Six Sigma and Business Process Management

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Abstract Business Process Management has no set methods of analysis for removing unneeded process steps, identifying inefficient or ineffective process steps, or simply determining which process steps to focus on for improvement. Often, tools and techniques from Six Sigma, an orientation to error-proofing that originated in the quality movement of the 1980s, are borrowed for those tasks. This chapter defines several Six Sigma techniques and shows how they can be used to improve deficient processes. The application of Six Sigma techniques is illustrated through a case study. Six Sigma can add to BPM efforts, however, it has few guidelines on how to choose techniques or redesign processes, thus requiring special skills and experience to add value to a process improvement project.

1 Introduction

Organizations should constantly improve their functioning to remain competitive. Yet, problems develop in the translation of strategy to actual business process, that is, the series of steps that accomplish some work (Kaplan and Norton 2001). Further, by improving business processes, the intellectual capital of the workers increases through added understanding of their role in the organization and through removal of resource gaps (Herremans and Isaac 2004; Harrison-Broninski 2010).

Business organizations are comprised of people who conduct thousands of processes in their daily business conduct. Organizations that do not manage their processes are less effective than those that do (Kaplan and Norton 2001). Further, organizations that allocate information technologies to processes, but do not manage the process, are mostly wasting their money.

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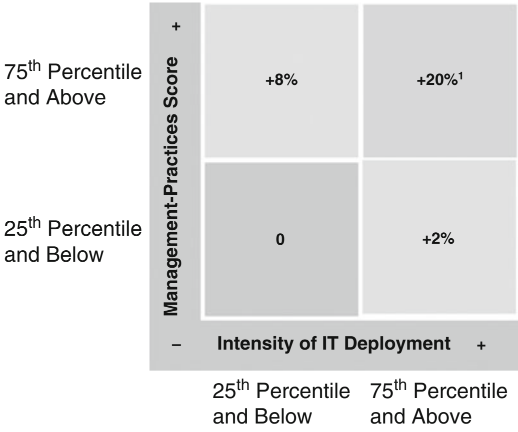

Fig. 1 Gains from managing both IT and business (Dorgan and Dowdy 2004)

As Dorgan and Dowdy (2004) show in Fig. 1, companies that actively manage their business processes but have a low intensity of technology for supporting work experienced an 8% gain from their investment. This shows that by simply doing no other changes than managing business processes can lead to higher return on investment. Companies that both actively managed business processes and had a high intensity of technology support for work experienced a 20% average gain from their investment. This result argues both for intelligent process management and strategic, intelligent technology deployment to support business processes.

Thus, in their search for survival capabilities, organizations have come to understand that excess of any sort is costly and should be removed. The first step to removing excess is to understand business processes, the work those processes accomplish, and how that work relates to the organization strategy (vom Brocke et al. 2010). Any process, process step, or process product (e.g., document, email, data, or other product of a process step) that does not contribute to the organization strategy or its ability to meet its mission is waste. Process value accrues to the extent that it fulfills some aspect of the organization's customer value proposition (Kaplan and Norton 2001). Thus, the overall goal of Business Process Management (BPM) is to improve processes to optimize fulfillment of customer value (see also Hammer 2010).

BPM uses techniques to measure, analyze, and improve processes; however, there is no single body of knowledge or techniques that apply to BPM. Six Sigma provides useful techniques for BPM (Harmon 2010).

1.1 Six Sigma

Modern quality programs have their roots in the 1950s in the U.S. and in Japan where Walter Shewhart and W. Edwards Deming popularized continuous process improvement as leading to quality production. Six Sigma is the practice of continuous improvement that follows methods developed at Motorola and is based on the notion that no more than 3.4 defects per million are acceptable (Motorola 2009). This means that a company fulfilling one million orders per year, and having only one error opportunity per order with 3-sigma correctness (99.95%) will experience 66,738 errors versus a 6-sigma (99.9997%) company, which would experience 3.4 errors. As engineered product complexity has increased (in telecommunications, for instance, the potential for over 50,000 errors per product are possible), without the type of quality management provided through Six Sigma tenets, virtually every product would experience some type of defect.

Six Sigma borrows from the lean manufacturing practice *genba kanri*, which loosely translates from Japanese as "workshop management," to error-proof and remove waste from processes (genba-kanri.com 2009). The guiding principles of lean are not to make defects, accept defects, create variation, repeat mistakes, or build in defects (genba-kanri.com 2009).

A sigma is a standard deviation from some population mean. Six Sigma practice strives for 99.9997% accuracy in the process. Lean Six Sigma combines lean manufacturing waste removal discipline with Six Sigma's defect prevention goal.

Six Sigma and lean are compatible families of techniques. Where lean removes waste, Six Sigma removes errors from processes. The purpose of Six Sigma is to improve predictable quality of developed products and services through the removal of normally distributed errors (see Fig. 2). If outcomes of a process are normally distributed, errors vary from the mean, or average, which is marked as the vertical line in the center of the diagram. The standard deviation, or sigma, is a measure of variance from the mean with equal areas on either side of the mean line. The tolerances for sigma levels one through six are listed in Fig. 3 (σ is the Greek symbol for sigma).

To set up a statistical process measurement system, the normal distribution is hypothetically turned 90° and compared to process control charts containing measures of product characteristics to determine which measures are outside accepted tolerance limits. The diagram in Fig. 4 shows a normal distribution on the right and a control chart on the left. The lines approximate 3-sigma tolerances, which is the industry norm for companies that do not practice Six Sigma. As can be seen in the diagram, there are many measures outside of the 3-sigma tolerance limits that would need investigation.

When applied to business processes, Six Sigma is useful for eliminating unnecessary or inefficient steps from a process through the application of techniques such as check sheets, Pareto analysis, cause and effect diagrams, root cause analysis, and value added analysis. These are only a few of the hundreds of techniques useful for identifying, prioritizing, analyzing, and fixing errors or inefficiencies in processes.

Six Sigma's organizing concepts are DMAIC and DMADV, which translate to define – measure – analyze – improve – control and define – measure – analyze – design – verify, respectively. In general, DMAIC is the approach recommended for improving an existing process and DMADV is the approach recommended for new process design. But, these sets of methods are more similar than different and all activities tend to be done for all projects.

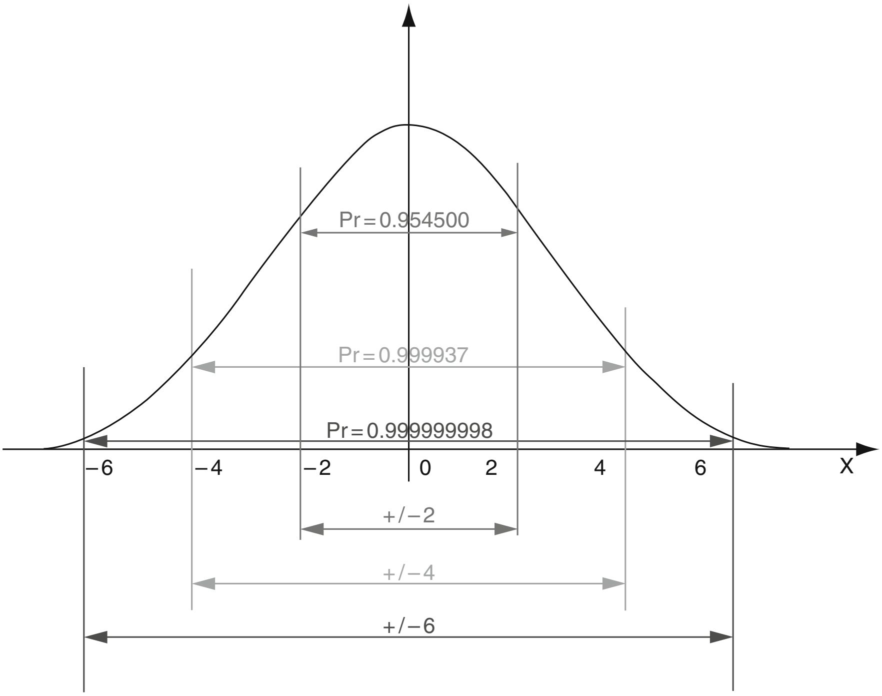

Fig. 2 Normal distribution with 2, 4, and 6 Sigma shown

1σ	690,000 per million opportunities (69% error rate)
2σ	308,000 per million opportunities (30.8%)
3σ	66,800 per million opportunities (6.7%)
4σ	6,210 per million opportunities (.62%)
5σ	230 per million opportunities (.02%)
6σ	3.4 per million opportunities (.00003%)

Fig. 3 Six Sigma errors and error rates

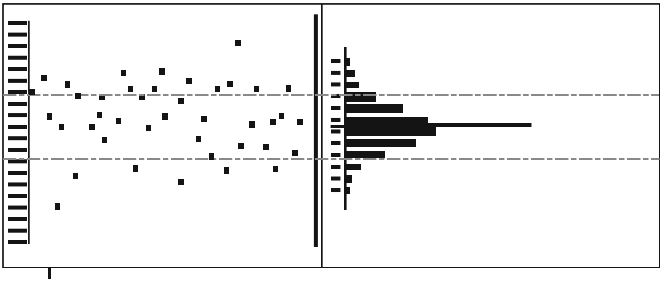

Fig. 4 Setup of SPC control charts

1.2 Process Management

Process management and improvement requires leaning – that is removal of unneeded steps for improvement, cleaning – that is the simplification and step-level leaning of remaining steps, and greening – that is the potential use of out-sourcing, coproduction, or automation. The application of several techniques to each process improvement step is demonstrated through the analysis of a help desk.

Within these three areas of analysis, a set of basic Six Sigma techniques are applied.

- Business Process Mapping
- Cause and Effect Diagram
- Check Sheets and other manual forms of problem identification
- Pareto Diagrams and other Graphic
- Quality Function Deployment
- Root Cause Analysis

These techniques are commonly applied to a wide range of problems and are representative of the reasoning used for process improvement. Each of these methods is demonstrated in the following Help Desk process.

2 Help Desk Process and Problem Analysis

The purpose of a Help Desk is to take requests that may be problems, service, or access requests, and satisfy them according to type and priority. Help Desks can be formalized following the IT Infrastructure Library, (ITIL®, Rudd and Loyd 2007). In this particular case, the current process is known to be error prone with lost requests, many open requests that are known to be closed, and other issues. The current process in Fig. 5 works as follows. A client calls the help desk and makes a request. The Help Desk is manned by Level-1 support staff who, typically, are more junior than the other levels, but are capable of resolving known issues and simple requests and perform all client interface activities. When the Level-1 person does not know the resolution to a request, it is sent to a Level-2 person who evaluates and prioritizes the request for completion. After some delay, the request is researched and a resolution is developed and sent to the Level-1 support person. Upon receipt, the resolution is sent after a delay to the client who, after some delay, tests the resolution. The client sends the outcome of the test to the Level-1 support person. If the request is correct or is fixed, it is marked as complete and the process ends. If the request is not correct or is not fixed, it is resent to Level-2 support for further action and goes through their process again.

There are some fairly obvious problems with this method of Help Desk process management. For instance, the use of Excel requires coordination. How is one to know what the most current version of the spreadsheet is? Level-1 and Level-2

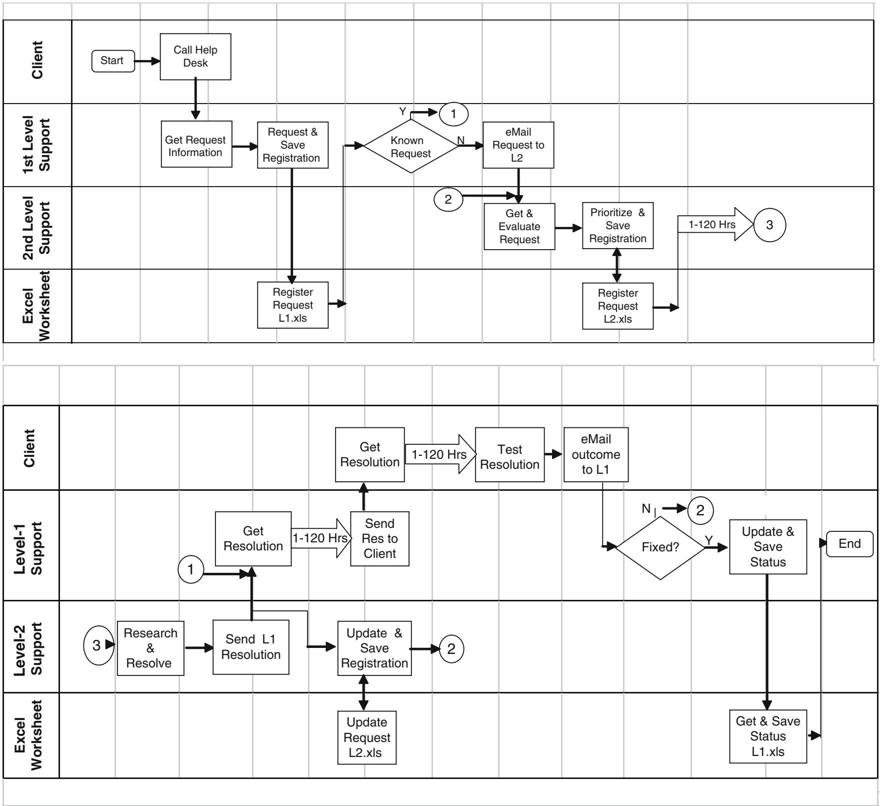

Fig. 5 Help desk current process map

appear to use different spreadsheets. Status is only updated at the end of the process; therefore, significant delays beyond the 120 h identified are possible. There is no reminder system and no method of automatic escalation. Therefore, loss of requests and unclosed requests are to be expected.

2.1 Process Map

To enable an analysis of the process, a process map is first developed. Process maps depict the roles, activities, and interactions of all participants in a process. Participants might include people, roles, departments, computer applications, and external organizations. If the focus is the information technology support for a process, the applications might also show individual databases that are accessed and/or updated by a process.

Suppliers	Inputs	Process	Outputs	Customer
Customer	Problem, issue, or request	Call Help Desk	Open Request Information	Help Desk Level-1 Support Staff
Customer	Request Information	Get Request Information	Request Information	Customer
Level-1 Support	Request Information	Request & Save Information	Register Requester L1.xls	Customer
Level-1 Support	If known	eMail Request to Level-2	Known request	Customer
Level-2 Support	If unknown to Level-1, Request	Get & Evaluate Request	Evaluation	Level-1 Support
Level-2 Support		Prioritize & Save Registration	Register Request L2.xls	Level-1 Support

Fig. 6 Help desk SIPOC diagram

Complex processes may require more elaborate information. One such Six Sigma technique is process *S*uppliers, *I*nputs, *P*rocess, *O*utputs, *C*ustomers analysis (SIPOC). A SIPOC analysis is a tabular summary of all related information to each process step (see Fig. 6). Suppliers and Customers are shown on the process map as roles with interactions, but the SIPOC details the actual documents, files, databases, and actual data affected by or used in the process (Rasmusson 2006).

Obvious as the problems may be, formal review and analysis is needed to determine all possible root causes for mitigation. The first course of action is to determine the frequency of the known problems. For this, a combination of check sheets and Pareto analysis can be used.

2.2 Check Sheets

A check sheet is a customized form used to collect data about the frequency of error occurrence. The data can be input to other analysis tools such as Pareto diagrams. While the format of a check sheet is usually a simple table with room for tick marks for the counts, more complex diagrams might be used to both locate and find errors that recur. Check sheets can be used to count errors, identify defect locations or causes, or to confirm presence or absence of an attribute.

A check sheet with the errors identified by tick marks is shown in Fig. 7. The most common error is lost requests but request not updated is also fairly common. It is likely that all errors would be addressed in priority order by the frequency of their occurrence. Therefore, to determine which should be the priority for immediate resolution, a Pareto analysis might be used.

Error	Count
Spreadsheet version	𝍸 𝍸 𝍸
Request entry not made	𝍸 𝍸
Request not updated upon resolution	𝍸 𝍸 𝍸 𝍸
Lost request	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸

Fig. 7 Example of check sheet for error counts

2.3 Pareto Analysis

A Pareto distribution is a special form of distribution named for Vilfredo Pareto who discovered its 80–20 rule properties. The Pareto distribution has since been recognized to apply to a wide range of social, geophysical, and scientific situations such as sales revenue from number of customers, error rates in software modules, and manufacturing defects in a process.

A Pareto diagram, in this case, is a graphical representation of problems to be prioritized for further action. Items to be compared are sorted from highest to lowest frequency and placed across the X-axis of a histogram. Item frequencies are on the Y-axis. A cumulative percentage line shows where the 80% point is found.

According to classic Pareto analysis, the breakdown is 80–20. However, in reality, many problems show a clear break point at some other distribution, such as 60–40 or 70–30. Variations of Pareto analysis – ABC and XYZ – look at different distributions for errors or management. ABC concentrates on consumption value of raw materials in different combinations while XYZ analysis evaluates classes of finished goods in terms of their demand qualities as high, medium, low, or sporadic (Bhattacharya et al. 2007; Canen and Galvio 1980; Katz 2007; Kumar et al. 2007).

The Pareto diagram for the Help Desk (Fig. 8) can be interpreted in two ways. The first two categories represent 69% of the total problems counted; however, by adding the third category, 87% of the problems are presented. Either analysis could be defended, but the highest priorities would be the focus of immediate work. The other items would be considered at a future date. One would not redesign the process without analyzing all of the problems in any case.

Next, the analysis would focus on the reason requests are lost since it is the most frequent issue. A cause and effect diagram is often used for this type of analysis.

2.4 Cause and Effect Diagram

Cause and effect diagrams were developed by Kaoru Ishikawa in 1982 to support systematic identification and classification of different types of causes that might

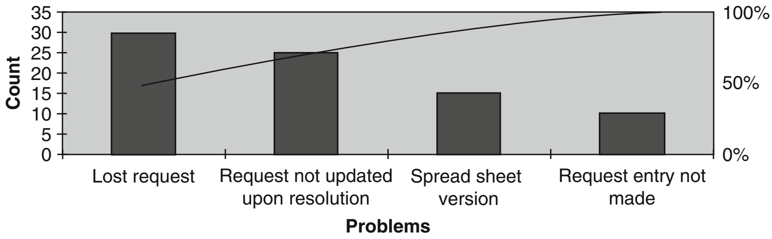

Fig. 8 Pareto analysis help desk problems

contribute to a problem. The graphic, also called an Ishikawa or fishbone diagram, facilitates identification of errors and the relationships between them.

Development of cause–effect diagrams uses brainstorming activity to combine the expertise of subject matter experts with the probing capabilities of a process improvement team. The group meets and identifies as many sources of errors as possible in the time allotted, categorizing them by type.

The backbone of the diagram is a right-facing arrow for which the problem being analyzed is listed near the arrowhead. Lines creating the fishbone effect, "bones," branch off of the backbone and each are named with a type of cause, such as the 4-Ms: Methods, man, machines, materials, the 4-Ps: Policy, procedure, people or plant/equipment (Brassard et al. 2000). Alternatively, the main bones can be customized to fit the context. For instance, when analyzing a process map, the bones could be the steps of the process. As the group discusses possible causes for the error, it identifies subcauses relating each to cause type. This, in effect, sorts the subcauses by type and allows discussion by cause type or by general cause. One drawback to Cause and Effect Diagrams is that they can quickly become so complex that understandability decreases. Therefore, they are best used with problems that have no more than six main "bones" each with fewer than six related problems.

The Ishikawa analysis (see Fig. 9) shows that lack of process, inadequate backup and learning, personnel who are not up to date, and use of Excel, without standards or security and lack of regular backups are key issues.

2.5 Root Cause Analysis

The purpose of root cause analysis (RCA) is to find all potential causes for some problem then ensure that sufficient changes are made to prevent the problem from recurrence (Wilson et al. 1993). Root cause analysis starts with a problem identified from, for instance, a Cause and Effect Diagram, to probe further into the root causes of problems to ensure that all aspects are evaluated and mitigated.

The RCA process is used to identify the true root (most fundamental) cause and the ways to prevent recurrence for significant issues for which outcomes can be

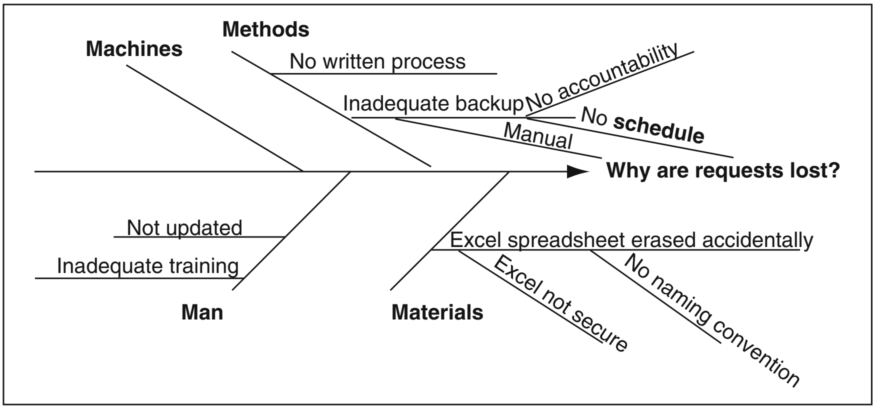

Fig. 9 Cause and effect diagram for lost requests

affected. This technique is also called "why – why chart" or "five whys". Attention in each level of analysis is drawn to all possible contributing factors through repeatedly asking questions that build on answers to prior questions. The steps to RCA are:

1. *Immediate action:* If the problem is still active, it should be resolved so that a normal operational state is achieved before anything is done.
2. *Identify the problem:* At this stage the problem should be completely, clearly articulated. The author should attempt to answer questions Who? What? Why? When? How? and How many? each relating to the problem to be analyzed.
3. *Identify the RCA team:* The team should include 4–10 subject matter specialists and experts in the RCA method to ensure analysis addresses all issues. The team should be given authority to correct the problems and empowered to define process changes as required.
4. *Root Cause analysis:* The method is applied to ask progressively more detailed levels of probing to determine the root cause. Although called the 5-whys, there is no number of levels that is correct; rather, the probing continues until one or more root causes for each problem are found.
5. *Action Plan:* The corrective action plan should eliminate the problem while maintaining or improving customer satisfaction. In addition to the plan, metrics to determine the effectiveness of the change are also developed. Once complete, the action plan is implemented.
6. *Follow Up Plan:* The follow-up plan determines who will take and who will evaluate the measures of the revised process, how often the metrics will be taken, and the criteria that will be applied to determine that the problem is resolved. The follow-up plan can be created while the action plan is being implemented; it goes into effect immediately upon the action plan implementation.

Root Cause Analysis: Why is there no Help Desk training?
A. There have never been processes for the Help Desk
  Q. Why has there never been a Help Desk process?
  A. **Supervisor turnover** and supervisor lack of training; when the Help Desk was established, the staff were knowledgeable and did not need training
    Q. Why is there supervisor turnover?
    A. …
A. Supervisor turnover and **supervisor lack of training**; when the Help Desk was established, the staff were knowledgeable and did not need training
  Q. Why is there no supervisor training?
…
A. Supervisor turnover and supervisor lack of training; when the Help Desk was established, the **staff were knowledgeable and did not need training**
  Q. Why were staff knowledgeable and now they are not?
  A. Because of **staff turnover, which is about every six months** and because new people, rather than existing staff, are now taking the Help Desk jobs.
    Q. Why is staff turnover so high?
    A. Help Desk has been viewed as a way to train new staff. The best Help Desk staff are moved as soon as possible to other IT positions.

Fig. 10 Partial root cause analysis

The RCA for the "Inadequate Training" problem that caused requests to be lost is evaluated here. The RCA would be conducted for each of the problems with appropriate mitigations developed.

1. *Identify the problem:* On December 15, 2009, when numerous internal customers complained to the CIO about lost and unsatisfied requests, the Help Desk in Dallas, TX was found to be operating with no written process. The problem was highlighted by the short tenure of most of the Help Desk staff; 10 of the 15 staff members had been on the job for less than 6 months. No one took ownership for the lost requests problem, so the cause was unknown. No one on the Help desk had attended any formal job training. Help Desk staff learned problem resolutions on the job from each other. All 15 Help Desk staff members were affected by this problem.
2. *Identify the team:* The team consisted of two RCA specialists, two Level-1 Help Desk members and two Level-2 support people – one each from operations and application support.
3. *Immediate action:* The immediate action was to identify and resolve the lost problems. The Help Desk Manager sent an email to all users identifying the loss of several problems and asking anyone with outstanding requests to call, verifying all requests. Two Help Desk staff manned phones for 3 days to verify requests and add them to the Excel spreadsheet, as needed. As a result of this action, 400 requests were identified as outstanding; 100 of those requests had not been in the Excel spreadsheet.
4. Training, turnover, and lack of multiuser software were key issues. A partial *root cause analysis* of training issues is shown in Fig. 10.

5. *Action Plan:*

   - Provide a plan for the Help Desk Manager to remain in the position for a minimum of 1 year.
   - Create a career path for someone to stay in the Help Desk area if desired to reduce constant staff change.
   - Provide for senior Level-1 staff to mentor junior staff.
   - Change job descriptions of the Manager and Help Desk staff to provide merit pay for single-call request completion, short times from open to close of requests, etc.
   - Create a process for the Help Desk so that there is accountability for all requests with metrics to verify that all requests are logged as received and monitored for daily completion.
   - Develop in-house training for Help Desk staff that the Manager also attends. In the development of training, use the Help Desk process as the basis for the training.
   - Create measures to monitor Help Desk operation that become the responsibility of the Help Desk Manager.

6. *Follow Up Plan:*

   - The Manager of the Help Desk is to be tasked with monitoring training effectiveness as evidenced through measures to be defined. Metrics and an analysis of them should be in the monthly report to the CIO and Manager of Operations.

As can be seen from the analysis of the Help Desk problems, each of the techniques is useful but they require significant analysis and take time. Each technique assumes that skilled staff is conducting the analysis to minimize opinion and maximize the potential for complete mitigation of problems. Plus, each technique focuses on only one aspect of a problem, rather than a whole problem. Thus, many such analyses are required to fully analyze all issues relating to a complex process, and all recommendations must be integrated.

2.6 Value Added Analysis (VAA)

Where RCA seeks to prevent incidents from recurring in a process, value-added analysis seeks to remove nonessential process steps. VAA is not strictly part of the Six Sigma training but is a useful complementary technique nonetheless. There are four types of event-driven processes: Management, customer affecting, primary (relate to customer affecting, e.g., design engineering), and support (e.g., HR, legal, IT). A single process can have elements of more than one process type within it and, when conducting analysis, part of the task is to tease out the each step's process type.

To conduct value added analysis, the following steps are conducted:

1. Map the process.
2. List all process steps and place them in a table with four other columns for duration, value adding activities (VA), nonvalue-adding activities that are required (NVA), and nonvalue adding activities that are unnecessary (NVAU).
3. Review each process step, asking the questions:
   (a) Does an end Customer require this activity, and will that Customer pay for this activity? If yes, then it is value adding (VA).
   (b) Could a customer-facing activity be eliminated if another activity were done differently or correctly? Is this activity required to support or manage the value adding activities, e.g., legal, HR, etc.? If yes to either, then it is nonvalue-adding (NVA).
   (c) Could this activity be eliminated without impacting the form, fit, or function of the Customer's "product?" If yes, then it is nonvalue adding and unnecessary (NVAU).
4. Evaluate all NVAU activities for elimination.
5. Evaluate remaining activities for automation, outsourcing, or coproduction.

NVA and NVAU activities that do not appear able to be automated or eliminated are marked for further analysis for streamlining, outsourcing, or some other replacement with VA activities.

Figure 11 indicates a significant number of NVAU, unneeded activities. The goal of analyzing this information is to completely eliminate as many of the NVAU activities as possible. The times associated with each step are added to establish a baseline against which to measure changes for improvement. Figure 12 shows the time for a single request to provide a basis for evaluating potential savings that might be gained by changing the method of performing Help Desk activities.

Figure 12 analysis indicates that significant time can be saved from using a different method of performing Help Desk request monitoring. The NVA and NVAU steps should be further evaluated to simplify the process and reduce the amount of human interaction. Plus, wait times should be completely eliminated if possible; they are simple waste, exacerbating the loss of Help requests.

Automation can streamline the VA times and remove much of the NVA time. For instance, by using an online data entry method for entering Help requests, approximately 3 min per request can be eliminated since only the user is involved in that activity. By letting the user select priority, 5 min per request of Level-2 support time can be saved. Because Excel is not multiuser software, every time an update is needed, the Help Desk Representative finds the current file, opens the file, and waits while it opens. With multiuser software that can stay open on all Help Desk PCs throughout the day that time is eliminated. Additionally, because the software would be running nonstop on all Help Desk PCs during work hours, there should be fewer delays in saving files, thus saving another several minutes per request.

Use of multiuser software for all levels of staff provides a single file that is updated with one record per Help request, thus mitigating the likelihood of request losses both from the single instance and from the single file with multiuser

	Evaluation		
Process Step	**VA**	**NAV**	**NVAU**
Call help desk		NVA	
Get request information		NVA	
Request registration		NVA	
Save registration		NVA	
Register request L1.xls			NVAU
Check if known request	VA		
EMail request to L2			NVAU
Get request			NVAU
Evaluate request	VA		
Prioritize registration		NVA	
Save registration		NVA	
Register request L2.xls			NVAU
Wait 1-120 Hours			NVAU
Research and resolve request	VA		
Update and save resolution		NVA	
Update resolution L2.xls			NVAU
Send L1 resolution			NVAU
Get resolution	VA		
Wait 1-120 Hours			NVAU
Send resolution to client			NVAU
Update resolution		NVA	
Save resolution		NVA	
Update request L2.xls			NVAU
Get resolution	VA		
Wait 1-120 Hours			NVAU
Test resolution	VA		
eMail test results to l1		NVA	
Test if resolution fixes the problem		NVA	
Update and save status		NVA	
Get and save status		NVA	

Fig. 11 Value added analysis

protections. In addition, by selecting software with automatic escalation, no request should ever go unresolved.

Evaluating the NVAU time affords savings as well. By automating with a multiuser Help desk tool, much of the NVA and NVAU work can be automated. With a selectable problem type, the software can determine that the problem is novel or not by user selection from a drop-down problem type or entry of a new problem. Then, routing to Level-1 is bypassed and the problem could go immediately to Level-2. There are two "send-get resolution emails" in the current system that take significant time. By automating the workflow, the emails are produced automatically when the status of the software is updated, thus saving 1,500 h/month.

Figure 13 below shows the proposed changed process that would use multiuser Help Desk software.

By eliminating any steps not needed as a result of automation and by streamlining those that remain, plus by forcing lower wait times of all types by building into

	Evaluation		
Process Steps	**VA**	**NVA**	**NAVU**
Call help desk		1 Min	
Get request information		1-4 Min, $\bar{X}$=2 Min	
Register request		1 Min	
Save request		10 Sec	
Register request L1.xls			10 Sec
Check if known request	5-15 Min, $\bar{X}$=10 Min		
EMail request to L2			2-5 Min, $\bar{X}$=3 Min
Get request			2-5 Min, $\bar{X}$=3 Min
Evaluate request	5-60 Min, $\bar{X}$=20 Min		
Prioritize request		5 Min	
Save registration		3 Min	
Register request L2.xls			10 Sec
Wait 1-120 Hours			1-120 Hrs $\bar{X}$= 20 Hrs
Research and resolve request	20 Min – 40 Hr $\bar{X}$= 2 Hrs		
Update and save resolution		5-60 Min, $\bar{X}$=20 Min	
Update resolution L2.xls			10 Sec
Send L1 resolution			5-60 Min $\bar{X}$=20 Min
Get resolution	5-60 Min, $\bar{X}$=20 Min		
Wait 1-120 Hours			1-120 Hrs $\bar{X}$= 20 Hrs
Send resolution to client			5-60 Min $\bar{X}$=10 Min
Wait			1-120 Hrs $\bar{X}$= 20 Hrs
Get resolution	5-60 Min, $\bar{X}$=20 Min		
Wait 1-120 Hours			1-120 Hrs $\bar{X}$= 20 Hrs
Test resolution	20 Min – 40 Hr		
	$\bar{X}$= 2 Hrs		
eMail test results to l1		5-60 Min, $\bar{X}$=10 Min	
Test if resolution fixes the problem		1 Min	
Update and save status		3 Min	
Get and save status		10 Sec	
Cumulative Individual Step Time	82.16 Hours	20.4 Hours	36 Min + 80 Hrs Wait

Fig. 12 Value added analysis – potential time savings

	Evaluation		
Process Step	**VA**	**NVA**	**NVAU**
Enter request information		1-4 Min, $\bar{X}$=2 Min	
Save registration		10 Sec	
Check if known request (2,000/mo)	0-15 Min, $\bar{X}$=2 Min		
Forward request to L2			0-5 Min, $\bar{X}$=2 Min
Evaluate request	5-60 Min, $\bar{X}$=20 Min		
Prioritize request (500)	5 Min 25Hr/Mo		
Wait 1-120 Hours			1-40 Hrs $\bar{X}$=8 Hrs
Research and resolve request	20Min – 40 Hr $\bar{X}$= 2 Hrs		
Update and save resolution		5-60 Min, $\bar{X}$=20 Min	
Update resolution L2.xls			10 Sec
Get resolution	5-60 Min, $\bar{X}$=20 Min		
Wait 1-120 Hours			1-40 Hrs $\bar{X}$=8 Hrs
Wait			1-40 Hrs $\bar{X}$=8 Hrs
Get resolution	5-60 Min, $\bar{X}$=20 Min		
Wait 1-120 Hours			1-40 Hrs $\bar{X}$=8 Hrs
Test resolution	20 Min – 40 Hr, $\bar{X}$=2 Hr		
Update and save status		10 Sec	
Get and save status		10 Sec	
Cumulative Individual Step Time	5.3 Hours	22.5 Min	2.2 Min with 32 Hrs wait time

Fig. 13 Proposed automated process

the software an automatic escalation of notices of noncompletion, makes the results dramatic (see Fig. 14, summary). The value-added time is reduced from 82 to 5.3 h, nonvalue added time is reduced from 20.4 h to 22.5 min, and the nonvalue added, unneeded time drops from 36 min with 40+ h of wait time to 2 min plus wait time.

Thus, the problems of lost and uncompleted requests could be reduced or eliminated completely by the use of software specifically for Help Desks. Plus, the movement of the request from Level-1 to Level-2 and the decision process could potentially also be automated so that Level-1 staff receive only problems for which a known solution exists; this implies that all calls to Level-1 should be resolvable in a single phone call. In addition to automated movement of problems to Level-2 staff for resolution, automated escalation would ensure that no problem went unnoticed for any period of time and the 120-h waits could be eliminated.

BEFORE			
	VA	NVA	NVAU
Cumulative Individual Step Time	82.16 Hours	20.4 Hours	36 min + 40 Hrs Wait time
AFTER			
Cumulative Individual Step Time	5.3 Hours	22.5 Min	2 Min + 32 Hrs wait time

Fig. 14 Improvement from automation and elimination of unneeded actions

2.7 *Quality Function Deployment (QFD)*

Quality Function Deployment supports both design and redesign of processes, and can be modified for different types of analyses. QFD is a technique to translate customer needs, requirements, and expectations into detailed product and process specifications. Therefore, while it can be used to analyze existing products, QFD is often applied to analyzing new needs and requirements that determine the nature of a new product. QFD is very good for summarizing complex thought processes and competing analyses of the same situation (Cohen 1995). One disadvantage is that the data can be very complex to interpret because the diagram can actually present too much information. Another disadvantage is that many items require subjective judgments that can alter the outcome. By attending to possible disadvantages, they can be managed.

QFD builds a "house of quality" matrix (Fig. 15) with project goals or needs in rows (what information), alternative means to reach the goals in columns (how), and the priority or quantity of each in each cell (how much), using simple symbols to rate the means on their ability to meet requirements (Cohen 1995).

To complete the "house," each need is prioritized and/or weighted in the "importance" column (Fig. 16). Priorities can be expressed in many ways; one simple method is to allocate a portion of 100% to each with the total allocations adding to 100. The method of assigning importance should be defined and provided in any reports so the reading audience understands its rationale; simple is better because it is more defensible and understandable.

A row is added below the "roof" to indicate the type of eventual metric or amount of the means that is desired. These entries are informational in the QFD but are used later when metrics for determining process success are developed.

The cells of the triangular "roof" of the house compare means of meeting needs when competing methods are defined. A positive relationship indicates synergy between two means while a negative relationship indicates a conflict or choice required between two means.

The right side of a QFD diagram seeks to answer "why" questions about the entries. This area also can be used for several types of information. Two common uses are benchmarks and rationale for rankings. In developing marketing plans or products, the right side can provide columns for benchmark information of this company versus its competition, industry average, and/or best practice. The use of

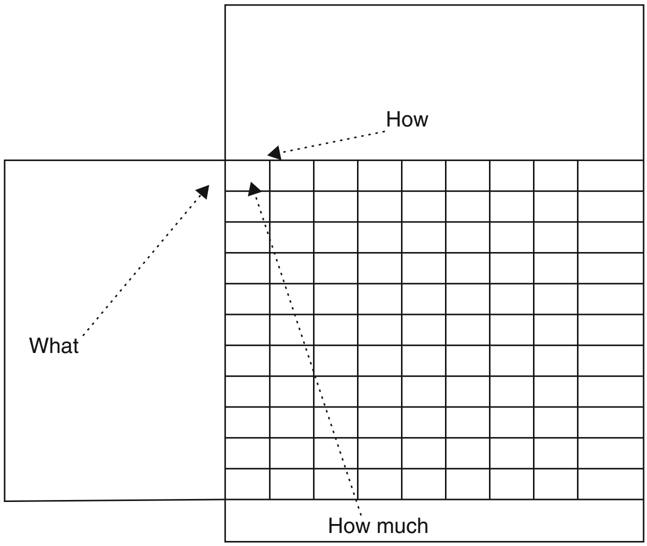

Fig. 15 Basic QFD matrix

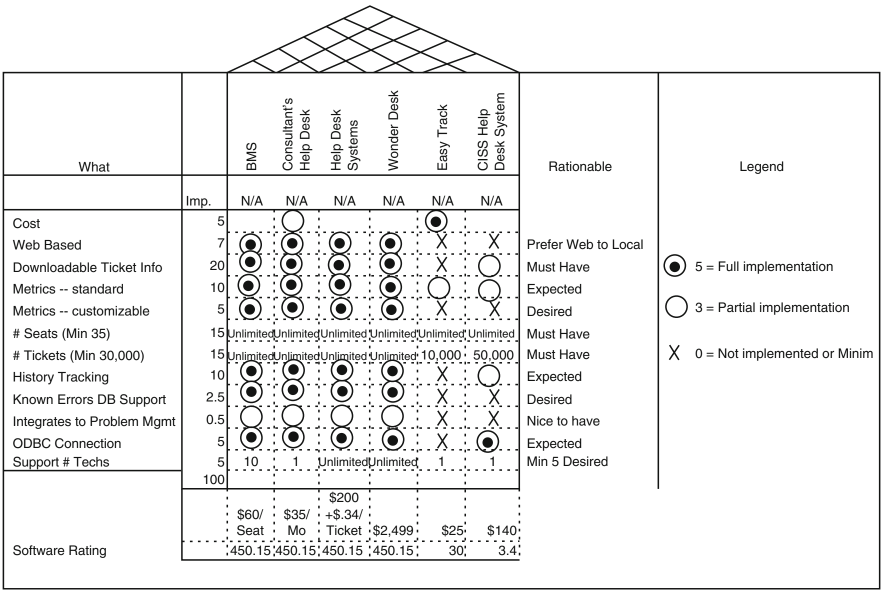

Fig. 16 QFD software evaluation

benchmark data provides an instant check on the importance of each need. Second, the area is also used in product development QFDs to identify the rational for priority definition, with a rationale provided on each row's need entry. This is useful for deflecting any political discussion that might relate to how needs are prioritized.

The last area is the "basement" of the house, which seeks to answer "how much" questions about the means entries. The basement can contain several types of information: raw materials costs or amounts, financial contribution or margin for a product feature, or other supply chain or financial information.

Figure 16 is a modified QFD for selecting software. In this modification, the "means" or alternatives for raw materials is replaced with potential product choices. These are evaluated according to the requirements down the left margin, and a score for each product is developed from the analysis. There are no synergies from combining products so the roof of the QFD is empty. The diagram shows that the Consultant's Help Desk option at $35 per month is the most cost-beneficial option of those evaluated.

Some advantages of QFD are that features and functions or products and processes analyzed using QFD tie directly to customer requirements. By providing benchmark, supply chain, financial, and trade-off information in a single place, analysis of the overall QFD outcomes is simplified. Further, QFD supports the thinking required to develop a complete summary of decisions relating to product concept definition, product design, process design, engineering design, and production documentation. Some disadvantages of QFD are that it is time-consuming and can be an expensive activity; the technique requires expertise to develop a solid analysis; the subjective evaluations can skew results; and the outcome can be difficult to interpret.

2.8 Process Redesign

While the Help Desk case somewhat oversimplifies real life problems, it is a useful example of the issues and complexities that arise during a process improvement project. The redesigned process increases individual contribution to organizational success by removing resource gaps by the use of software to provide a single point of storage and contact for all parties involved in entering or resolving a request. The redesigned process uses coproduction to have the users enter their own requests, which are served automatically to the next available support person. Help Desk Level-1 support evaluates whether or not the request has a known solution and applies the known solution. If this evaluation can be automated, its time is removed from the process. If no Level-1 solution exists, the escalation to Level-2 support is automatic. An automated process can provide reminders of outstanding requests, escalate the reminders as the request ages, and provide detailed metrics of performance.

3 Discussion

This chapter presents only a few of hundreds of techniques available for problem analysis and, while they provide adequate expert guidance to obtain an efficient process redesign, often such simple tools are not adequate.

BPM is critical to organizational success. Six Sigma is a proven, globally accepted technique that facilitates the analysis and improvement of processes (Antony 2006). As demonstrated through the Help Desk case, application of numerous techniques is needed to fully analyze a process and determine the importance, priority, causes, and possible solutions to the problems of a process. As process areas are more complex, the tools likewise become more robust and complex. QFD and SPC are defined briefly in this chapter and are two robust and scalable techniques. Another is failure mode effects analysis (FMEA). FMEA is a technique through which all possible errors for every possible eventuality and stage of a process, usually manufacturing, are analyzed for breadth and depth of impact, expected frequency, and cost (Casey 2008). Thus, many RCAs might be performed to define all possible problems for a single product or process. Then, FMEA analysis would design mitigations on the basis of prioritizing based on potential damage to the organization. Thus, the more complex the problem, the more elaborate the tools and techniques to remove and manage the process and its risks.

There are two main drawbacks to Six Sigma practice. The first drawback is organizational and the second relates to the techniques. Six Sigma can develop its own bureaucracy that risks overpowering the importance of "getting product out the door". This is not unique to Six Sigma; the tendency of organizations is to grow or wither. However, companies need to guard against becoming cultist about following Six Sigma and remember that producing products or services for their customers must always come first in importance.

The second issue relates to the techniques. Without Six Sigma, Business Process Management is a set of concepts without an organizing core. However, even with Six Sigma as an organizing theme, there are hundreds of Six Sigma techniques that can be applied to aspects of areas under study. There is little organization of techniques into a cohesive body of knowledge. The various Six Sigma certification levels – yellow, green, brown, black – discuss toolkits from which technique selection is made at the discretion of the user (Andersen 1999). Yet, there is no fixed set of techniques with variation of what is taught from one person to another (Antony 2008).

Within a process improvement project, there are about four key thought processes relating to problem recognition, analysis, redesign, and metrics definition, yet Six Sigma is unclear about which methods are best in any given phase or situation. And, occasionally, a method that might be used, such as cause and effect diagrams, is overwhelmed by the complexity of the situation and proves unusable (Conger and Landry 2009). Six Sigma also offers little guidance on how to customize or improvise tools to make them usable in such situations. Finally, while Lean Six Sigma is useful for removing errors and waste from a process, the techniques do not assist in developing recommendations for change or for designing new processes. Recommendations and design still rely on the skill and insight of the people conducting the analysis. Thus, Six Sigma is not only a useful way of focusing attention on elimination of waste and the reduction of errors but it can also be an overwhelming toolkit without much guidance for developing project outcomes.

4 Conclusion

Process management is a management imperative that is not done once. Either ongoing or periodic assessment of processes with improvement analysis is required for businesses to stay competitive. Analysis techniques from Six Sigma complement process management by introducing rigor to waste reduction and quality improvement. This chapter demonstrates how Six Sigma techniques can be applied to process analysis to improve its operation (Johannsen et al. 2010).

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