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Process improvement in healthcare
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Citation for published version (APA):

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Download date: 14 Jan 2019
IMPACT OF FIVE YEARS LEAN SIX SIGMA IN A UNIVERSITY MEDICAL CENTER
In 2002 the Red Cross Hospital in Beverwijk was the first Dutch hospital to use the Six Sigma method (Van den Heuvel et al., 2005). The achieved results were enthusiastically published and promoted. Other hospitals were attracted, including the University Medical Center Groningen (UMCG). In 2007 the UMCG introduced the Lean Six Sigma methodology, aiming at cost reduction and quality improvement, and creating the financial possibility to develop innovations. The Traumatology department joined this program in 2008. A physician assistant was trained to be a green belt, with a project aiming at reduced loss of stay. The results of the project were promising, and the department decided to use the LSS approach for new improvement projects. In preceding chapters some of the projects were already described.

This concluding chapter based on Niemeijer, Trip et al. (2012) describes how LSS was introduced in the UMCG, and how it developed in the following years (section 6.1). Section 6.2 focus again at the Traumatology department, where the main processes have been analyzed and improved during the years 2008-2011. Both the approach and the results are briefly described. In the final section (section 6.5) we give our overall conclusion.

6.1 Introduction of Lean Six Sigma at the UMCG

A major intervention in an organization, such as introducing Lean Six Sigma (LSS), requires top management commitment. The introduction therefore started in 2007 with a half-day “champion training” for senior management, about basic knowledge of LSS and the specific role of managers/champions in the program. An external consultant was hired for training sessions to management and employees, and an external master black belt for support of the projects. Selected high potential employees from all over the organization were trained to become an LSS project leader: a fourteen days training for black belts (fulltime project leaders) and an eight days training for green belts (part-timers). These trainings explain the DMAIC roadmap, with the corresponding tools, and the students are
required to practice the new knowledge in a project. Projects were selected from all over the organization, ranging from length of stay and nursing efficiency, to energy saving, computer maintenance, and registration. Many projects aimed at solving really hard problems, such as improving efficiency of the operation theatre, or collective purchasing of implants.

The first experiences with the program were promising. Belts started enthusiastically, describing processes and determining relevant measurements: “Critical to Quality” parameters, or CTQ’s. Both elements were relative new to large parts of the organization. Process descriptions of patient treatments (critical pathways) existed, of course, but most management processes were just simply there. Many data were registered, but seldom according to generally accepted standards. As a consequence there used to be much confusion regarding measurements. Many key players collect their own data and their own version of reality, which is a major drawback for change. The value of an LSS project is that the context of a problem is clearly delineated and that valid, accurate and precise measurements are collected to quantify the problem. The medical doctors in the UMCG appreciated this kind of diagnosis to managerial problems.

Most of the projects proceeded according to plan in the analysis and improvement phases. Improvement actions were designed and the calculated results were realized. But the progress of several projects ended when the actual interventions were to be done. Later on a few reasons were identified:

- Interventions were beyond the scope of the champion.
- Internal budgets and oblique financial structure made interventions financially unattractive.
- Implementation depended heavily on external capacity (especially ICT capacity).

These reasons can be related to the specific organization of the UMCG: decentralized, divided into ten sectors and managed by sector managing directors. Medical departments are part of a sector, but with their own budgets and direct relations to the management board. The financial system is very complicated, with more than 1,000 sources of income (the ministries of Health and Education, the European Union, and insurance companies
being the most important ones). Internal finance is likewise complicated and not transparent. It is difficult to calculate cost prices of activities. When the LSS program started it was thought that the champion of a project was authorized to intervene in the whole organization. After all, the improvement actions were well grounded, based on scientific methods. But it turned out that this was a step too far: most managers did not allow interference at their departments from plans designed by others. The lesson was that for projects to be successful the scope should be limited to the organizational scope of the champion. And for large problems, with more than one manager (or decision maker) involved, concerted efforts had to be organized.

Notwithstanding some negative experiences with implementing improvements, management decided to continue using LSS as the method for efficiency and quality improvement. Many projects were successful in demonstrating that processes comprised wasteful activities. It became clear to management that these activities could be skipped without compromising quality of care, and at the same time saving money for the organization. LSS could indeed be used as a vehicle for judicious cost saving: see Wijma et al. (2009) for a project about nursing efficiency.

### 6.2 Development of Lean Six Sigma at the UMCG

During the first two years the in-house LSS trainings were given twice a year by the external consultant. He trained 82 employees: 19 black belts and 63 green belts. As mentioned before Black belts are fulltime LSS project leaders, usually staff members and green belts are temporarily assigned to LSS projects, usually two days per week, next to their normal work as manager, nurse or medical doctor. Up until 2011 there have been 163 official projects (Table 6.1), in nearly all parts of the organization, but with an emphasis on the primary process of patient treatment and care. The nursing efficiency and length of stay of every nursing department has been analyzed. The categorization of table 6.1 is based on nine generic project definitions (Niemeijer et al., 2011).
<table>
<thead>
<tr>
<th>Primary process of patient care</th>
<th>Frequency</th>
<th>Management and hospital organization</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase number of admissions</td>
<td>26</td>
<td>Reduce costs by reducing inventory</td>
<td>17</td>
</tr>
<tr>
<td>Improve capacity</td>
<td>19</td>
<td>Improve productivity of personnel</td>
<td>13</td>
</tr>
<tr>
<td>Improve productivity of nursing personnel</td>
<td>24</td>
<td>Increase revenue by improving registration</td>
<td>11</td>
</tr>
<tr>
<td>Improve productivity of medical personnel</td>
<td>10</td>
<td>Improve utilization of equipment by use of ICT</td>
<td>10</td>
</tr>
<tr>
<td>Reduce unnecessary use of diagnostic tests</td>
<td>5</td>
<td>Improve process of purchase and maintenance</td>
<td>9</td>
</tr>
<tr>
<td>Patient satisfaction</td>
<td>2</td>
<td>Improve utilization of outpatient clinic</td>
<td>7</td>
</tr>
<tr>
<td>Improve safety</td>
<td>4</td>
<td>Improve productivity of secretary personnel</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>90</strong></td>
<td><strong>Total</strong></td>
<td><strong>73</strong></td>
</tr>
</tbody>
</table>

**Table 6.1** Number of projects, September 2007-December 2011.

The finance department calculated that the financial benefit of all projects amounted to some €15 million. Exact figures are hard to obtain, however, owing to the oblique financial structure.

Two years after the introduction of LSS, management decided to go along without external help. The master black belt was recruited and assigned the task of facilitating the LSS activities, including the training of new green belts. In the meantime a group of coordinating black belts has been arisen, not in a centrally organized group, but operating in their own sectors and departments. There have been stiff conversations about the organizational form for LSS, and the outcome was that a non-central organization felt most comfortable. The non-medical directors took upon them to solve all kind of tuning problems. The experience with the LSS projects was that related problems in different sectors or departments were very similar, with often-similar solutions as well. With a process view in mind, and from a distance (the helicopter view), this is not at all surprising. Owing to the dominating culture of the hospital (as a result of employees moving from one department to another) one might expect comparable results in different departments, and related causes, as well as related solutions.
For improvements to be implemented, however, it is really necessary for the employees involved to experience the problems themselves, and to design their own solutions. Projects were therefore “repeated” at different departments, wards or clinics. It really helps however, to have universally applicable measurements, such as the method described in Chapter 3, about “inappropriate hospital stay”, which is valid for all hospitalized patients who are not in an intensive care unit. “It seems to be a kind of waste – doing projects “double” – but this contributes to higher chances of implementing solutions. In this regard healthcare is really different from industry, where improved processes may be obtained by new settings of a machine or other technical measures. Most improvements in healthcare require another way of working, new standards or protocols, and eventually new habits: a “culture change”.

The Control phase of the DMAIC roadmap is concerned with preventing problems to recur. For a large part this deals with the same matter of a culture change. Within the LSS framework (belt and champion in the driving seats) and its project based approach (projects lasting five months at most) a widespread culture change is hardly feasible. To obtain lasting results the Lean philosophy and tools are useful, in particular the elements of visual management, working as a team, and continuous improvement (kaizen). The end of an LSS project is ideally the beginning of a never-ending continuous improvement journey for the whole team.

Since several projects dealt with related problems, be it in different departments, the desirability of overall solutions and measures became clear. Two examples serve to illustrate the point.

- The projects on nursing efficiency demonstrated a need for clearly defined functions, and general rules about staffing in relation to the number of patients and their needs. These matters can only be solved adequately in the form of guidelines and rules for the whole organization.
- Owing to the financial structure of the UMCG the projects on length of stay required central direction. Most projects analyzed that the ward needed fewer beds than available. Closing beds would bring only limited financial benefits, however, because staffing could not be reduced. A broader solution – combining the reduced beds of
several departments – was needed for substantial financial results. This is clearly beyond the scope of department managers, so eventually senior management had to interfere to force the cooperation.

6.3 Consolidation of Lean Six Sigma at the UMCG

When LSS was introduced in the UMCG, it was new and exotic, with the potential of being a hype. Five years later LSS appears to be anything but a hype. The method is heard of in most parts of the organization, although for many employees LSS is still rather exotic. For management LSS represents an obvious method to use for efficiency improvement. Indeed, within a current cost cutting program LSS is explicitly used to analyze processes and to eliminate waste. More than 100 people were trained in the LSS methodology, constituting a pool of black belts and green belts, to be employed for projects and process analyses, although no more than 10-20 of them are at any given time doing LSS projects or related work. Several managers within this group play a special role in “spreading the word” and “walking the talk”.

LSS projects are less scattered now than in the beginning. Initially there were projects all over the organization, but the problem was to raise the results to a higher, organization-wide level. Now top management selects themes for improvement, and within a theme one or more LSS projects may be done. The organization also learned that LSS is not always the most suitable method, so alternatives are allowed – use of LSS is less dogmatic than it was in the beginning. Scattered LSS projects still happen, however, allowing the UMCG to discover new themes.

Each half year there is an in-house training for new green belts, but the number of students is significantly smaller than in the beginning. To maintain the pool of belts, however, new employees must be trained to replace the dropouts. With a few guests from other hospitals in the neighborhood there are some six to eight students per training. The outline of the training is equal to the green belt training of the external teacher, but tailored to the UMCG needs (less statistical analysis, more “Lean thinking”) with UMCG cases only. With a new and separate workshop “Lean Thinking and Doing” all employees are targeted. Especially, co-workers of nursing departments, logistical departments, and laboratories are attracted to the workshop.
6.4 Process improvement at the department of Traumatology

The first LSS project at the Surgery/Traumatology department started in 2008. The goal was to reduce length of stay (LOS), with percentage inappropriate hospital stay as driver for improvement (Niemeijer et al., 2010). After this project the other main processes were analyzed and improved in following years. In Chapter 3 we presented results from October 2007 till May 2009. Results from the years 2006-2011 are shown in Figure 6.1.

![Admissions and Average Length of Stay, Trauma Ward](image)

**Figure 6.1:** Admitted patients and average LOS at the Trauma Ward.

In the years 2008-2010 the average LOS decreased, and the number of patients grew. In 2011 the number of patients decreased with 15%, mainly because of 60% less “other” non-trauma patients (who cannot (immediately) be admitted at the most suitable ward). In 2011 the effects of LOS reduction projects at the other surgical wards were felt. The capacities of these wards increased, and fewer beds of the Traumatology ward were needed. The option to reduce the number of beds was not the first aim of the LSS project on the trauma department. Trauma surgery is an emergency specialism. Therefore, the first aim of reducing the LOS was to create more flexibility on the Trauma nursing department to accept all non intensive care
trauma patients from the emergency ward. So we reduced the number of patients who have been transmitted to other hospitals.

In 2011 the average LOS of trauma patients increased with more than 10%. The extra number of polytrauma patients (203 in 2011 versus 191 in 2010) may be responsible. Ultimately, the percentage inappropriate hospital stay measured by using the Dutch version of Appropriateness Evaluation Protocol (D-AEP) (Panis et al., 2002), can tell whether or not the increase of LOS is acceptable.

The measurement of inappropriate hospital stay is a very strong indicator of the efficiency of a department. Nowadays, this percentage is measured each day by one of the nurses of the Traumatology nursing department. The average over the year 2011 was 10%, which is lower again than the 12% reported in Chapter 3. Figure 6.2 displays additional but characteristic measurements of a week in March 2010 and 2011.

![Graph showing Inappropriate Hospital Stay (D-AEP), Trauma Ward](image)

**Figure 6.2:** Some measurements of inappropriate hospital stay.

On the whole the results regarding LOS are much better now than they were in 2006 and 2007, before the process was improved. The average LOS of trauma patients is now less
than 9 days, and the production increased from 950 to (nearly) 1100. And most importantly for patients, the inappropriate hospital stay decreased from 30% to 10%.

The second LSS project, described in Chapter 4, started also in 2008 with the aim of reducing redundant diagnostic tests of trauma patients. The results of this project till December 2011 are shown in the control chart of Figure 6.3.

![Control Chart of tests per treatment: Inpatient and one-day surgery](image)

**Figure 6.3:** Average number of diagnostic tests per treatment before and after the interventions.

The average number of all diagnostic tests per treatment decreased significantly (p= 0.001) by 14.4%, despite the larger number of patients. At the (day) clinic the average number of tests per treatment decreased (p= 0.000) even more by 30.4%. Costs per treatment decreased on average with more than 10%. For the patient the most important achievement is that several redundant tests have been skipped.

The department of Traumatology also used LSS as a tool for efficiency improvement of a clinical pathway for elderly patients with a hip fracture, as described in Chapter 5. The gain for the patients is an impressive reduction of LOS from 13.5 days (standard deviation 10.2 days; N=137) before the project to 8.8 days in 2011 (standard deviation 8.2 days; N=308). The gain for the department is that these patients can be treated with fewer costs.
Apart from the described projects the Traumatology department hosted more projects to improve efficiency and reduce costs. In the second half of 2008 an LSS project aimed at reducing the cost of implants. Surgeons used their own type of implants and instruments during surgery, out of habit, or because they felt more comfortable with a specific type. After analysis of the data the project team decided to standardize the full set of implants and reducing stock. This result could be achieved solely because of leadership of the senior management of the department. The financial benefits of the project can be seen in Table 6.2.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of day and inpatients</th>
<th>Number of surgical treatments</th>
<th>Cost of implants per patients (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>1937</td>
<td>1643</td>
<td>198</td>
</tr>
<tr>
<td>2008</td>
<td>1949</td>
<td>1786</td>
<td>182</td>
</tr>
<tr>
<td>2009</td>
<td>2194</td>
<td>1948</td>
<td>168</td>
</tr>
<tr>
<td>2010</td>
<td>2276</td>
<td>1894</td>
<td>182</td>
</tr>
<tr>
<td>2011</td>
<td>2388</td>
<td>2053</td>
<td>193</td>
</tr>
</tbody>
</table>

*Table 6.2: Number of patients, treatments and cost of implants (2007-2011).*

The reduction of costs in 2008 (compared to 2007) was achieved during the period August-December. Before the interventions in August the costs actually rose.

An LSS project in 2009 aimed at reduction of material directly related to the patient at the trauma ward, such as dressings, sterilized gauzes, and injection syringes. The project measured the amount of wasted material, which was kind of a shock to many nurses. As a result stricter procedures for ordering material were introduced. Moreover, a much cheaper contract could be signed with a single supplier of bandage material. The financial results of this project are shown in the control chart of Figure 6.4.
The average cost per patient before and after the intervention decreased from €44 to €39. This is an interesting success, considering the fact that in recent years more material is used (e.g. for pain treatment for every patient) and more expensive material as well.

Other projects related to the department are the efficiency of nursing staff. Within the surgical clinic lack of personnel is now tried to solve with internal staff, instead of hired personnel. And finally, a project trying to improve the efficiency of the out-patient clinic can be mentioned. With tools from the lean toolkit interventions have been done with an emphasis on reducing waiting times for patients.

6.5 Conclusion

This thesis focuses on the use and impact of LSS in healthcare. Several processes in the hospital and all main processes of the Traumatology department have been analyzed and improved according to the framework of DMAIC. The cases of the Traumatology department show that LSS can be applied to several types of processes. We may conclude that quality
improvement for the patient and financial benefits for the organization are really two sides of the same coin. The cases also illustrate the value of the “mediation model for Six Sigma” (Schroeder et al., 2008), with leadership as an driver element, what should lead to strategic project selection and the use of improvement specialists and structured method (Figure 6.5).

**Figure 6.5**: Mediation model for Six Sigma (Schroeder et al., 2008).

Leadership engagement is a *conditio sine qua non*. Senior management was prepared to support the new and stricter procedures for surgeons and physicians. Without their support not a single project would have succeeded. Senior management was also responsible for project selection, identifying processes with a need to be improved. Looking at processes with an eye for improvement needs special skills not normally present in healthcare employees. Therefore every project was lead by an LSS green belt or black belt. The conscious choice to train employees as internal specialists to improve (care) processes in their own environment appears to be successful.

In the UMCG Lean Six Sigma was introduced mainly because of a major cost reduction program. The notion was that LSS would be useful to bring this unique program to a successful end, and at the same time lay the foundation for future improvements in a financially healthy organization. Our claim is that these results were achieved, except for the “financially healthy” part. Much more severe cost reduction is needed now and in the near future, owing to the bad financial state of the Dutch government. The introduction of LSS, however, aided the transition of the organization from purely problem oriented to a more process oriented, which in turn is helpful in eliminating waste and finding solutions for difficult problems. The organization is therefore well prepared to face the challenges of the near future.