Using Six Sigma tools to improve internal processes in a hospital center through three pilot projects

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Abstract

San Juan de Dios Hospital is a main private medical center in Córdoba (Spain). We have used Six Sigma methodology to help us find ways to improve processes.

Objectives: (1) Reduce the variability scheduling pre-anesthesia consultations, (2) reduce absenteeism of outpatients and reduce delays, and (3) increase the efficiency of Internal Medicine-Rehabilitation ward.

Methods: (1) We analyzed scheduled vs. performed pre-anesthesias. From September 2012 we introduced a new tool that estimated a maximum number of appointments for each day of the week. Periods: 15 November 2011 to 01 October 2012, vs. 01 September 2012 to 31 January 2013. (2) We calculated daily % absenteeism and average delay per visit. From September 2012 actions were taken with the administrative team, patients, and physicians more affected by this problem. Periods: 15 November 2011 to 01 October 2012, vs. 01 October 2012 to 31 January 2013. (3) From June 2012 we launched an interdisciplinary team. We discussed biweekly the clinical condition of the patients, and reached consensus regarding a potential discharge date, which was shared with referral center, a tertiary hospital in the area. Data of hospital stays, occupancy rates and discharges were studied.

Results: (1) Period 1: Standard deviation (9.63), daily average (35.45). Period 2: 7.54 (−22%), 37.95 (+7%). (2) Period 1: 11.4% absenteeism, average total delay 523.54 minutes. Period 2: 6.25% (−45%), 125.17 minutes (−76%). (3) Period 1: Admission per week 0.88, length of stay (LOS) 164.14 days, occupancy rate 63%. Period 2: 1.00 (+14%), 58.29 (−64%), 84% (+32%).

Conclusions: Six Sigma methodology could be successfully used to improve processes and outcomes in hospitals, especially when several departments are involved.

Keywords: Hospital management, Six Sigma, Process improvements, Efficiency, Physician's engagement, Quantitative analysis, Outcome assessment, Statistics and numerical data

Introduction

San Juan de Dios hospital in Cordoba (HSJDC) is a hospital center, located in the South of Spain. More than 10 000 surgeries, more than 80 000 outpatients visits and more than 22 000 emergency cases are performed yearly. The hospital has currently 5 operating theaters, 13 outpatient exam rooms, and 148 beds.

The center is accredited by the Healthcare Quality Agency of Andalusia (ACSA) with the distinctive 'Advanced level'. In HSJDC a different number of training initiatives are performed, and the hospital pays special attention to initiatives related to quality and healthcare outcomes.

Given the culture of systematic quality improvement in the center, and framed in a series of activities to improve outcomes of care and process efficiency, the hospital has launched a series of projects to streamline processes and increase efficiency of operations based on Six Sigma. In this article we will take a closer look to those actions taken and the results obtained.

What is Six Sigma

Six Sigma is a very robust and validated methodology for quality improvement, cost reduction, and efficiency improvement that helps us to discover potential ways to improve processes mainly due to

quantitative analysis and involvement of customers. The basic idea is to aim at virtualy zero-error processes (outside the previously defined standard). It is born from Deming's theories of process improvement, which tries to reduce variability, to standardize, and to eliminate process steps that do not add value for the customer.

The letter sigma (ð) is a character used by statisticians to express the variability of any process, in other words, the degree of uncertainty with the outcome. There is a big body of evidence that the use of this methodology might result in a big reduction or elimination of defects in manufacturing or delivery of a product or service to the customer. The higher sigma, the fewer defects allowed. A goal of Six Sigma translates into a maximum of 3.4 defects per million opportunities or events or processes, meaning any default event that a product or service fails to meet customer requirements.

While the concept is quite consistent with the objective of quality to which all aspire health organizations, it is true that sometimes it can be very difficult to reach a Six Sigma performance level in real life. For example, for a hospital with 100 000 surgeries a year, theoretically it would be permitted only one undesirable event every 3 years (not very realistic). However, the idea behind is still very valuable, and in some environments (such as laboratory or radiology, which performs a large number of tests) it can be specially useful.[1–3]

Therefore, Six Sigma (and other tools that use statistical process improvement) could be tremendously helpful to discover an acceptable degree of variability (i.e. measured in the form of standard deviation) so that any process is always within certain limits set by user requirements. It would be expressed as time required for delivery of a service or good within a specific time window, or a defined quality level. Among the final benefits to be gained from Six Sigma are profitability and productivity improvements. Finally, an important difference compared to other methodologies is customer orientation. This means that the 'Voice of the Customer' (much more than just performing a survey) is taken into account.

Also, Six Sigma contains an organizational structure of Project leaders, which are called Black Belts or Green Belts. They are trained in project management, problem-solving methodology, and statistical methods. This seeding effort helps the organization to make a proper problem definition and a data-based diagnosis 'from inside' before undertaking attempts at solving the specific issue. Tools used in Six Sigma, such as Pareto analysis, link customer demands to product features and establish the relative importance of diverse issues.

Six Sigma is the application of scientific method to design and improve processes, in our case, care or patient service. The method works in the following steps: Define, Measure, Analyze, Improve, and Control. Let us review each step:

D (Define). In the definition phase we identify potential Six Sigma projects to be evaluated by management, based on a criteria set to prevent improper use of resources. After selecting the project, preparing and selecting the most suitable team to run it, giving it the necessary priority. The tools used are Process map, Flow chart, etc.

M (Measure). The measurement phase is the characterization of the process by identifying key customer requirements, key features of the product (or outcome variables), and parameters (input variables) that affect the operation of the process and key characteristics or variables. From this characterization, it is defined the measurement system and process capability. The tools used are scales, block diagrams, etc.

A (Analyze). In the analysis phase, the team evaluates data from current and historical results. Then, we develop and test hypotheses about possible causal relationships using appropriate statistical tools. Thus, the team confirms the determinants of the process, i.e. the key input variables or 'vital spots' affecting the output of the process. The tools used are process capability analysis, fishbone, etc.

I (Improvement). In the improvement phase the team tries to determine the cause–effect formula (mathematical relationship between the input variables and the response of relevant variables; 'Critical to Customer' or 'Critical to Quality') to predict, improve, and optimize the performance of the process (Finding 'X' for an 'Y'). Finally, it is defined the operational range of the input parameters or process variables.

C (Control). The necessary checks to value the contributions of the Six Sigma project are implemented. When you have achieved the goals of the project and mission is considered complete, the team reports the results to upper management and is dissolved. In this phase we quantify the problem (the 'Y') and decide what and how we will measure progress and monitor the solution to be implemented (the 'X').

Experiences of Six Sigma in healthcare

Six Sigma has been used in many different health situations, as the following experiences to be found in the literature:

- Process bone densitometry[4]
- Process hip arthroplasty[5]
- Process phlebotomy[6]
- Transfer of a surgical patient to ICU[7]
- Glycemic control in patients undergoing cardiac surgery[8]
- Delivery of results of Anatomic Pathology[9]

Some experts argue that other process improvement methodologies, such as Lean are better suited to improve certain processes, specially if the measures taken and the tools used are relatively simple.[10] Lean[11] was born in the Japanese car industry after World War II and, like Six Sigma, has also been transferred to the service sector. Some authors advocate than mixing them is the best way to obtain the best of both worlds.[12]

The basic idea is to evolve from the traditional concept of manufacturing (the worker does not think, just executes the orders, the organization is seen as a hierarchical entity, the inventory is a necessary evil to counter-act the problems of demand and production, etc). Lean systems pretend to minimize inefficiencies and variability, spending as much time and energy as possible on the most productive tasks (i.e. what the client wants) to achieve high levels of service (perceived by the user or customer).[13] The process map is analyzed to find bottlenecks, by using some tools: visual management, complexity reduction, 5S (a method of organizing the workplace: sort, straighten, scrub, standardize, sustain), cellular production, pull systems, line balancing, one-pieceflow, among others.[14,15]

As described Black and Revere in 2006, Lean and Six Sigma 'emerged in the fertile soil created by other concepts such as total quality management (TQM)'.[16] Recent applications of Lean and Six Sigma in healthcare organizations are based on TQM and possibly try to get even a higher level of detail in the evaluation and improvement of processes, maintaining high levels of customer focus, quantifying results, and trying to get specific results a period of time. These are the most relevant characteristics of Lean:

- Organizational approach: the organization is involved and learn
- Business case with focus on savings or expected benefit
- Projects with a specific objective, linked to organizational strategy
- Sistematic follow-up
- Problems encountered in the hospital
- The active involvement *on spot* of every employee is very appreciated and even stimulated.

In our case, we decided to put into practice Six Sigma methodology because we consider it more versatile and valuable in the long term. However, we greatly recognize the usefulness of Lean (specially the 'don't boile the ocean' principle). As a result, Medical Director trained as Green belt in 2012 and some potential improvement areas were studied.

Problems detected in our Hospital

Variability of pre-anesthesia consultations

At HSJDC we perform around 40 preoperative tests a day. However, the variability is very high. Half of these tests are really scheduled, while the other half are just on spot, non-scheduled. The non-scheduled test could be (1) outpatients visits attending the hospital and, once visited, his doctor decides to perform the preoperative test because he knows for sure that the patient is going to the operation room (OR); (2) patients coming from private practices (outside the hospital) of physicians who use our OR; and (3) patients belonging to specific private healthcare organizations (paid by their employers) who will be treated by surgeons who work in our center.

In summary, the citation process and, consequently, forecasting of preoperative tests has a high level of uncertainty, which entails negative consequences on resource planning, speed of care, delivery of results, OR time planning and patient satisfaction. Consequences: delays, long waiting times, workload for the laboratory and nursing, difficulties to forecast staffing, loss of quality of care, cost increase/income reduction

Absenteeism and delays in outpatient visits

In HSJDC we perform approximately 6000 outpatient visits a month. Rush hours range from 9 to 13 and from 17 to 20 hours. Low activity is observed during extreme hours of the day and noon. Patients can book an appointment by phone, from 8 am to 10 pm, Monday to Friday, and also by e-mail and through the online booking service. In general, the allocation system is relatively flexible and the average waiting time between requesting a date and the visit use to be lower than 7 days.

After analyzing the group of 48 doctors who work in the outpatient area of our hospital, we observed that only 8 (16.6%) were responsible for 50% of absenteeism in the hospital. It was also noted that approximately 2.5% of patients were 'repeat

absentees' (who failed for two or more outpatient visits in the last 2 months).

Impact

- Difficulties in scheduling appointments
- Increase of recovery process
- Workload for team appointments
- Lower turnover.

Efficiency of Internal Medicine-Rehabilitation ward

Patients at Internal Medicine-Rehabilitation ward are derived from University hospital for long stays (average LOS 60 days). The primary services are Neurology and General Surgery. The objectives of the hospital are (1) to maintain the occupation rate as high as possible, (2) to achieve a high patient turnover (in order to take more patients and to reduce the pressure in the reference center, and (3) minimize the delay between application and arrival date.

Analysis

Preoperative tests

A tool was designed, along with the IT department, that calculated daily number of scheduled preoperative tests and preoperative tests made. Periods compared: 15 November 2011 to 01 September 2012 (42 weeks) vs. 02 September 2012 to 31 January 2013 (22 weeks).

Surveys (Voice of the Customer) were conducted with the following groups: anesthesiologist coordinator of pre-anesthesia consultation, nurse coordinator of outpatient visits, patients seen at the preoperative. After analyzing the context and needs, we chose to focus our efforts around daily preoperative tests programming.

Absenteeism

We compared two periods, from 15 November 2011 to 01 October 2012 (46 weeks) vs. 01 October 2012 to 31 January 2013 (17 weeks). Data analyzed: scheduled visits per physician, visits by physician, delay in minutes (average per physician), maximum delay per physician, and absenteeism per physician. Also, surveys were conducted among patients (telephone survey of 34 patients that repeatedly missed visits), administrative personnel, and physicians.

Internal medicine-rehabilitation ward

There have been two meetings with the representatives of the reference center, and university hospital. These doctors and nurses belong to the department of clinical admissions, and they are responsible for identifying the most suitable candidates within the hospital (based on clinical criteria, and social welfare) to be sent to our center. Then they send us the most relevant clinical information through a secure system. At these meetings, issues for improvement were found, according to these professionals, that offered several ideas such as increasing the level of information on bed availability, changing the transference system of patients, or receiving information about the number of beds potentially available in the short and mid term.

We compared two periods: 01 January 2012 to 31 May 2012 (22 weeks) vs. 01 June 2012 to 31 January 2013 (35 weeks). Data analyzed: length of stay, admissions, discharges, occupation rate, delay between referral and effective patient transference.

Statistical analysis: In all cases, we have used nonparametric Mann–Whitney *U* test.

Actions

Preoperative tests

On 01 January 2012, a change was implemented in the reservation and appointment system for preoperative tests. Specifically, we set a maximum number of spots to patients for each day of the week. The maximum number for each day varied depending on the expected demand for that particular day. That is, if we know that a specific day in the week demand of unscheduled visits was higher, we set a lower roof of spots. If, on the other hand, we expected lower demand, a higher roof was set.

The objective of this system was to create an easy-to-use administrative tool to move demand of preoperative tests from those days overcrowded to others underserved. However, if case of urgent need, it could be exceeded the maximum limit of spots.

Across the whole the project (6 months), the group was informed by regular e-mails to inform them about the results of the project and to solicit them new ideas for improvement. Also, meetings were held every 3 months, to analyze the results and to define new actions for improvement.

Absenteeism

In the previous section, we remarked that since the team decided that it would work especially with the group of physicians and patients at risk. Therefore, the actions taken were

- To inform the administrative team of the names of those patient who missed more than one appointment in the last 3 months (14 patients). If they requested a new visit, we insisted on the importance of attending, and that doctor

hours were scarce, as demand surpassed offer. Anyway, no appointment was denied to any patient.
- To educate physicians at risk on the importance of asking patients to attend to appointments, and that, in case they couldn't attend, it was ok to inform to the hospital in order to offer that spot to another patient.
- To review and, if needed, to correct agendas of certain physicians, who had allowed 'overlapping' of patients to allocate more appointments per hour.
- To create new agendas in available spots, forcing doctors to finish at the estimated time.
- To cancel certain agendas of physicians with low activity (having fewer patients and irregular demand, the possibilities of delays increased).

Across the project (3 months), informative activities were conducted to clinicians responsible for 50% of absenteeism in the hospital, and regular e-mails were sent to members of the team, to brief them on the progress of the project and to agree on new ideas for improvement. Meetings were also held quarterly to stabilize the results.

Internal Medicine-Rehabilitation ward

From June 2012, we launched an interdisciplinary group formed by the internal medicine specialist, medical rehabilitation specialist, nursing coordinator, pastoral worker, logopedist, social worker, psychologist, and medical direction. It was established that meetings would be held every 2 weeks.

This team, under the direction of a coordinator, had a common goal to reduce the impact of physical, emotional, and spiritual health of the patient and family in all areas. Its scope was the patients admitted to the Internal Medicine-Rehabilitation ward of our hospital, in subacute state after vascular disease. Some of the objectives of our team were

- Performing an individual work plan aimed at promoting recovery in all areas, combining all the disciplines and abilities of the team
- Promoting the active participation of patients and care givers in the rehabilitation program, with action plans to ensure the information, training and support after discharge
- Tackling potential personal, logistic, or any other needs at the right time to facilitate reintegration into the community after discharge
- Offering specific support to caregivers.

In these multidisciplinary team meetings all patients were discussed, with the participation of all professionals involved. Two main metrics were established:

- Clinical complexity: primary or concomitant disease. From 1 (low complexity) to 5 (high complexity)
- Difficulties for discharge: social problems or any other trouble (conditions of the house, family support, etc.) that might hamper discharge. From 1 (low difficulty) to 5 (high difficulty)

At the end of the meeting, consensus around a potential discharge date was reached (always estimate), expressed in weeks. Finally, the patient information was collected in an Excel spreadsheet, along with details of any free beds, and sent by e-mail (password protected) to all members of the continuity of care department at the reference center.

Across the project (9 months), Medical director (and Six Sigma green belt) shared regular communications by e-mail with the team sharing progresses and new ideas for improvement. Meetings were also used to stabilize improvements.

Results

Preoperative tests

There is a slight increase in the number of preoperative tests, along with small increase in the number tests done (+7%), with a significant reduction in the standard deviation (−22%) (Table 1, Fig. 1).

Absenteeism

There has been a significant increase in absenteeism in consultations (−45%) and the average delay in the period (−76%) (Table 2).

Table 1: Results

Preoperative tests	Pre	Post	Diff	Mann Whitney
Start	15/11/2011	01/09/2012		
End	01/09/2012	31/01/2013		
Days	291	152		
Average	35,45	37,95	7%	NS
% Programmed	54,94	56,17	2%	NS
St Deviation	9,63	7,54	−22%	NS

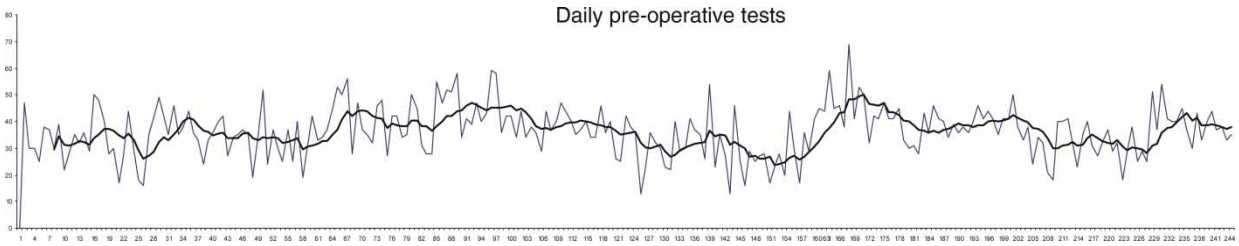

Figure 1: Change in pre-operative tests.

Table 2: Results

Absenteesm	Pre	Post	Diff	Mann Whitney
Start	15/11/2011	01/10/2012		
End	01/10/2012	31/01/2013		
Days	321	122		
Absenteesm	11,40	6,25	−45%	NS
Delay	523,54	125,17	−76%	$p < 0,001$

Table 3: Results

Int. Med Ward	Pre	Post	Diff	Mann Whitney
Start	01/01/2012	01/06/2012		
End	31/05/2012	31/01/2013		
Days	151	244		
Delay	13,95	18,82	35%	NS
Admissions/week	0,88	1,00	14%	NS
Length of stay	164,14	58,29	−64%	$p < 0,001$
Occupancy rate	63%	84%	32%	NS

Internal Medicine-Rehabilitation ward

We observed a very significant increase in the number of discharges per week (+14%) and the occupancy rate (+32%), with lower average stay (−64%). Also, it was observed an increased waiting time from request effective transfer (from 13.9 to 18.4 days) (Tables 3 and 4).

Even with these positive results, statistical analysis was only significant in two cases: Delays in External visits and Length of stay. We attribute this to the sample size; however, the positive trend observed must be proved in further studies.

Discussion

Preoperative tests

We observed positive results, but they could have been even more positive but we faced several constraints. On one hand, maximum number of appointments was not fixed rigidly, and it was taken into account a certain degree of flexibility so that we could set appointments above that number, if needed. This decision was made because sometimes preoperative consultations are cancelled and demand is immediately transferred to next appointments.

As a limitation, the large volume of preoperative tests generated by external patients (at least 30%) makes very difficult to predict in advance patient demand. These two factors should be taken into account in future improvement projects.

Absenteeism

The excellent results in terms of reduced absenteeism and smaller delays may be due to several factors. On one hand, actions taken with the professionals most affected by the problem (an issue that also affects them) have made them aware of the importance of that aspect. In regular meetings, we found that many physicians were not really aware of this problem.

Absenteeism has several significant consequences. On the one hand, it reduces the efficiency of external visits (lower demand), on the other hand, it generates troubles when we must forecast demand and schedule activities (we plan expecting

Table 4: Summary of results (including statistical test)

Preoperative tests	Pre	Post	Diff	Mann Whitney
Start	15/11/2011	01/09/2012		
End	01/09/2012	31/01/2013		
Days	291	152		
Average	35,45	37,95	7%	NS
% Programmed	54,94	56,17	2%	NS
Stdev	9,63	7,54	−22%	NS
Absenteesm	**Pre**	**Post**	**Diff**	**Mann Whitney**
Start	15/11/2011	01/10/2012		
End	01/10/2012	31/01/2013		
Days	321	122		
Absenteesm	11,40	6,25	−45%	NS
Delay	523,54	125,17	−76%	$p < 0,001$
Int. Med Ward	**Pre**	**Post**	**Diff**	**Mann Whitney**
Start	01/01/2012	01/06/2012		
End	31/05/2012	31/01/2013		
Days	151	244		
Delay	13,95	18,82	35%	NS
Admissions/week	0,88	1,00	14%	NS
LOS	164,14	58,29	−64%	$p < 0,001$
Occupancy rate	63%	84%	32%	NS

a certain level of absenteeism, but that is not always true and therefore, in some cases this will generate delays), also it has negative impact on continuity of care and OR planning (a patient who does not attend consultations can be scheduled for surgery).

Delays are a variable that has a huge influence on patient experience and satisfaction. In our center, a hospital with a high number of consultants working every day, patients are allocated according to a pre-fixed agenda done by physicians. Patients receive a SMS with a reminder of the exact time at which the visit will be held. The physician verifies that the visit has finished and records this in the electronic medical record. It is considered 'delay' the difference between the real and theoretical time for a particular visit.

The good results observed reveal that it is essential to raise awareness among physicians about this serious problem, which carries important consequences for patients, for quality of care and for patient satisfaction. Along the project we sent regular e-mails to participating clinicians to inform them of the results of the improvement.

Internal Medicine-Rehabilitation ward

Our mid-term length of stay ward has special needs in several dimensions. On one hand, we seek a high and stable occupancy rate to plan activity and staff efficiently. On the other hand, we try to absorb as many admissions, in order to reduce length of stay in our reference hospital. Finally, we try to offer our patients the best environment to take advantage of our rehabilitation therapy. To achieve both objectives, we must achieve the highest possible patient rotation.

One of the reasons for this result is that teamwork and a potential sense of common ground was lacking in this team. Developing a multi-disciplinary team and running effective meetings was just a first step but we feel that some work is still needed. As a second step, probably it can be tried a certain level of self-management of this team of great professionals.

After these positive results, it was clear to the entire team that this level of performance was a new standard. As a working conclusion, it was defined a managerial goal for the entire team, that was easy to understand, to communicate, and to follow:

- 80% occupancy rate (only 1 not occupied bed in a specific moment)
- 1 discharge per week.

In this case, it is clear for us that the Six Sigma process made easier to the team that creating a collaborative environment and a clear and meaningful control system is a great strategy to improve efficiency in the healthcare environment.

There is a certain level of uncertainty that we will be able to keep this level of performance stable in the

Table 5: Summary

Actions	Impact
Introduce a system that assigns a fixed number of appointments for preoperative tests each day of the week, depending on diverse parameters known to be related to the demand for pre-anesthesias	22% reductions in the variability of pre-anesthesias made
Implement an early warning system and conduct awareness actions for doctors most affected by the problem	45% reductions in the rate of absenteeism 76% reduction of for the delay in consultation
Bimonthly review of patient status discussed within a multi-disciplinary team managing an Internal Medicine-Rehabilitation ward	64% reduction of Length of Stay 14% Admissions per week 32% increase in the occupancy rate

long-term. Also, the goal of managers cannot be only 'doing the same', but re-inventing and improving results through revisiting procedures and processes. However, it is also critical for managers to gain credibility thanks to simple and self-evident proofs of performance.

Concluding remarks

In summary, the three projects share similar characteristics:

- They are directly related to patient care
- They impact quality of care, and patient experience
- They are quantifiable
- They have metrics that can be established as improving and monitoring tools
- They involve several departments, at different levels, within the hospital
- They have a direct or indirect financial impact.

Also, in our view, a very important point: in all cases, the project is initiated because a problem is detected from the team itself. In general this is not an initiative that has been started from the top management, but has been promoted from the professionals who are in daily contact with the patient. That said, the impact of the project can be summarized as follows (see Table 5):

This experience demonstrates how we collectively can manage processes of change in healthcare organizations. While our data are positive when dealing with improvement projects, we should make a few remarks. First, it is important to properly define the problem to be solved, including its impact on the quality of care, patient satisfaction, team environment and legal and economic context. In this phase, is critical to quantify the scope of the problem as precisely as possible.

Second, we need to identify the root causes, for which we should start an iterative analysis, which does not have not be simplistic or improvised. The analysis is possibly the most important step, since at this point we identify the causes most influencing on the origin of the problem. At the end of this stage, we need to have a working hypothesis that is what will define the action plan.

Third, the action plan is a set of decisions that take place, which can be divided into normative (what people need to do from now on, and how the manager will help them to achieve it), procedural (what organizational processes/administrative we will change or initiate) and control (what are we going to measure from now on, where we will extract data, how we will analyze it, and how often).

During analysis phase, we should be realistic regarding where we obtain the data from, how we analyze them, and how we believe it will help us to meet the target (expected improvement) without being too optimistic or conservative. As a general rule, in our experience, any change project that does not provide at least a 10% expected improvement, should be considered very carefully.

One of the criticism to Six Sigma is that in some cases there is a very explicit focus on savings and this might cause some resistance on healthcare workers. We can give the impression that quality of healthcare is subordinate to money. In fact, it is the contrary. Six Sigma makes an important contribution to the improvement of quality of healthcare. There is published evidence that Six Sigma seems to work both ways, costs are eliminated and quality is improved.[17] In sum, 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 pitfalls.

However, we must consider the cost of implementing the project. At least, salaries of Green

Belts and of the other team members involved should be only included when extra personnel has to be employed to replace them. As a recommendation, economic contribution will be calculated as total net savings achieved from all running and completed projects. They can include reductions in working time spent by employees, only if this time could be utilized elsewhere.

In order to avoid overload, a given manager, to be truly effective, should take into account how much time he can devotes to Six Sigma projects. As a rule of thumb, project management does not have to be more than 15% of total time estimated for the project. Therefore, if we estimate 1000 hours for a project, we need to allocate 150 hours to run it. It is our choice to start, lead, transfer, or cancel projects, but we better provide on our promises if we want not to hamper our credibility. Our time is limited, in real life we have to share our energies with daily tasks and nobody. It is therefore imperative to choose well those areas that we consider to improve, and be very rigid in these procedures. We also recommend a natural period of a year (when you start the new fiscal year) to review programs and either keep or replace those we deem best.

As an organization, we face some challenges in the near future:

- Calculating always the economic impact of projects
- Investing in resources and people in the long term: train more green belts
- As the number of projects increase, coordination and management will be required (a Master Black Belt) to set up a management control system to evaluate progress and support Green Belts
- It is better that new projects are always generated by professionals
- Putting valid data in the hands of the project team are needed.

A very attractive idea is to hold a 'Project grid': running every year several projects (or even better, having a 'waiting list' of projects). Therefore, we need clear selection criteria for new projects:

- Those aligned with strategic priorities of the organization
- Projects that can be developed in 12–18 months
- Problems that should require a certain level of in-depth analysis (i.e. no obvious solution)?
- We have to give priority to those projects that can be translated or 'spread' if successful
- Sense of urgency to address the problem
- Projects that can be tackled with reasonable amount of resources
- Critical issues tied to business priorities, with measurable and manageable parameters

We still need to work more in HSJDC to successfully implement Six Sigma and have it really integrated within the quality management system. In doing so, we hope to produce enough annual savings that compensate the cost of training employees and having them initiate Six Sigma projects. These results have already been obtained in other industries. To reach this performance level, we understand that we need to expand and grow our Six Sigma structure and commit to long-term investments and recognition efforts.

As a closing remark, more important than positive results of a particular project, we need to promote a truly internal cultural change, in which Six Sigma is an important part but it is not the only factor (we also need top management support, i.e.). Giving employees a basic set of tools and skills and empowering them to use a team-based approach to solve problems helps to establish a solid foundation for sustainable change.

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