Six Sigma in healthcare: lessons learned from a hospital

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Abstract: Six Sigma is a quality improvement approach aimed at optimising processes while reducing defects and costs. It has been developed and is widely used in industry and recently has been introduced, on a limited scale, in healthcare. In this article, we discuss the results of the implementation of Six Sigma at the Red Cross Hospital in Beverwijk, the Netherlands. From the initial start in 2002, up to now, 44 projects have been initiated and 21 projects are closed. Projects are initiated in various departments and disciplines. Co-workers on almost all levels within the organisation are being trained and have been provided with tools to perform projects that improve quality and reduce costs of healthcare delivery. The results show that the completed projects produced €1.2 million in annual savings. The expected total net annual savings of all running projects are €3 million.

Keywords: quality improvement; Six Sigma; healthcare; hospital.

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1 Introduction

Six Sigma is an integrated approach for pursuing continuous improvement of customer satisfaction as well as organisational profits (Snee, 2004). Six Sigma was developed at Motorola in 1987. In the mid-1990s, General Electric started implementing Six Sigma. The GE 1997 Annual Report states that Six Sigma delivered more than US$300 million to its operating income. Subsequently, many companies, such as American Express, Boeing, Citibank, Ford, and 3M, have followed General Electric (Breyfogle, 2003). More recently, applications of Six Sigma have also been suggested in healthcare (Barry *et al.*, 2002; Stahl *et al.*, 2003). We introduced Six Sigma at the Red Cross Hospital with the purpose of enhancing continuous improvement in combination with our ISO quality management system. ISO and Six Sigma have proven to be highly complementary in other organisations (Warnack, 2003). In this article, we first describe Six Sigma. We then demonstrate the implementation of Six Sigma in our hospital. Finally, we present our results and discuss our experiences.

2 Six Sigma

Organisations that implement Six Sigma invest in quality improvement, cost reduction and efficiency improvement. The term *Sigma*, used by statisticians, defines the standard deviation of a random variable. A number of times sigma indicates the amount of defects that are likely to occur in a given (production or service) process. A three sigma process, for example, has a defect rate of 6.7%, while a Six Sigma process has only 3.4 defects per million opportunities. The objective to achieve processes to perform at Six Sigma-level symbolises the systematic pursuit of breakthroughs. Defects cause an increase in costs. Six Sigma reduces costs by reducing the number of defects (Bisgaard and Freiesleben, 2000). Several variants of the programme are current (*e.g.*, Harry, 1997; Breyfogle, 2003).

In order to quantify the performance of a given process, a Six Sigma project starts by defining and implementing relevant measures and metrics, the so-called Critical To Quality characteristics (CTQs). Six Sigma tackles performance problems in four phases: Measure (M), Analyse (A), Improve (I) and Control (C). These phases consist of 12 steps

that guide a project leader in the execution of a quality improvement project (Harry, 1997). In addition to this stepwise project approach, Six Sigma contains an organisational structure. Project leaders, which are called Black Belts or Green Belts, are trained in project management, problem solving methodology, and statistical methods. The stepwise strategy that Black Belts and Green Belts follow enables them to make a proper problem definition and a data based diagnosis before undertaking attempts at solving the problem. Tools used in Six Sigma, such as Quality Function Deployment (QFD) and Pareto analysis, link customer demands to product features and establish the relative importance of various problems. Managers, in their roles as coach, (the so-called Champions) review the progress of a project and ensure that the Black Belts and Green Belts focus on the interests of the organisation. Experts on the Six Sigma methodology are called Master Black Belts and they are responsible for managing the Six Sigma organisation. Through this structure, Six Sigma is able to combine the available knowledge from the various functions in an organisation to achieve the best possible process improvements (Jensen, 1998). The focus of Six Sigma on data and the statistical verification of conclusions have proven to be a good counterbalance to the often more subjective and intuitive way of working in healthcare.

3 Experiences with Six Sigma in healthcare

One of the first healthcare organisations to fully implement Six Sigma was Commonwealth Health Corporation in 1998 (Thomerson, 2001). This was achieved with the help of consultants from General Electric. The Commonwealth Health Corporation has 500 plus beds and is a multi-site health system with the headquarters in Bowling Green, Kentucky, USA. The implementation gave positive results. Throughput in the radiology department was improved by 33% and costs per radiology procedure decreased by 21.5%. At the beginning of 2002, Commonwealth had invested about US$900,000 in Six Sigma, which lead to savings in excess of US$2.5 million (Lazarus and Stamps, 2002b). A number of healthcare organisations have followed the example of Commonwealth Health Corporation with even better results (Sehwail and DeYong, 2003). Mount Carmel Health System, a three-hospital system in Columbus, Ohio with 7300 employees reported a financial return of US$3.1 million with expectations for these financial returns to grow rapidly as more Six Sigma projects are completed (Lazarus and Stamps, 2002b). Charleston Area Medical Center, a 919-bed three-campus medical centre in West Virginia, achieved US$841,000 in savings on supply chain management by using Six Sigma (Lazarus and Stamps, 2002a). Thibodaux Regional Medical Center, a non-profit 149-bed hospital in Louisiana, started implementing Six Sigma in 2001. Their projects were in the areas of accounts receivable days, medication management, patient safety, employee satisfaction, hospital acquired infections, and medical management. In May 2002, they reported a savings of more than US$475,000 per year (Stock, 2002). Earlier reports on our own experiences at the Red Cross Hospital in Beverwijk, the Netherlands, were equally convincing (van den Heuvel *et al.*, 2004).

4 Implementation and results at the Red Cross Hospital, Beverwijk

The Red Cross Hospital is a general hospital with 384 beds located in the Netherlands with an annual budget of €72 million. The Institute for Business and Industrial Statistics at the University of Amsterdam supported the implementation of Six Sigma in this hospital. It started with the one-day introduction training for management and directors. In order to implement Six Sigma successfully, some apparent minor adaptations were necessary. First, we reduced the threshold for initiating a project from €100,000 to €20,000. Secondly, we only used Green Belts to run the projects. Finally, Green Belts were allowed to run the projects in couples, instead of one Green Belt per project.

The first group of 15 Green Belts started their training in September 2002. Seven projects were initiated. To stimulate commitment, participants were allowed to choose the subject of their projects. In February 2003, the second group of Green Belts started. The hospital directors incited managers to train a sufficient number of Green Belts and maintain a substantial programme of new projects. Gradually, project selection was taken over by management to ensure alignment with the strategic goals of the hospital.

As the number of projects increased, the necessity for coordination and management of the Six Sigma programme became evident. We observed that Green Belts faced difficulties in closing their projects. Decisively, we appointed a Master Black Belt to set up a management control system to evaluate progress and to support Green Belts in finishing their projects. The Master Black Belt organised the necessary training programmes and ascertained that once Green Belts completed a project, they initiated another project. In September 2004, the fifth group of Green Belts began with their projects. Co-workers started to show more and more interest in following a Green Belt training. We have consistently started new groups of approximately 15 employees every six months. Participants emerged from different departments and disciplines within the organisation. We developed a special training for medical specialists. Recently, we started training employees from partner-organisations, such as home care and a nursing home, to initiate projects that improve cooperation, communication and quality of care.

Table 1 shows the cumulative number of Green Belts trained and the number of projects that have been initiated.

Table 1 Numbers of Green Belts and Six Sigma projects

Six Sigma	*2002*	*2003*	*2004*
Green Belts	15	38	63
Projects	7	19	44

Currently, 44 projects were started and 21 projects are closed. The total savings amount to €1.2 million. The expected total net annual savings of all running projects are estimated at €3 million. These amounts are cumulative savings on an annual basis.

Table 2 shows the development of savings and costs per year.

Table 2 Investments and revenues in euro of the Six Sigma approach

Six Sigma	*2002*	*2003*	*2004*	*Total*
Costs	40,000	88,000	101,000	229,000
Savings	0	0	1,268,000	1,268, 000
Results	–/– 40,000	–/– 88,000	1,167,000	1,039,000

Costs are related to training, consultancy and hospital personnel that have been employed to support the Six Sigma organisation. The salaries of Green Belts were only included when extra personnel had to be employed to replace them. Savings are actual achieved total net savings from all running and completed projects. They include reductions in labour time spent by employees, only if this time could be utilised elsewhere.

Table 3 shows a number of projects and their estimated target savings and actual annual savings.

Table 3 A selection of Green Belt projects (savings in euro)

Project	*Target savings*	*Annual savings*
Improving patient scheduling operating theatre	50,000	229,000
Reducing accounts receivable	20,000	225,000
Optimising technical maintenance	20,000	211,400
Reducing formation of physiotherapists	25,000	64,400
Revision of terms of payment	20,000	60,000
Reducing admission time hip replacement	46,000	56,000
Reducing admission time after delivery	25,000	56,000
Improving logistics linen distribution	50, 000	44,000
Availability ambulatory files	37,000	37,000
Reducing waiting times first contacts cardiology	34,000	34,000

We have been able to initiate Six Sigma projects in almost every unit and relate it to each discipline in our hospital (van den Heuvel *et al.*, 2005). As mentioned before, we use an amount of €20,000 as a threshold for initiating projects. Based on 21 projects, the average savings per project amount to €68,000.

5 Lessons learned from the implementation of Six Sigma in a hospital

5.1 Categorising of the projects

A number of areas can be identified that are particularly profitable to initiate projects. Below we give an overview of the projects in five categories:

1 Shortening the length of stay of patients

   The first group of projects where substantial savings can be realised quite easily are related to reducing admission time. To achieve this, the clinical pathway of a given disease has to be described and optimised using various Six Sigma and Lean tools (George, 2003). This will invariably lead to considerable cost reductions

because currently, the full content of a clinical pathway is seldom analysed and evaluated from the perspective of every participating healthcare provider. Therefore, redundancy in activities, examinations and administration resulting in unnecessary costs is most likely to occur in many clinical pathways. In the end, optimising a clinical pathway as described above will lead to a shortening of admission time or at least in reducing variability of admission time. Shortening admission time, due to the nature of the Dutch funding system, has a positive net effect on the budget because more patients can be admitted using the same capacity. Reducing variability in length of stay facilitates planning and, subsequently, optimal usage of the available bed capacity also. Financial savings related to reducing variability have, until now, been underestimated in our hospital.

2 Minimising the use of materials and devices

A second group of projects is related to minimising the use of materials and devices. For example, intravenous medication is changed to oral medication at the earliest possible moment, or reducing the number of intravenous pumps by pooling.

3 Optimising the use of available capacities

A third group of projects pertained with the optimal use of available capacities such as the capacity of the operating theatre. Starting operations on time and making the most of available timetables through flexible planning can do this. The same holds for optimising the use of costly diagnostic scanners such as MRI and CT.

4 Reducing the amount of staff

The fourth group of favourable Six Sigma projects is related to reducing the amount of staff that has to be employed. Approximately 70% of our annual budget consists of costs related to personnel. Therefore, reducing the number of employee activities or tasks within a given process and optimising personnel scheduling can lead to substantial savings.

5 Improving cash flow

The fifth group consists of all activities that are directly related to improving cash flow. Reducing accounts receivable, which produced €225,000 annual savings, appeared to be a very successful project in this category. Also a revision of terms of payment was quite beneficial.

Details of how some of these projects were carried out have been described elsewhere (van den Heuvel *et al.*, 2004).

5.2 Additional benefits

Apart from the financial benefits, Six Sigma made an important contribution to the improvement of quality of healthcare. Unlike in industry, where a defective product can be rejected without any problem, in healthcare defects and rework directly affect the patient and therefore, the patient's perception of quality. Shorter waiting lists, elimination of unnecessary examinations, reducing the number of defects as well as complications and improving the output of the care process directly contribute to the improvement of the quality of healthcare. Each Green Belt needs to indicate the amount of savings before starting his project and needs to monitor progression. This explicit focus on savings

caused some resistance. One got the impression that quality of healthcare had been made subordinate to money. In fact, we noticed that Six Sigma made an important contribution to the improvement of quality of healthcare. Especially in healthcare, Six Sigma seems to work both ways; costs are eliminated and quality is improved (Kooy and Pexton, 2002). The introduction of Six Sigma in a hospital stimulates a culture of awareness to find opportunities to improve healthcare delivery and to take responsibility for eliminating shortcomings. In the past, decisions were too often based on assumptions and feelings and on inaccurate and incomplete information. By utilising Six Sigma, co-workers now take responsibility and provide management with solutions based on facts and data.

In the Red Cross Hospital, a quality improvement system was already developed and functioning within the framework of our ISO 9000 quality management system. Selection of projects, however, appeared to be difficult. We did not have a standardised project management approach at our disposal, which lead to significant waste of time and effort in initiating and running projects. Since we combined projects with regular tasks without giving employees time off to focus on running their projects, results were delayed. This, in fact, cost more money because savings were postponed. In Six Sigma, possible savings of every project were estimated in advance. Based on our estimations, we determined which project required the highest priority.

The progress of Six Sigma projects is very easy to manage due to the uniformity of the project approach in 12 steps and well defined outcomes. This transparency has proven to be a very powerful management tool, supporting directors and managers in defining and accomplishing the right projects. Cost reductions bear the risk that they affect the quality of healthcare in a negative way. Therefore, ISO 9001:2000, with a strong emphasis on quality assurance, combined with Six Sigma emphasising efficiency improvement, is an excellent combination in our hospital. Further integration of our ISO quality management system and Six Sigma is advantageous because both systems are focussed on processes, are client-oriented and data driven.

As in other service organisations, we also encountered some difficulties in introducing quantitative methods (Does *et al.*, 2002). Nowadays, when employees in our hospital face an opportunity for improvement, they will often make quantitative analyses and calculations themselves. They will also give indications as to how the improvement will contribute, for instance, to the financial aims of the hospital. Facts based on data prove to be strong arguments to convince medical specialists to change to a different method of working.

Quality improvement programmes often focus on realising the larger and prestigious improvement projects. Furthermore, only few privileged employees are allowed to participate in the programme. In our experience, the attention of the employees returns to their daily tasks after a while and they inevitably lose interest in the programme. With Six Sigma, we have invested in an infrastructure and we do not promote specific projects. Thanks to this infrastructure, every trained employee can start and accomplish any improvement project within a short time and with little effort.

At the beginning of 2004, our hospital faced a budget deficit threat of €1.5 million. Instead of discharging employees, managers were asked to define and start enough projects for 2004, resulting in savings that could eliminate the deficit. As we had gained enough experience with Six Sigma and as a sufficient number of trained Green Belts were available, we managed to find the required amount of savings. Presently, we are ahead of reaching this goal. This outcome clearly proves that Six Sigma is a major contribution to the continuity of our hospital.

In 2003, the Institute of Medicine (IOM) produced a report demonstrating that healthcare has serious safety and quality problems and is in need of fundamental changes. Care processes are poorly designed and are characterised by unnecessary duplication of services and long waiting times and delays. Waste is identified as an important contributor to the increase in healthcare expenditures. In order to better serve the needs of patients, healthcare systems have to be redesigned (Institute of Medicine, 2003). In our opinion, Six Sigma is able to address a number of the problems mentioned by the IOM by improving care processes, eliminating waste and enhance patient satisfaction.

6 Conclusion

The Red Cross Hospital has successfully implemented Six Sigma and has integrated it within the ISO 9001:2000 quality management system. In doing so, we have produced €1.2 million in annual savings. In training employees and having them initiate Six Sigma projects, we have reduced costs and have improved the quality of healthcare. The results are comparable with those in industry and other hospitals. Since the Six Sigma organisation in our hospital is still expanding, we expect to achieve greater substantial savings in the near future. The fact that Six Sigma successfully combines quality improvement and cost reduction substantiates that it could be a solution to present day financial problems in healthcare.

References

Barry, R., Murcko, A.C. and Brubaker, C.E. (2002) *The Six Sigma Book for Healthcare*, Chicago: Health Administration Press.

Bisgaard, S. and Freiesleben, J. (2000) 'Economics of Six Sigma programs', *Quality Engineering*, Vol. 13, pp.325–331.

Breyfogle, F.W. (2003) *Implementing Six Sigma. Smarter Solutions Using Statistical Methods*, Hoboken, New Jersey: Wiley.

Does, R.J.M.M., Van den Heuvel, E.R., De Mast, J. and Bisgaard, S. (2002) 'Comparing non-manufacturing with traditional applications of Six Sigma', *Quality Engineering*, Vol. 15, pp.177–182.

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

Harry, M.J. (1997) *The Visions of Six Sigma*, 5th ed., Phoenix: Tri Star.

Van den Heuvel, J., Does, R.J.M.M. and Vermaat, M.B. (2004) 'Six Sigma in a Dutch hospital: does it work in the nursing department?', *Quality and Reliability Engineering International*, Vol. 20, pp.419–426.

Van den Heuvel, J., Does, R.J.M.M. and Bisgaard, S. (2005) 'Dutch hospital implements Six Sigma', *Six Sigma Forum Magazine*, Vol. 4, No. 2, pp.11–14.

Institute of Medicine (2003) *Crossing the Quality Chasm: A New Health Care System for the 21st Century*, National Academy of Sciences, Washington.

Jensen, M.C. (1998) *Foundations of Organisation Strategy*, Cambridge: Harvard University Press.

Kooy, M. and Pexton, C. (2002) 'Using Six Sigma to improve clinical quality and outcomes', *Clinical Quality*, August, pp.13–16.

Lazarus, I.R. and Stamps, B. (2002a) 'The promise of Six Sigma: getting better faster', *Extra Ordinary Sense*, Vol. 3, pp.3–29.

Lazarus, I.R. and Stamps, B. (2002b) 'The promise of Six Sigma', *Managed Healthcare Executive*, Vol. 12, pp.27–30.

Sehwail, L. and DeYong, C. (2003) 'Six Sigma in health care', *International Journal of Health Care Quality Assurance Incorporating Leadership in Health Services*, Vol. 16, pp.i–v.

Snee, R.D. (2004) 'Six Sigma: the evolution of 100 years of business improvement methodology', *International Journal of Six Sigma and Competitive Advantage*, Vol. 1, No. 1, pp.4–20.

Stahl, R., Schulz, B. and Pexton, C. (2003) 'Healthcare's horizon: from incremental improvement to design the future', *Six Sigma Forum Magazine*, Vol. 1, No. 3, pp.17–25.

Stock, G. (2002) 'Taking performance to a higher level', *Six Sigma Forum Magazine*, Vol. 1, No. 3, pp.23–26.

Thomerson, L.D. (2001) 'Journey for excellence: Kentucky's Commonwealth Health Corporation adopts Six Sigma approach', *Annual Quality Congress Proceedings*, Vol. 55, pp.152–158.

Warnack, M. (2003) 'Continual improvement programs and ISO 9001:2000', *Quality Progress*, March, pp.42–49.