistics at the University of Amsterdam, Amsterdam, The Netherlands.

REFERENCES

De Koning, H., De Mast, J. (2007). The CTQ flow-down as a conceptual model of project objectives. *Quality Management Journal*, 14(2):19–28.

De Koning, H., Verver, J., Van den Heuvel, J., Bisgaard, S., Does, R. (2006). Lean Six Sigma in healthcare. *Journal of Healthcare Quality*, 28(2):4–11.

Does, R. J. M. M., Vermaat, T. M. B., De Koning, H., Bisgaard, S., Van den Heuvel, J. (2006). Standardizing health care projects. *Six Sigma Forum Magazine*, 6(1):14–23.

Does, R. J. M. M., Vermaat, T. M. B., Verver, J. P. S., Bisgaard, S., Van den Heuvel, J. (2009). Reducing start time delays in operating rooms. *Journal of Quality Technology*, 41(1):95–109.

George, M. (2003). *Lean Six Sigma for Service*. New York: McGraw-Hill.

Liker, J. K. (2004). *The Toyota Way*. New York: McGraw-Hill.