Chapter-2: Literature Survey on Management Issues

2.1 Evolution of quality management practices in Indian organizations

During the last decade, product and service quality has emerged as a key issue in most Indian industries. Globalization of industries and liberalization of import regulations by the Government of India has forced many companies to compete with multinational companies both in the home and the export market. This has made them take a serious look at their quality improvement initiatives.

Historically, the quality improvement efforts in Indian companies may be broadly divided into three distinct phases [Jagadeesh (40)]. The first phase is the pre-independence period. The second phase is the period between 1947 and 1992. Finally, the third period is from 1992 to the present. Before 1947, India was a British colony, had very little industrial production and typically exported raw materials to the United Kingdom for processing. Very little efforts existed in improving the quality of Indian goods. Since the 1920s, a number of Indian engineering companies started industrial production and some of them established a reputation for quality products [Piramal (82)]. However, there were no organized efforts to improve quality.

In the post-independence era (1947-1992) the government followed a policy of import barriers and restricted production via ‘permits’. It strongly encouraged import substitution. This resulted in a protected business environment from both foreign and domestic competitors [Agarwal (1)]. There was very little incentive for Indian companies to improve quality. They produced shoddy products and sold whatever they produced as there was a perpetual shortage of consumer and industrial goods. The customers were happy that they got the product and accepted poor quality. The emphasis was ‘production volume’ and not on ‘product quality’ [Pati & Reis (81)]. For example, Hindustan Motors still produces The ‘Ambassador’ line of automobiles that are based on the Morris platform prevalent in the United Kingdom in the late 1950s. In the early 1980s, the first organized quality improvement efforts were undertaken by the Confederation of Indian Industries (CII). Leading companies started setting up quality circles and, in 1987, the Confederation of Indian Industries with the support of 21 companies set up a TQM division. A National Committee of chief executives of these companies formed the National Committee on Quality, and quality month was declared to be an annual event. CII also launched the first newsletter on quality.

In 1987 and 1988, the CII invited the Juran Institute to India to conduct three training workshops, and then in 1989 a team from India attended the Deming Seminar in London. Study teams organized by the CII were taken to Japan and the USA to study quality practices. During 1990, the CII consolidated and focused on training, and in February 1991, an Indian company with the assistance of the CII, obtained the first ISO 9000 certification in India. The CII organized the launch of the National Quality Campaign led by the Prime Minister of India in May 1992. Around this time, the process of globalization and liberalization was started in the country, bringing a new dimension to
the business and industrial sectors. From then on, a new approach to thinking in terms of quality, productivity, and competitiveness began.

However, the developments related to Indian companies concerning quality of products and services; need to be examined on a comparative global scale. This would provide a better picture of the progress made by Indian companies in improving quality.

In the early 1990s, a survey by World Competitiveness Report looked at products and services from 41 countries and ranked them based on quality. The quality of Indian products was found to be very low. According to the summary of results reported in [Skaria (90)], India’s rank based on different quality parameters included being 39th in price-to-quality ratio, 38th in practice of TQM, 40th in customer orientation, 28th in product liability, 39th in time to innovate, 38th in time to market and 22nd in corporate credibility. In comparison to similar products from other countries, Indian products and services were far from satisfactory, and have a very poor image.

In 1992, India faced an acute foreign exchange crisis and that led to economic reforms. Lower trade and investment barriers and scrapping of the ‘permit’ system led to the entry of many MNCs into the Indian market. This tremendously increased the level of competition for most consumer and industrial products. Meanwhile, many Indian companies had increased their production levels, which eliminated much of the ‘shortage’ in many sectors. The economic reforms that started in 1992 have ushered in a new era of progress and prosperity in the country. While all these developments are seen at the gross level, companies in India have been trying individually to improve their product quality, and their overall performance through various quality improvement practices.

For example, [Gupta & Sagar (33)] describe a case of total quality control in an engineering company through the extensive use of personal computers, and state that the Indian company was able to overcome many quality related problems including: high rejection levels, slow inspection rates, frequent errors in measurement, inconsistency in interpreting inspection data, time consuming data storage and retrieval, rigid inspection schedules, not responding to changing environment, and quality plans not adjusted to varying batch sizes. The company improved the problem solving capacity through quality circles, and a quality database at each stage. Comprehensive information systems enabled the personnel to obtain better guidance, leading to improved decision-making. Thus, the success is attributed to systematic application of TQM.

[Business Today (18)], a leading Indian business publication, in an exclusive coverage on status of quality of India, presented a detailed report on companies that are market leaders in their respective industries. The cases covered include reports on leading Indian companies like Mukund, BPL, ABB, HDFC, Amex, Hindustan Lever, Ranbaxy, Indal, Gujarat Ambuja, Vysya Bank, Oberoi Hotels, and Thermax. The [Business Today (18)] report emphasized that these companies carved a niche for themselves by focusing on quality in their planning, operations, and marketing strategies. According to [Mehta (58)], like Japan and other nations, India too can compete successfully in the global market by
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improving the quality of the products produced by Indian companies. The globally competitive and successful software sector of the Indian economy is a case in point.

In a recent study on the state of quality initiatives in Indian companies [Mandal et al (52)], opinion was sought on the current attitude of major Indian companies on the use of quality management practices (QMP) after the liberalization of the Indian economy. Ninety percent of the companies felt that the current attitude to QMP is supportive, whereas the remaining 10% felt that there has not been any change. This response indicates that, after the opening up of the Indian economy, the focus has shifted to quality and the use of QMPs to face the competition that resulted from the entry of multinational corporations into India.

In that study, questions were asked as to which type of quality standard certification had been obtained by the respondent company, the time taken to obtain certification and whether the certification was for the entire company or a particular division/production unit(s). A large number of responses came from ISO 9000 certified companies (81%). In 1993, there were more than 1,500 companies in India certified to ISO 9000 standards [Taylor (95)]. However, according to [Taylor (95)], this number is very low compared to the UK, which had 22,000 certified companies in the same period.

TQM in India is still in the nascent stage. Until recently, there was no market compulsion to embrace modern quality management practices by Indian organizations. Companies located in the western region of India have adopted TQM to a large extent. A reason for this is that most of the multinational companies are located in the western region of India and these companies are more receptive to new ideas, such as TQM, in comparison to their native counterparts.

Quality management practices that have been adopted by Indian manufacturers include quality circles (QC}s), design of experiment (DOE), business process re-engineering (BPR), goods manufacturing practices (GMP), quality improvement projects, and JR-DQV evaluation (JRD-QV is an award that is open to companies of large business houses in India). The design of the JRD-QV award is partly based on the Malcolm Baldrige National Quality Award (MBNQA).

While various quality initiatives have been adopted by many Indian firms, the software sector stands out as the most successful in the global economy. The competitiveness of Indian software firms, while founded on lower cost, is also based on technical expertise and excellence in quality and execution. It is conceivable that other services could model themselves after the software sector, and develop capabilities to successfully compete in the global economy. Such an evolution of the service sector could then contribute significantly to the continued emergence of the Indian economy [Banerjee et al (10)].
2.2 Dr. J. M. Juran on quality improvement

All quality improvement takes place project by project and in no other way. The critical word here is project. We define a project as a problem scheduled for solution – a specific mission to be carried out.

Quality improvement does not come free. Each improvement project requires an investment in two forms:

1. A diagnosis to discover the causes of poor quality.
2. A remedy to eliminate the cause

But the return on investment is high.

2.2.1 Juran’s trilogy

- Quality Planning
- Quality Improvement
- Quality Control

2.2.2 Quality planning

- Determine who the customers are
- Determine the needs of the customers
- Develop product features that respond to customer’s needs
- Develop processes able to produce the product features
- Transfer the plans to the operating forces

2.2.3 Quality improvement

- Establish the infrastructure
- Identify the improvement projects
- Establish project teams
- Provide the teams with resources, training, and motivation to:
  - Diagnose the causes
  - Stimulate remedies
  - Establish controls to hold the gains

One high point: It is not enough to establish policies, create awareness, and then leave all else to subordinates. Upper managers should personally participate in the review of progress on improvement and they should

1) Establish quality goals
2) Provide resources
3) Review progress
4) Give recognition
5) Revise the reward system
6) Serve on project teams
7) Face up to employee apprehensions

2.2.4 Quality control

- Evaluate actual product performance
- Compare actual performance to product goals
- Act on the difference [Juran (44)]

2.3 Principal concepts of Dr. Deming

2.3.1 Deming’s 14 points

- Create constancy of purpose for improvement of product and service
- Adopt the new philosophy
- Cease dependence on mass inspection
- End awarding business on price
- Improve constantly and forever the system of production and service
- Institute training
- Institute leadership
- Drive out fear
- Break down barriers between departments
- Eliminate slogans, exhortations and numerical targets for the workforce
- Eliminate numerical quotas or work standards
- Remove barriers to taking pride in workmanship
- Institute a vigorous programme of education
- Take action to accomplish the transformation

2.3.2 Eight obstacles to transformation

- Hope for instant pudding
- Our problems are different
- Show me an example in my industry
- Insulation surrounding top management
- We prefer not to make any change
- Much data, little information
- Our troubles lie wholly with the workforce
- We installed quality control [Deming (24)]
2.3.3 What does resistance to change look like?

Some resistance is intense, dramatic, and even violent. Juran reminds us of some examples: When fourteenth-century European astronomers postulated a Sun-centered universe, this idea flew in the face of the prevailing cultural beliefs in an Earth-centered universe. This belief had been passed down for many generations by their ancestors, religious leaders, grandparents, and parents. (Furthermore, on clear days, one could see with one’s own eyes the Sun moving around the Earth.) Reaction to the new “preposterous” unacceptable idea was swift and violent. If the Sun-centered believers are correct, then the Earth-centered believers are incorrect – an unacceptable, illegitimate, wrong-headed notion. To believe in the new idea required rejecting and tossing out the old. But the old was deeply embedded in the culture. So the blasphemous astronomers were burned at the stake.

Another example from Juran: When railroads converted from steam-powered to diesel-powered locomotives in the 1940s, railroad workers in the United States objected. It is unsafe, even immoral, they protested, to trust an entire trainload of people or valuable goods to the lone operator required to drive a diesel. Locomotives had “always” been operated by two people, an engineer who drove, and a fireman who stoked the fire. If one were incapacitated, the other could take over. But what if the diesel engineer had a heart attack and died? So intense were the resulting strikes that an agreement was finally hammered out to keep the fireman on the job in the diesels!

Of course, the railroad workers were really protesting the likely loss of their status and jobs.

In an organization, resistance to change can be open and direct or subtle, but the result is the same – to delay, disrupt, or prevent a proposed change in the cultural pattern. Here are some of the more obvious direct forms of organizational resistance to change:

- Bitter confrontation and arguments in meetings
- Resignations
- Transfers
- Strikes or other job actions
- Firings
- Whistle-blowing, particularly to the press

More subtle forms of resistance to change include:

- Failing to return a phone call or answer an e-mail
- Failing to keep appointments
- Assigning to a subordinate a task that prevents complying with a change (such as loading up a staff person with work so he/she is too busy to attend Six Sigma project team meetings)
- Being late to meetings
- Ignoring meetings altogether; not showing up
- Promising something (such as sales figures or data) and not delivering
• Ignoring the change (such as parking in the same old closeby place instead of the newly assigned far-off place, wearing the same casual clothes instead of newly required formal clothes, keeping the same old hours instead of the newly established hours, and failing to produce a newly requested weekly report)
• Writing expense reports in long hand instead of using the new computer software package

2.3.4 Preventing or overcoming resistance to change

Juran Institute employs the “Rules of the Road” for handling resistance to change.
• Secure the active participation of those who will be affected, both in the planning and in the execution of the change. Consider also including third parties who can supply perspective, balance, and objectivity.
• Provide sufficient time for the mental changes required for coming to terms with the idea of a change.
• Start small and proceed gradually, allowing people to experience success and satisfaction from small increments of change.
• No surprises; don’t suddenly dump an unexpected change on anyone. This is almost guaranteed to provoke resistance.
• Choose the right time
• Strip off all technical cultural baggage not strictly needed for introducing the change. If possible, refrain from changing several things at once. Many simultaneous changes are confusing and difficult to handle, and could trigger resistance.
• Work with the recognized leadership of the culture (who may be different from the organization chart). Deal with “who is really who.”
• Treat the people with dignity. They usually respond in kind.
• Put yourself in the other person’s place. You may even engage in some role-playing to “get into their head” [De Feo & Barnard (23)].

2.4 Eight key concepts of the Taguchi quality engineering philosophy [Ross (86)]

• Minimize loss by ensuring uniformity around the preferred value
• Design processes/products that produce uniform products economically
• Exploit non-linear effects of process parameters on performance characteristics
• Cure the effect not the cause
• A zero defect standard is an inadequate goal
• Design products/processes robust against operating conditions/use
• Taguchi method is not essentially a problem-solving technique
• Exploit the three types of product/process parameters

2.5 Crosby’s concepts [Crosby (21)]

2.5.1 Crosby’s 14-step quality improvement process
<table>
<thead>
<tr>
<th>1. Management commitment</th>
<th>Make this crystal clear to all (in deeds as well as words)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Quality improvement teams (QITs)</td>
<td>Set QITs with people from each department. Focus them on their QIP role</td>
</tr>
<tr>
<td>3. Quality measurement</td>
<td>Determine status of non-conformance through-out company</td>
</tr>
<tr>
<td>4. Cost of quality</td>
<td>Estimate COQ [cost of conformance (COC) + cost of non-conformance (CONC)] to pinpoint areas of business</td>
</tr>
<tr>
<td>5. Quality awareness</td>
<td>Provide means of raising personal concern for quality in ALL employees</td>
</tr>
<tr>
<td>6. Corrective action</td>
<td>Develop systematic means of resolving, forever, concerns found in previous steps</td>
</tr>
<tr>
<td>7. Right first time planning</td>
<td>Plan for company-wide first-time quality (Crosby’s Zero Defects)</td>
</tr>
<tr>
<td>8. Quality education and training</td>
<td>Train everyone in QIP</td>
</tr>
<tr>
<td>9. Launch right first time</td>
<td>As the Company performance standard</td>
</tr>
<tr>
<td>10. Goal setting</td>
<td>Encourage self-setting of QI goals</td>
</tr>
<tr>
<td>11. Error cause removal (ECR)</td>
<td>Ensure reporting of inhibitors to error-free work and timely response</td>
</tr>
<tr>
<td>12. Recognition</td>
<td>Show appreciation of those participating</td>
</tr>
<tr>
<td>13. Quality council participation</td>
<td>Form liaison body</td>
</tr>
<tr>
<td>14. Do it all over again</td>
<td>It is a never-ending process</td>
</tr>
</tbody>
</table>
2.5.2 Crosby’s four absolutes

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Conventional wisdom</th>
<th>New reality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Quality-definition</td>
<td>Goodness, Technical excellence, Grade</td>
<td>Conformance to requirements</td>
</tr>
<tr>
<td>2. System</td>
<td>Appraisal and detection of errors</td>
<td>Prevention: process capability in line with requirements and in control</td>
</tr>
<tr>
<td>3. Measurement</td>
<td>Product percent and number defective</td>
<td>Company-wide cost of non-conformance</td>
</tr>
<tr>
<td>4. Performance standard</td>
<td>Budgeted/planned defective levels</td>
<td>Zero defects</td>
</tr>
</tbody>
</table>

2.6 The new definition of quality [Harry (36)]

Past definitions of quality focused on conformance to standards, as companies strived to create products and services that fell within certain specification limits. Such definitions of quality assumed that if companies produced quality products and services, their performance standards were correct regardless of how those standards were met. In other words, performance standards may have been achieved after considerable rework of a specific part or service. In addition, previous definitions of quality often overlooked the fact that products or services rarely consist of a single element. Even a product or service made up of as few as five different elements that individually conform to standard may not work properly when put together. We call this concept “interacting standards.”

The Six Sigma Breakthrough Strategy broadens the definition of quality to include economic value and practical utility to both the company and the consumer. We say that quality is a state in which value entitlement is realized for the customer and provider in every aspect of the business relationship. This new definition of quality focuses on achieving “value entitlement.”

[Kan (45)] says that customer satisfaction is the ultimate validation of quality. Product quality and customer satisfaction together form the total meaning of quality.

With ever-increasing market competition, customer focus is the only way to retain the existing customer base and to expand market share. Studies show that it is five times more costly to recruit a new customer than it is to keep an old customer, and that dissatisfied customers tell 7 to 20 people about their experiences, while satisfied customers tell only 3 to 5.

One easy mistake in customer satisfaction analysis, however, is to equate the areas of weakness with the priority of improvement, and hence investment. For instance, if a product has low satisfaction with documentation (D) and high satisfaction with reliability (R), that does not mean that there is no need to continually improve the product’s reliability and that the first priority of the development team is to improve...
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documentation. Reliability may be the very reason the customers decide to buy this product and that customers may expect even further improvement. On the other hand, customers may not like the product’s documentation but it may still be tolerable given other considerations. To answer the question on priority of improvement, therefore, the subject must be looked at within the broader context of overall customer satisfaction with the product. Specifically, the correlations of the satisfaction levels of specific attributes with overall satisfaction need to be examined. After all, …..; it is the overall satisfaction level that affects the customer’s purchase decision.

To seek possible answers to questions such as these, apparently a multitude of techniques is needed for analysis [Kan (45)].

Research in customer satisfaction suggests that quality attributes fall into three categories: basic factors, performance factors, and excitement factors [Anderson & Mittal (5), Brandt (15), Johnston (42), Kano (46), Matzler et al (55)].

2.6.1 Kano’s model of customer satisfaction

Customer satisfaction research is based on the disconfirmation model within the expectation paradigm [Oliver (78)]. According to this model, satisfaction is formed through a cognitive comparison of perceived performance with pre-purchase expectations. Perceived performance can be greater than expectations, resulting in positive confirmation (satisfaction), or lower than expectations, resulting in negative disconfirmation (dissatisfaction). If the product performs as expected, the outcome is moderate satisfaction or indifference.

In this context, it is important to distinguish between different types of quality attributes as proposed by [Kano (46)]. In his model, quality attributes are grouped into three categories, each with a different impact on customer satisfaction.

- **Basic factors (dissatisfiers)** are minimum requirements that cause dissatisfaction if not fulfilled but do not lead to customer satisfaction if fulfilled or exceeded; negative performance on these attributes has a greater impact on overall satisfaction than positive performance. The fulfillment of basic requirements is a necessary but not a sufficient condition for satisfaction. Basic factors are entirely expected. The customer regards them as prerequisites; they are taken for granted.

- **Excitement factors (satisfiers)** are the factors that increase customer satisfaction if delivered but do not cause dissatisfaction if they are not delivered; in other words, positive performance on these attributes has a greater impact on overall satisfaction than negative performance. Excitement factors surprise the customer and generate ‘delight’.

- **Performance factors** lead to satisfaction if performance is high and to dissatisfaction if performance is low. In this case, the attribute performance-overall satisfaction relationship is linear and symmetric.
2.6.2 What is value?

Value is relative, not absolute. External customers might consider something to be of better value if they have to pay less for a product or service that meets their expectations. On the other hand, suppliers may look on better value to be when they have to use less resources to provide a product, or service, that satisfies the external customer. Value (BSI, 2000; CEN/TC 279, 2000) may be expressed by the relationship:

\[
\text{Value} \propto \frac{\text{Satisfaction of needs}}{\text{Use of resources}}
\]

The \( \propto \) symbol (read the \( \propto \) symbol to mean ‘is a function of’) indicates that ‘satisfaction of needs’ and ‘use of resources’ can be traded off, one against the other, to obtain an optimum balance. Hence, from a Six Sigma viewpoint, optimization of value may be achieved in a number of ways. The better the needs are satisfied and/or the fewer the resources used, the greater is the value [Truscott (99)].

In the world of Six Sigma, “entitlement” means that companies have a rightful level of expectation to produce quality products at the highest possible profits; for customers, “entitlement” means that they have a rightful level of expectation to buy high-quality products at the lowest possible cost. “Value” represents economic worth, practical utility, and availability for both the consumer and the company that creates the product or service. Economic worth refers to the fact that customers want to purchase products and services at the lowest possible cost, just as companies want to produce high-quality goods and services at the lowest possible cost. In addition, customers have every right to expect that the products and services that they purchase will be available when they need them and in the volume required. Providers have the same rightful expectation within their own businesses. Companies that produce products or services that do not conform to such standards are not achieving their economic and value entitlement.

Practical utility, as it applies to the customer, refers to the three areas of a finished product — form, fit, and function. All must meet the customer’s needs. For example, new-car buyers look for “form” – they want an automobile that pleases the eye. They also look for “fit” – they expect the trunk lid to align with the body of the car, that there are no air or water leaks, rattles, or squeaks, and that engine noise be held to a minimum. Finally, car buyers look for “function,” which means they are concerned with such things as gas mileage, automatic versus manual transmission, and the amount of horsepower the engine has.

While practical utility for consumers means that the product or service must possess a certain value, practical utility for companies refers to the fact that their processes must create value for the company. In other words, companies focus on process quality and consumers focus on the final product or service quality.

In the past, quality programs adopted by corporations focused on meeting the customer’s needs at virtually any cost; many companies, despite poor internal processes, managed to
produce high-quality goods and services. Even today, four sigma companies can produce six sigma products through enormous amounts of rework. However, they can’t raise their prices to recapture these costs because they must price their products competitively. As a result, they suffer tremendous profit losses.

Business quality is highest when costs are at the absolute lowest for both the producer and the consumer. Six Sigma provides maximum value to companies – in the form of increased profits and maximum value to the consumer with high-quality products or services at the lowest possible cost. It is a business strategy and philosophy built around the concept that companies can gain a competitive edge by reducing defects in their industrial and commercial processes. Classically speaking, a defect is anything that fails to meet the customer’s expectations or requirements. Again, Six Sigma takes a much broader view of defects. Within the framework of Six Sigma, a defect is anything that blocks or inhibits a process or service. For example, when a machine operator fails to change a gear during maintenance, it adversely influences the operation of a process, although it may not result in a defective product.

Within the Six Sigma Breakthrough Strategy that we developed over the last fifteen years are a series of established steps that (a) reveal how well products perform and how well services are delivered, and (b) show companies how to improve their processes and maintain the gains they achieve. The improvement process we have developed uses mathematical measurements to systematically reduce defects that occur in producing a product or service.

The sigma concept of measuring defects was created in the early 1980s as a way to develop a universal quality metric that applied regardless of product complexity or dissimilarities between different products. Higher sigma values indicate better products and lower sigma values represent less desirable products, regardless of what the product is. In short, the higher the sigma level, the fewer the number of defects per unit of product or service. The lower the sigma level, the greater the number of defects per unit. Products produced at a six sigma level of quality operate virtually defect-free – by definition, with only 3.4 defects per million opportunities (DPMO). As such, Six Sigma has become recognized as the standard for product and service excellence. This level of quality is in stark contrast to historical standards of what companies strived for, which was four sigma, or 6,210 defects per million opportunities. Six Sigma standards are about 1,800 times more demanding than the old standard. Common sense cannot create a 1,800 times improvement. Such extraordinary improvements occur only when people employ extraordinary reasoning – reasoning that results only from new questions being asked about how a product or service is created. As new questions emerge, new measurements are instituted. When the opportunities for non-conformance – defects – are brought to six sigma levels – whether in manufacturing, engineering, administration, sales, or service – companies can then take valuable resources once spent on anticipating, detecting, and fixing defects to perform activities that add value for customers and ultimately the company. Every time we produce a defect in a process, time, labor, capital equipment, overhead, and material have to be used to detect, analyze, and fix that defect. This cycle of detection, analysis, and correction ties directly back to the three elements of customer
satisfaction – delivering the highest-quality product (defect-free products and services), on time (reduced cycle time), and at the right price (which impacts manufacturing costs). When the probability of a defect becomes so low that a company rarely encounters one, maintaining systems to detect, analyze, and fix defects are virtually unnecessary. Expenses drop dramatically. This is the ultimate goal of Six Sigma.

In today’s competitive world, a great many companies conscientiously make improvements in product lines and delivery cycles, yet are unable to stay ahead of complex technological changes and escalating customer expectations. At best, these companies are just keeping pace. This explains why corporations, both in Europe and the United States, that operated at 3.5 to 4 sigma thirty years ago are still operating at that level today. Despite improvements, the evolution of technology, the complexity of product features, and more sophisticated customer demands have thwarted significant advances in how industrial and commercial processes are created, leaving the relative capability of organizations unchanged. History has shown that standards lag behind technology. Significant breakthroughs in technology, such as those we have seen in the past two decades, force companies to find new ways to meet customers’ expectations.

As the phrase “six sigma quality” has increased in popularity, and more and more companies that have embraced Six Sigma have begun to achieve significant financial benefits, an increasing number of companies have become eager to jump on the bandwagon.

Here are just a few reasons for the enthusiasm so many analysts on Wall Street voice:

- **General Electric’s CEO Jack Welch**, a self-proclaimed cynic when it comes to quality programs, describes Six Sigma as “the most important initiative GE has ever undertaken.” GE’s operating income, a critical measure of business efficiency and profitability, hovered around the 10 percent level for decades. In 1995, Welch mandated that each GE operation, from credit card services to aircraft engine plants to NBC-TV, work toward achieving Six Sigma. GE averaged about 3.5 sigma when it introduced the program. With Six Sigma embedding itself deeper into the organization’s processes, GE achieved the previously “impossible” operating margin of 16.7 percent in 1998, up from 13.6 percent in 1995 when GE implemented Six Sigma. In dollar amounts, Six Sigma delivered more than $300 million to GE’s 1997 operating income, and in 1998, the financial benefits of Six Sigma more than doubled, to over $600 million.

- **Larry Bossidy**, CEO of AlliedSignal Inc., brought the $14.5 billion industrial giant back from the verge of bankruptcy by implementing the Six Sigma Breakthrough Strategy. The company has now trained thousands of employees from every business unit and staff function in Six Sigma and the Breakthrough Strategy, with the goal of increasing productivity 6 percent each year in its industrial sectors. Broad-base Six Sigma initiatives allowed operating margin in the first quarter of 1999 to grow to a record 14.1 percent from 12 percent one year earlier. Since Bossidy implemented the
program in 1994, the cumulative impact of Six Sigma has been a savings in excess of $2 billion in direct costs.

- Former AlliedSignal executive Daniel P. Burnham, who became Raytheon’s CEO in 1998, has made Six Sigma a cornerstone of the company’s strategic plan. By pursuing Six Sigma quality levels throughout the company, Burnham expects Raytheon to improve its cost of doing business by more than $1 billion annually by 2001.

- Since taking over GE’s industrial diamonds business in Worthington, Ohio, in 1994, William Woodburn has increased the operation’s return on investment fourfold and cut the operation’s costs in half by employing the Six Sigma Breakthrough Strategy. He and his team have made their existing facilities so efficient that they have eliminated the need for new plants and equipment for at least another ten years. Woodburn and GE’s industrial diamond business exemplify how Six Sigma can enable a company to cut costs, enhance productivity, and eliminate the need for new plant and equipment investments.

- Polaroid Corporation’s Joseph J. Kasabula, quality strategy manager for product development and worldwide manufacturing, believes that the most compelling reason companies embrace Six Sigma is its impact on the bottom line. While other programs may improve quality, Kasabula believes they do not focus on increasing a company’s profits. With Six Sigma, companies focus on the processes that affect quality and profit margins on a project-by-project basis. Six Sigma is helping Polaroid to add 6 percent to its bottom line each year.

- Asea Brown Boveri (ABB), which successfully applied the Six Sigma Breakthrough Strategy to its power transformer facility in Muncie, Indiana, has reduced measurement equipment error by 83 percent; piece count error from 8.3 percent to 1.3 percent; and no-load loss to within 2 percent. ABB also improved material handling, resulting in an annual estimated cost savings of $775,000 for a single process within a single plant [Harry et al (36)].

Six Sigma projects could lead to either hard savings or soft savings. Hard savings are those, which directly impact the bottom-line. They typically result in cost reduction or revenue enhancement. Also called bottom-line savings, hard savings can be deciphered by carrying out a financial analysis of year-to-year spending and looking for ways to reduce spending. Revenue enhancement can be seen in projects, which result in increase of sales volumes. On the other hand, soft savings are difficult to quantify and include projects such as cash flow improvement through reduction in inventories, customer satisfaction through on time delivery and so on [Sarkar (88)].

2.7 Six sigma measurements [Breyfogle (16)]

The intent of these measurements is to provide a concise overview of Six Sigma metric alternatives so that an organization can better select metrics and calculation techniques
that are most appropriate for their situation. This facilitates good communication with other organizations, suppliers and customers that might be using or developing their application of Six Sigma techniques.

2.7.1 Converting defect rates (DPMO or PPM) to sigma quality level units

Sometimes organizations calculate a ppm defect rate or defects per million opportunities (DPMO) rate and then convert this rate to a Six Sigma measurement unit that takes into account a shift of the mean by 1.5σ, which is often assumed within a Six Sigma program for “typical process drifting. Table 2.2 describes the relationship of ppm defect rates to sigma quality level units with and without the shift by 1.5σ. This sigma quality level relationship with the 1.5σ shifts can be approximated by the equation

\[ \text{Sigma quality level} = 0.8406 + \sqrt{29.37 - 2.221 \times \ln(\text{ppm})} \]

2.7.2 Six sigma relationships

The following summarizes Six Sigma nomenclature, basic relationships, yield relationships, and standardized normal distribution relationships for Z that will be described henceforth:

2.7.3 Nomenclature
- Number of operation steps = m
- Defects = D
- Unit = U
- Opportunities for a defect = O
- Yield = Y

2.7.4 Basic relationships
- Total opportunities: TOP = U \times O
- Defects per unit: DPU = \frac{D}{U}
- Defect per unit opportunity: DPO = \frac{DPU}{O} = \frac{D}{U \times O}
- Defects per million opportunity: DPMO = DPO \times 10^6

2.7.5 Yield relationships
- Throughput yield: \( Y_{TP} = e^{-DPU} \)
- Defects per unit: DPU = -\ln (Y_{TP})
- Rolled throughput yield: \( Y_{RT} = \prod_{i=1}^{m} Y_{TPi} \)
Some Implementation Issues of Six Sigma in Quality Management

- Total defects per unit: $TDPU = -\ln (Y_{RT})$
- Normalized yield: $Y_{\text{norm}} = \sqrt[\sqrt{Y_{RT}}]{m}$
- Defects per normalized unit: $DPU_{\text{norm}} = -\ln (Y_{\text{norm}})$

2.7.6 Standardized normal distribution relationships for $Z$

- $Z_{\text{equiv}} \equiv Z \sim N(0;1)$
- $Z$ “long-term”: $Z_{LT} = Z_{\text{equiv}}$
- $Z$ “short-term” relationship to $Z$ “long-term” with 1.5 standard deviation shift: $Z_{ST} = Z_{LT} + 1.5\text{shift}$
- $Z$ Benchmark: $Z_{\text{benchmark}} = Z_{\text{norm}} + 1.5$

2.7.7 Process cycle time

The time it takes for a product to go through an entire process is defined as process cycle time. Process cycle time is an important parameter for meeting the needs of customers. The inspection, analysis, and repair of defects extend the process cycle time.

Within a manufacturing just-in-time environment, process cycle time could be calculated as the time it takes for material arriving at the receiving dock to become a final product received by the customer. An objective of a Six Sigma program might be to significantly reduce this cycle time.

Real process cycle time includes the waiting and storage time between and during operations. Theoretical process cycle time does not include waiting, shutdown, and preparation time.

Process-cycle-time analysis consists of comparing real and theoretical process cycle times. Factors that constitute additional steps to the theoretical process cycle time include...
Some Implementation Issues of Six Sigma in Quality Management

inspection, shipping, testing, analysis, repair, waiting time, storage, operation delays, and setup time. The identification and resolution of causal differences can reduce the real process cycle time. Possible solutions include improved work methods, changed production sequence, transfer of part inspection ownership to production employees, and reduction in batch size.

Reducing real process cycle time can reduce the number of defective units and improve process performance. Other advantages include the reduction in inventory costs, reduction in production costs, increased internal/external customer satisfaction, improved production yields, and reduction in floor space requirements. Process-cycle-time reductions have advantages but must not be achieved by jeopardizing product quality.

2.7.8 Yield

Yield is the area under the probability density curve between tolerances. From the Poisson distribution, this equates to the probability with zero failures. Mathematically, this relationship is

\[ Y = P(x = 0) = \frac{e^{-\lambda} \lambda^x}{x!} = e^{-\lambda} = e^{-DPU} \]

Where \( \lambda \) is the mean of the distribution and \( x \) is the number of failures.

\[ \text{Yield} = e^{-DPU} \]

\[ \text{Prob(defect)} = 1 - e^{-DPU} \]

2.7.9 Z variable equivalent

The Poisson distribution can be used to estimate the Z variable. This is accomplished by determining the Z value for the defects per unit (DPU) from the normal distribution Table 2.1. This Z value is defined as the Z variable equivalent (Z_{equiv}) and is sometimes expressed using the following relationships with Z “long-term” (Z_{LT}) and Z “short-term” (Z_{ST}):

\[ Z_{LT} = Z_{equiv} \]

\[ Z_{ST} = Z_{LT} + 1.5_{shift} \]

The value for Z_{ST} can be converted to a parts per million (ppm) defect rate by use of the “conversion of Z variable to ppm” table (Table 2.2).
2.7.10 Defects per million opportunities (DPMO)

A defect per unit calculation can give additional insight into a process by including the number of opportunities for failure. Calculations for the metrics in spreadsheet format are as follows:

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<th>Characteristic Type</th>
<th>Description</th>
<th>Defects</th>
<th>Units</th>
<th>Opportunities</th>
<th>Total Opportunities</th>
<th>Defects Per Unit</th>
<th>Defects Per Total Opportunities</th>
<th>Defects Per Million Opportunities</th>
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<td></td>
<td></td>
<td>D</td>
<td>U</td>
<td>O</td>
<td>TOP = U × O</td>
<td>DPU = D/U</td>
<td>DPO = D/TOP</td>
<td>DPMO = DPO × 1,000,000</td>
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</table>

An application example might have 15 or 20 different description types. Totals could then be determined for the Defects (D) and Total Opportunities (O) columns for each description type. The overall Defects Per Opportunities (DPO) and Defects Per Million Opportunities (DPMO) could then be calculated from these totals. A Pareto chart of the defect characteristic type by DPMO can give insight to where process improvement efforts should focus.

2.7.11 Rolled throughput yield

When organizations only focus on a defect rate at the end of a process, they can lose sight of reworks that occur within processes. Reworks within an operation have no value and comprise what is termed the “hidden factory.” Rolled throughput yield measurements can give visibility to process steps that have high defect rates and/or rework needs.

One method to determine the rolled throughput yield is to determine the yield for each process operation. Multiply these process operation step yields to get the rolled throughput yield for a process. A cumulative throughput yield up to a process step can be determined by multiplying the yield of the current step by the yields of previous steps.

Process yield can pictorially be described using two plots on one chart. In both cases the x axis lists the step numbers sequentially. One of the plots shows yield for each process step, while the other plot shows degradation in yield with the progression of process steps.

Rolled throughput yield could be calculated from the number of defects per unit (DPU) through the relationship

\[ Y_{RT} = e^{-\sum DPU} \]

Where the number of defects per unit within a process is the total of the defects for each operation divided by the number of units produced.
The total number of units needed to produce one unit that has no defects is
Units produced = 1 + (1 – e^{-DPU})

The real time to create conforming units then becomes

\[ T_{\text{real}} = T_{\text{base}} [1 + (1 – e^{-DPU})] \]

Where the base time is the average time for activities described within the process. The real time described in this equation does not include the analysis, repair, and testing time for nonconforming units. Adjustments should be made to this calculated value for these issues.

### 2.7.12 Normalized yield and Z value for benchmarking

Typically, yields for each of the m steps within a process differ. Rolled throughput yield (\(Y_{RT}\)) gives an overall yield for the process. A normalized yield value (\(Y_{norm}\)) for the process steps is expressed as

\[ Y_{norm} = \frac{1}{m} Y_{RT} \]

The defects per normalized unit (\(DPU_{norm}\)) is

\[ DPU_{norm} = -\ln (Y_{norm}) \]

The following Six Sigma relationships are used to determine a benchmark value for Z (\(Z_{\text{Benchmark}}\)). The normality approximation for Z equivalent (\(Z_{\text{equiv}}\)) and the relationship of Z equivalent to Z long term (\(Z_{LT}\)) are expressed as

\[ Z_{\text{equiv}} \equiv Z \sim N(0 ; 1) \]

\[ Z_{\text{equiv}} = Z_{LT} \]

The Z “long-term” to Z “short-term” (\(Z_{ST}\)) relationship with a 1.5 standard deviation shift is

\[ Z_{ST} = Z_{LT} + 1.5 \text{shift} \]

The Z value for benchmarking (\(Z_{\text{Benchmark}}\)) is then

\[ Z_{\text{Benchmark}} = Z_Y + 1.5 \text{shift} \]
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Note 1: $0.0541$ means $0.0000541$
Note 2: The tabular value corresponds to $Z_\alpha$, where $\alpha$ is the value of probability associated with the distribution area pictorially represented as
### Table 2.2. Conversion between ppm and sigma [Breyfogle (16)]

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<th>Percent within spec.: Centered Distribution</th>
<th>Defective ppm: Centered Distribution</th>
<th>Percent within spec.: 1.5 Sigma Shifted Distribution</th>
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* Sometimes referred to as sigma level or sigma quality level when considering process shift.
2.8 What six sigma can do for your company?

While Six Sigma is a long-term, forward-thinking initiative designed to fundamentally change the way corporations do business, it is first and foremost designed to generate immediate improvements to profit margins. Instead of projecting three or more years into the future, Six Sigma focuses on achieving financial targets in twelve-month increments. Once those targets are met, companies will find that changes in the market and Six Sigma’s impact on their own financial landscape have changed their internal dynamics so extensively that new financial targets must be set to keep the company moving forward. Companies operating at a three sigma level that marshal all their resources around Six Sigma can expect to make one sigma shift improvement each year. These companies will experience:

- A 20 percent margin improvement
- A 12 to 18 percent increase in capacity
- A 12 percent reduction in the number of employees
- A 10 to 30 percent capital reduction

Companies can expect to make one sigma shift improvement per year up to 4.7 sigma, meaning that a three sigma company that focuses all its resources on Six Sigma can expect to move to four sigma during the first year of implementation. Companies already at four sigma can expect to improve to 4.7 sigma during the first year of implementation and deployment. The financial benefits of progressing from 3 to 4 to 4.7 to Six Sigma are exponential, and experience has shown that companies can achieve a sigma level as high as 4.7 sigma without large capital outlays. In the second year, such companies can expect to move from 4.7 sigma to 5 sigma, and in the third year they will progress from 5 to 5.1. The closer companies come to achieving Six Sigma, the more demanding the improvements become. At 4.8 sigma companies hit a “wall” that requires a redesigning of processes, known as “Design for Six Sigma.” However, the profit-margin increases between a 3 sigma level company and 4.8 sigma company are so dramatic, making these companies so much more profitable than their competitors, that they can selectively pick what plant, product, operation, or process they need to improve to attain five sigma or higher.

Many companies ask if, as they improve their sigma level, subsequent projects will be as profitable as earlier projects. Since most companies start at roughly three sigma, virtually each employee trained in the Six Sigma Breakthrough Strategy will return on average $230,000 per project to the bottom line until the company reaches 4.7 sigma. After a company reaches 4.7 sigma, the cost savings are not as dramatic. However, improved profit margins allow companies to create products and services with added features and functions that result in greater market share. So while Six Sigma improves the quality of a company’s products and services and, in some cases, catapults a company ahead of its competition, the overwhelming and most visible impact of Six Sigma is the immediate benefit to any company’s profit margins [Harry et al (36)]. The Figures 2.1 and 2.2 [Pyzdek (83)] help us to visualize this aspect.
The key is to identify and eliminate variation in processes. Every process can be viewed as a chain of independent events and, with each event subject to variation; variation accumulates in the finished product or service. Because of this, research suggests that most businesses operate somewhere between the three- and four-sigma level. At this level of performance, the real cost of quality is about 25-40 percent of sales revenue. Companies that adopt a Six-Sigma strategy can readily reach the five-sigma level and reduce the cost of quality to 10 percent of sales. They often reach a plateau here and to
improve to Six-Sigma performance and 1 percent cost of quality takes a major rethink [Oakland (77)].

2.9 Six sigma and the pitfalls of TQM

If TQM has left behind it a positive legacy, is still alive in many organizations, and has provided the impetus for the creation of the Six Sigma system, why does it still have a black eye?

Some of the mistakes of yesterday’s TQM efforts certainly might be repeated in a Six Sigma initiative if you aren’t careful.

2.9.1 Comparison between TQM and six sigma [Pande et al (80)]

<table>
<thead>
<tr>
<th>TQM Pitfall: Lack of Integration</th>
<th>Six Sigma Solution: Links to the Business and Personal “Bottom Line”</th>
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<tbody>
<tr>
<td>Quality often was a “sidebar” activity, separated from the key issues of business strategy and performance. Warning signs included a “quality council” made up of delegates rather than of the core management team, or a staff quality “department” with no links to P&amp;L or other bottom-line considerations. Another “integration gap” arose when a company’s middle managers were left out of the decision process, and problem-solving authority was handed to teams over which they had no official control. True integration was undermined as well when, despite the term “total” quality, the effort actually was limited to product and manufacturing functions.</td>
<td>Six Sigma organizations are putting Process Management, Improvement, and Measurement into action as part of the daily responsibilities especially of their operating managers. Incentives – like GE’s well-publicized 40 percent of bonus money being tied to Six Sigma – help reinforce the message that Six Sigma is “part of the job.” One area that still demands attention is the application of Six Sigma to administrative or service processes.</td>
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### TQM Pitfall: Leadership Apathy
In every TQM effort that has thrived, leadership was actively engaged in leading the process. Much more often, however, top management’s skepticism has been apparent, or their willingness to drive quality ideas has been weak. In those organizations quality felt “temporary” – and when the leaders who had initiated it left the company, quality was proven to be temporary.

### Six Sigma Solution: Leadership at the Vanguard
Passion for and belief in Six Sigma at the very top of the business is unquestioned in companies like Bombardier, Allied Signal, and GE. Along with that passion – and a readiness to beat the drum for the Six Sigma system almost constantly – is a leader’s recognition that Six Sigma is synonymous with constant reinvention of the business. The signs are ripe for a company or department to take on Six Sigma only when its top people have made a decision that change is essential to continued success, let alone survival.

### TQM Pitfall: A Fuzzy Concept
The fuzziness of TQM started with the word quality itself. It’s a familiar term with many shades of meaning. In many companies, Quality was an existing department with specific responsibilities for “quality control” or “quality assurance,” where the discipline tended to focus more on stabilizing rather than improving processes. The whole idea of quality “philosophies” also made the whole concept seem mysterious to many people. The vagueness of TQM was aggravated when, as new approaches emerged – e.g. ISO 9000 certification or reengineering – they were not integrated into the existing quality effort.

### Six Sigma Solution: A Consistently Repeated, Simple Message
On this score, Six Sigma may have some of the same difficulties as TQM. After all, the words “Six Sigma” aren’t perfectly descriptive of this system we’re presenting. Still “Six Sigma is a business system for achieving and sustaining success through customer focus, Process Management and Improvement, and the wise use of facts and data.” By continuing to communicate this definition; and avoiding debate about which tools are mandatory or which Six Sigma philosophy you’re following, you can keep the focus from getting diffused or confusing.
Some Implementation Issues of Six Sigma in Quality Management

<table>
<thead>
<tr>
<th>TQM Pitfall: An Unclear Goal</th>
<th>Six Sigma Solution: Setting a No-Nonsense, Ambitious Goal</th>
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<td>Many companies made quality even fuzzier by having positive-sounding goals like “meeting or exceeding customer requirements,” with no way to track progress toward that goal. Quality methods taught in the 1980s and 1990s also did a pretty poor job of dealing with the reality of diverse and changing customer requirements. Without tools to really understand customer needs, TQM in action was liable to become an “open-loop” system in which a company might meet today’s customer requirements but not be ready for tomorrow’s.</td>
<td>A clear goal is the centerpiece of Six Sigma. It’s an extremely challenging goal, but still believable, unlike past campaigns for “zero defects.” Whether the goal is expressed in yield (99.9997 percent perfect), Defects per Million Opportunities (3.4 DPMO), or Sigma (6σ), people involved in Six Sigma initiatives can see their results grow; and they can equate them to dollar impact as well. Just as importantly, by focusing on ways to track changes in customer needs and requirements, Six Sigma companies are building a dynamic system for measuring performance based on the latest and most stringent demands of the customer. While the goal may change over time, the closed-loop Six Sigma system will help the organization to adjust.</td>
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<tr>
<th>TQM Pitfall: Incremental vs. Exponential Change</th>
<th>Six Sigma Solution: Incremental Exponential Change</th>
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<td>TQM teachings often emphasized that change would be driven by an abundance of small improvements. There was no explicit exclusion of more radical change in the TQM toolkit, but it can’t be denied that an impatience had built up among many corporate leaders when the “reengineering” concept broke loose.</td>
<td>One of the great opportunities of Six Sigma is to begin afresh, with the recognition that both small improvements and major change are an essential part of the survival and success of 21st century business.</td>
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Some Implementation Issues of Six Sigma in Quality Management

<table>
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<tr>
<th>TQM Pitfall: Ineffective Training</th>
<th>Six Sigma Solution: Blackbelts, Greenbelts, Master Blackbelts</th>
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<td>We use the term “ineffective” as a catch-all for the variety of problems that can arise during roll-out of TQM training. In truth, there’s no perfect way to train an organization for TQM – or Six Sigma. There are always challenges around timing (When is it appropriate to give people new skills?), depth (How detailed does this need to be?), and resources (How much time and money can we afford to devote to training?). By no means was TQM training always ineffective, but it did tend to be “light” and focused much more on teaching tools than on providing a clear context about how to make improvement work. As a result, people knew the tools, but not when and how to best apply them. The emphasis of TQM training was on projects – time-bounded, off-line improvement efforts – and therefore didn’t appear relevant to people’s daily responsibilities. Perhaps, worst of all, quality training often fall victim to a numbers game, with success being determined by “number of people trained” or “teams formed.”</td>
<td>Six Sigma companies are setting very demanding standards for learning, and are backing them up with the necessary investments in time and money to help people meet those standards. Whereas most organizations scream in agony when training takes more than two hours, GE’s Blackbelts – the primary drivers of Six Sigma improvements – take three weeks of training, with follow-up exams and continued learning through conferences and other forums. Even more impressive is the “Greenbelt” commitment: every management employee being given a minimum of two weeks training in Six Sigma methods. It’s easy (and we’ve heard many do it) to dismiss GE’s effort as being possible only because of its tremendous resources. But it isn’t fair to assume that the GE people getting these skills are any less busy than your people may be. The truth is, the training commitment is a sacrifice – an investment – that’s being made consciously. You don’t need to match GE or any other Six Sigma company course-for-course to be successful, but the principle of continuous renewal and improvement does demand a heavier investment and higher learning expectations than most companies traditionally have assumed. The other challenges – linking training to people’s jobs, and creating results mean that go beyond the standard training metric.</td>
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TQM Pitfall: Focus on Product Quality
Despite the “total” descriptor, many quality efforts were concentrated on production or manufacturing processes, not on service, logistics, marketing, or other equally critical areas. We know, for example, of a printing company that was focusing its teams on eliminating millimeters of deviation in trimming paper (an important quality factor, granted), while their order-tracking processes were a mess. Even if the product quality was excellent, customers wouldn’t get them on time.

Six Sigma Solution: Attention to All Business Processes
Six Sigma not only works in Service and in transactional processes, but probably offers more opportunities there than in Manufacturing. Thus, Six Sigma has the potential to be more “total” than Total Quality.

2.10 Six sigma: The organizational infrastructure

2.10.1 Martial arts

What is the relationship between a business-improvement process such as Six Sigma and the martial art of Judo? What is its relevance? Before discussing this it might be useful to reflect on why and how martial arts come into the picture at all.

In the west, ‘martial arts’ are generally thought of as war-like arts, of battles and conquests, of victors and vanquished. Martial art means much more in Japan. It is a way of life. An effect that martial arts, as practiced in Japan, can have on persons introduced to a martial art is that they see seasoned practitioners performing feats well beyond their own current capabilities. There are many types of martial arts. These include boxing, wrestling, Kung Fu, Karate, Jujitsu and Judo. Why Judo? Judo is formed from two Chinese words, Ju and Do. ‘Ju’ is a Chinese character meaning ‘pliable’ or ‘adaptable’. ‘Do’ denotes ‘way of life’. Judo is the art of self-perfection. The ultimate aim of Judo is to: ‘perfect oneself by systematic training so that each person works in harmony within oneself and with others for the common good’. This perhaps is a good enough reason, in itself, to explain why Judo comes into the picture as far as Six Sigma is concerned. There are however many other rational reasons for this decision. First, Judo is standardized throughout the world whereas, for example, there are some 1500 styles of Karate and over 700 forms of Jujitsu. Second, Judo in its pure form, in marked contrast to other forms of martial art, is not about beating an opponent. It is an instrument of aggression and domination through combat. It is the intention of Judo training that an individual secure improved physical and mental fitness. Mental development will be displayed through increased self-confidence, self-discipline, improved decision-making skills, enhanced empathy and spirit of fairness. Third, it is an inexpensive all-year-round activity that appeals to people of either sex and any age group drawn from all walks of life. Fourth, Judo recognizes a person’s degree of knowledge, ability and powers of leadership by a system of ranks. Ranks is denoted, in part, by the colour of one’s belt. In Six Sigma, the colours of yellow, green and black are deployed in order of increasing seniority [Truscott (99)].
2.10.2 Structures and roles [Harry et al (36)]

- The inverted pyramid is a powerful metaphor for the support Six Sigma needs to succeed. At the bottom of the pyramid, supporting and balancing the structure, is the executive leadership.
- Although few in number, their internal will and executive commitment lays the foundation for success.
- Without commitment from the executive leadership, Six Sigma will not have the support of senior management, middle management, and so on. If support is broken at any juncture, the structure will fall and Six Sigma will fail.

<table>
<thead>
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<th>A HIGH-LEVEL COMPARISON OF ROLES</th>
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<tr>
<td>Qualifications</td>
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<td>Senior executives and managers, such as a vice president or director of manufacturing or marketing</td>
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### Training

| Number of employees trained | One Champion per business group or manufacturing site | One MBB per 30 BBs. They do not have to be on-site. They can represent a division. | One BB per 100 employees. 100,000 employees would require 1,000 BBs. | One GB per 20 employees |

#### 2.10.3 The roles of champions

- Create the vision of Six Sigma for the company.
- Define the path to implement Six Sigma across the organization.
- Develop a comprehensive training plan for implementing the Breakthrough Strategy.
- Carefully select high-impact projects.
- Support development of “statistical thinking.”
- Ask BBs many questions to ensure that they are properly focused.
- Realize the gains by supporting Six Sigma projects through allocation of resources and removal of roadblocks.
- Hold the ground by implementing BB recommendations.
- Make sure that the organization’s leadership and the finance department act upon project opportunities.
- Recognize people for their efforts.

#### 2.10.4 The roles of MBBs

- Understand the big business picture.
- Partner with the Champions.
- Get certified as MBBs.
Some Implementation Issues of Six Sigma in Quality Management

- Develop and deliver training to various levels of the organization.
- Assist in the identification of projects.
- Coach and support BBs in project work.
- Participate in project reviews to offer technical expertise.
- Help train and certify BBs.
- Take on leadership of major programs.
- Facilitate sharing of best practices across the corporation.

2.10.5 The roles of BBs

- Act as Breakthrough Strategy experts and be Breakthrough Strategy enthusiasts.
- Stimulate Champion thinking.
- Identify the barriers.
- Lead and direct teams in project execution.
- Report progress to appropriate leadership levels.
- Solicit help from Champions when needed.
- Influence without direct authority.
- Determine the most effective tools to apply.
- Prepare a detailed project assessment during the Measurement phase.
- Get input from knowledgeable operators, first-line supervisors, and team leaders.
- Teach and coach Breakthrough Strategy methods and tools.
- Manage project risk.
- Ensure that the results are sustained.

2.10.6 The roles of GBs

- Function as GBs on a part-time basis, while performing their regular duties.
- Participate on BB project teams in the context of their existing responsibilities.
- Learn the Six Sigma methodology as it applies to a particular project.
- Continue to learn and practice the Six Sigma methods and tools after project completion [Harry et al (36)].

2.11 Defining criteria for project selection [Pande et al (80)]

One of the challenges of project selection – as in many business decisions – is to agree not just on what to do, but also on what not to do. As we’ve noted, you can’t do everything all at once – and some potential Six Sigma projects will likely have to be left off your initial list. The key word is priority; which problems / opportunities will you tackle first?

The best project selection is based on identifying the projects that best match your current needs, capabilities, and objectives. The following subsections provide you with a “generic” list of possible criteria to include in your project selection process, grouped into three categories: Results or Business Benefits; Feasibility; and Organizational Impact.

2.11.1 Results or business benefits criteria

- **Impact on external customers and requirements**. How beneficial or important is this problem / opportunity to our “paying customers” or key external audiences (e.g., shareholders, regulators, supply-chain partners)?

- **Impact on business strategy, competitive position**. What value will this potential project have in helping us to realize our business vision, implement our market strategy, or improve our competitive position?

- **Impact on “core competencies.”** How will this possible Six Sigma project affect our mix and capabilities in “core competencies”? (Could involve strengthening a core competency or “off-loading” an activity no longer deemed a key internal skill.)

- **Financial impact (e.g., cost reduction, improved efficiency, increased sales, market-share gain)**. What is the short-term dollar gain likely to be? Long-term? How accurately can we project these numbers? (Beware of inflating possible gains beyond what’s realistic.)

- **Urgency**. What kind of lead-time do we have to address this issue or capitalize on this opportunity? (Note: Urgency is distinct from impact; a small problem can be urgent, and a huge issue can have a long lead-time.)

- **Trend**. Is the problem, issue, or opportunity getting bigger or smaller over time? What will happen if we do nothing?
☐ **Sequence or Dependency.** Are other possible projects or opportunities dependent on dealing with this issue first? Does this issue depend on other problems being addressed first?

### 2.11.2 Feasibility criteria

- **Resources needed.** How many people, how much time, how much money is this project likely to need?

- **Expertise available.** What knowledge or technical skills will be needed for this project? Do we have them available and accessible?

- **Complexity.** How complicated or difficult do we anticipate it will be to develop the Improvement solution? To implement it?

- **Likelihood of success.** Based on what we know, what is the likelihood that this project will be successful (in a reasonable timeframe)?

- **Support or Buy-In.** How much support for this project can we anticipate from key groups within the organization? Will we be able to make a good case for doing this project?

### 2.11.3 Organizational impact criteria

- **Learning benefits.** What new knowledge – about our business, customers, processes, and/or the Six Sigma system – might we gain from this project?

- **Cross-functional benefits.** To what extent will this project help to break down barriers between groups in the organization and create better “whole process” management?

As extensive as the preceding list of criteria is, you may have other criteria that are relevant to your business. You should not use all these factors in your project selection; instead, chose the five to eight that are most relevant criteria for your organization today. Where possible, it’s easier to stick to the criteria for which you have more factual answers. Remember: The objective is to target the best project to fit your specific business and organizational needs, and the goals of your Six Sigma effort.

When you have a very long list of potential projects, it may be a good idea first to narrow the list down by using some qualifying criteria (e.g., minimum potential dollar benefits; benefits to external customers) or some type of group–voting process. To gain a more careful assessment, note that scoring each possible project on each of your chosen criteria will give you a comparison and show which best support all the factors for a worthwhile project. A “criteria matrix” can help structure your comparison of the projects.
However you use or define the criteria for project selection, remember that there are lots of reasons to consider a project to be worthy of DMAIC process, as well as many things to watch out for before formally launching a project. Fundamentally, these reasons all go back to our two “macro” criteria: Is the project Meaningful and is it Manageable?

2.12 Selecting project team members

Our point is that when it comes to teams, many organizations act like novice travelers: they over-pack a team with every conceivable type of person whose skill or contribution might be needed during the project. Not surprisingly, big teams move more slowly, and their members also tend to be less engaged and enthusiastic. There are plenty of different “rules of thumb” on team size, but a good optimum number for almost any project team is between five and eight. Beyond that, communication tends to get overly complicated, decisions harder to make, and cohesiveness weak.

Here are some key questions for you to ponder, as an aid to selecting team members:

- Who has the best knowledge of the process being improved, and/or contact with the customer?
- Who has the most knowledge about the problem, and/or the best access to data?
- What key skills or perspectives will be needed throughout the course of the project?
- What groups or functions will be most directly affected by the project?
- What degree of management/supervisory/frontline representation is likely to be needed?
- What skills, functions, or organizational levels can be obtained as needed during the project?

It’s okay to adjust the membership of the Six Sigma team over the course of a project – especially in the transition from developing solutions to implementing them. Indeed, different skills and talents often are needed to make process improvements work successfully. Also, having a flexible approach to team makeup – as long as it doesn’t disrupt the cohesiveness of the group – will help you avoid the “over-packing” problem.

Once people are on board the Six Sigma effort, the next challenge is to give them the skills, knowledge, and tools they will require if everyone pulling together is going to achieve meaningful change and improvement [Pande et al (80)].

2.13 A discussion of strategies for six sigma implementation [Sanders et al (87)]

The 6σ methods are based heavily on the use of statistical methods to understand product and process performance. Given that the use of statistical methods to understand process
Some Implementation Issues of Six Sigma in Quality Management

Performance better has been in existence for decades, the creation of the Six Sigma process by Motorola meant there must be other characteristics that made it new and unique. The newness of 6σ efforts seem to be in (1) the packaging of the tools, (2) the focused problem-solving projects, and (3) the attention to bottom-line results and sustaining those gains over time.

The model or strategy used to deploy the 6σ initiatives varies from organization to organization. In reality, there are as many strategies as there are companies implementing 6σ. The concepts and tools also vary across organizations.

Although it is impossible to differentiate perfectly the many approaches to 6σ training and improvement efforts, there seem to be three general categories of deployment strategies. We define the first of the three deployment categories as the “Six Sigma Organization” strategy. The Six Sigma Organization category consists of deployment strategies whereby all individuals from all levels and areas are trained in 6σ concepts and tools. The second type of model is characterized by the development of a “Six Sigma Engineering Organization,” where the focus of the initial training and project work is within the engineering community. In these strategies, the majority of the engineering community is trained and developed. This category typically includes individuals and projects from the manufacturing and product design process. The third broad category is best characterized as “Strategic Selection.” This model involves the development and training of a group of strategically selected individuals. These individuals are assigned complex projects identified by needs and objectives critical to the site or organization.

2.13.1 The “six sigma organization”

The first category of 6σ implementation strategies includes those that work toward training the entire organization on 6σ philosophy and methods. In organizations that choose these strategies, 6σ serves both as a motivational device and as a metric. Goals are often defined in terms of “sigma.” In fact, it is common in these strategies for Six Sigma to be defined as the quality process for the entire organization. Motorola’s implementation approach would fall into this category. “To Motorolans, the term Six Sigma has become synonymous with quality”.

In the Six Sigma Organization, a large amount of resources is focused on increasing awareness across all functions and levels of the organization. Hence, these approaches require a large percentage of the overall personnel be trained, to some extent, in 6σ. These organizations often define different “levels” of 6σ expertise with the training content and project work differing across the levels. At the lower levels, specialized statistical tools are not taught. As one moves up the hierarchy, more in-depth training in specialized tools is provided. Often, a small group of 6σ “experts” is developed in order to be able to train others at lower levels of the hierarchy.

The major strength of the Six Sigma Organization deployment approach is the possible creation of a “constancy of purpose”. A common language and a common improvement process is put in place. A high level of awareness is developed both internal and external.
to the organization. Quality improvement initiatives are usually integrated under the 6\(\sigma\) framework. Participation in training and project work is encouraged and sometimes even required. The widespread focus on improvement methodologies may facilitate cross-functional project work. Finally, due to the large number of projects being worked and improvement ideas being attributed to the 6\(\sigma\) initiative, there are reports of large gains both in terms of process performance and efficiencies. The Six sigma Organization approaches are often used to reenergize or motivate an entire organization to focus on improving performance and reducing cost [Sanders et al (87)].

Six Sigma organizations focus on [Oakland (77)]:

- Understanding their customers’ requirements;
- Identifying and focusing on core-critical processes that add value to customers;
- Driving continuous improvement by involving all employees;
- Being very responsive to change;
- Basing managing on factual data and appropriate metrics;
- Obtaining outstanding results, both internally and externally.

Properly implemented Six Sigma strategies involve:

- Leadership involvement and sponsorship;
- Whole organization training;
- Project selection tools and analysis;
- Improvement methods and tools for implementation;
- Measurement of financial benefits;
- Communication;
- Control and sustained improvement [Oakland (77)].

2.13.2 The Six sigma engineering organization [Sanders et al (87)]

A second set of strategies for 6\(\sigma\) has as their common thread the focus on training a large percentage of the company’s design and manufacturing engineers. Instead of attempting to motivate the entire organization, attention is given to developing a skill set in the engineering community. Hence, the project objectives are almost always based on new products, product changes, or problem-solving efforts on the manufacturing floor. In these types of strategies, the term Six Sigma is typically associated with a technical set of skills meant to supplement engineering knowledge in order to solve problems or implement changes more efficiently and effectively. Hence, 6\(\sigma\) is not treated as a motivational device or used to set goals or targets. Rather, the driving force behind the training and project work are products introduced more quickly and more reliably, dollars saved, and solutions found to plaguing problems.

One of the distinct advantages of the Six Sigma Engineering strategy is the similar educational and technical backgrounds of the individuals undergoing the training. The common quantitative background allows more mathematical and technical tools to be taught at a faster pace. Although fundamental ideas, concepts, language, and philosophy
are still taught, more time is spent teaching in-depth technical tools and methods appropriate for typical engineering problems.

Also, because the projects tend to be similar in nature (either product design changes or manufacturing problems), it is easier to have training discussions around the appropriate application and applied interpretations of the concepts and methods.

2.13.3 Strategic selection of individuals and projects

Some organizations choose to deploy $6\sigma$ activities through the careful selection of individuals and projects aligned to the overall organizational strategy. The strategic selection of projects is a major prerequisite to the training and, often, to the selection of the individuals to be trained. This deployment model is one where the critical mass is determined by who and why rather than by how many [Sanders et al (87)].

2.13.4 Summary of six sigma implementation strategies [Sanders et al (87)]

<table>
<thead>
<tr>
<th>Personnel trained</th>
<th>Six Sigma Organization</th>
<th>Six Sigma Engineering Organization</th>
<th>Strategically Selected Projects and Individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>“Everybody”</strong></td>
<td>“Everybody”</td>
<td>A large percentage of the</td>
<td>Strategically selected individuals</td>
</tr>
<tr>
<td></td>
<td>• Senior managers</td>
<td>engineering staff</td>
<td>• Project driven</td>
</tr>
<tr>
<td></td>
<td>• Area managers</td>
<td>• Design/product</td>
<td>• Informal leaders</td>
</tr>
<tr>
<td></td>
<td>• Some from business</td>
<td>• Manufacturing/process</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• process areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Engineers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Individuals from</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• operations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical course content</td>
<td>Overview</td>
<td>• Overview</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Philosophy and basic</td>
<td>• Philosophy and basic concepts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• concepts</td>
<td>• Fundamental tools and methods</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Fundamental tools</td>
<td>• Advanced-fundamental tools</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• and methods</td>
<td>• Project work</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Project work</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Strengths
- High level of awareness
- Common language
- Common tool set and problem-solving approach
- Focused resources
- Larger set of tools for engineers
- Similar backgrounds among individuals in training
- More attention given to project application
- Projects aligned with organizational objectives
- Less initial dollars required for training
- High amount of flexibility in training content (as needed)
- Strongest project focus

### Common weaknesses
- Tendency for cynicism to develop
- A focus on “buzzwords” and slogans
- Large amounts of resources required for mass training
- An inflexible road map for process improvement or problem solving
- Lack of common language across all areas of organization
- Difficulty in deployment outside of operations and engineering
- Managers not provided training to effectively integrate skills learned into everyday engineering responsibilities
- Isolation of those trained
- Lack of common language
- Difficulty in integrating beyond “Six Sigma Projects”
- Tendency for attitude of elitism to develop

When the focus is to reduce waste and improve efficiency of a process, lean tools should be leveraged. When the goal is to reduce variation and improve performance, use Six Sigma methodology [Sarkar (88)].

#### 2.14 Essentials of effective six sigma training [Pande et al (80)]

The keys to good Six Sigma training are not dramatically different from those for any kind of training. As we often saw in the days of TQM training, however, these lessons tend to be ignored in the rush to get people’s quality “ticket punched.” TQM training tended to be dry, uninspiring, and irrelevant to people’s everyday jobs. It also left people with an awareness-level understanding of concepts and tools, but without the depth of knowledge to actually use them. The following are some of the essentials you should keep in mind when planning your Six Sigma training:

- **Emphasize “hands-on” learning.** From leaders to experts to practitioners, people in a business learn best when they can put concepts and skills into immediate practice. Ideally, such “hands-on” work will include efforts exerted on real processes, projects, and improvement needs.
Some Implementation Issues of Six Sigma in Quality Management

- **Provide relevant examples and links to the “real world”**. If your people are going to internalize how Six Sigma will work in your organization, the examples and exercises you provide will have to reflect your business and its specific challenges. Generally, a Service business or process needs to use service-related examples; a Manufacturing group learns most from plant floor-related scenarios. Even if you haven’t done Six Sigma yet, a good training provider who knows the methodologies should be able to come up with some good examples that will work in your environment.

- **Build knowledge**. With so much material to cover, it’s easy to fall into the “data dump” trap. The concepts of Six Sigma can be interesting and exciting, but starting with advanced ideas and jargon will turn people off. Establishing a foundation of key principles and ideas – stated in common terms – sets the stage for more sophisticated skills and methods. It’s also important to put tools into a context (e.g., an improvement model like DMAIC, the Six Sigma Roadmap) so that their application and relevance is clear.

- **Cater to a variety of learning styles**. Visuals, games, exercises, and so on should be varied and, for most audiences, include some fun.

- **Make training something more than learning**. Training is a key element in your Six Sigma “marketing plan.” It represents a golden opportunity to gain buy-in, to deputize change agents, and to clarify the themes of the effort and its value to the business. Look for ways to reinforce those messages during the training.

- **Make training an ongoing effort**. One of the comments we most often hear from participants in Six Sigma training is the suggestion that they get “refreshers” on a regular basis. Businesses, however, tend to offer only “hit-and-run” training. We give kids (ages 5 through 21) about 16 years to absorb an education, but people in the working world are expected to learn and master major new concepts and tools in (if they’re lucky) three days! Six Sigma (i.e., “learning”) organizations will almost certainly have to adopt a practice of continuous education and training, just as their processes themselves are in need of continuous renewal and improvement. Considering the speed of change today, occasional once-off learning or cookie-cutter training won’t make it in the 21st century [Pande et al (80)].

2.14.1 What is meant by competency? [Truscott (99)]

Competency is defined as the key knowledge, skills, abilities, behaviours and other characteristics needed to perform specific tasks.

Six Sigma demands the empowerment of people in an organization. Empowerment is one thing. Making it work to achieve a given objective is another. Prior to the empowering of people in an organization, to perform any new task in a satisfactory manner, three necessary personal requisites need to be satisfied. We have to ensure that they acquire the appropriate knowledge, nurture the correct attitude and develop the necessary skills. The American Society for Quality (ASQ) body of knowledge requirements for black belts is
based on the six major classes within the cognitive domain as shown in the following table.

The major classes of Six Sigma training objectives in the cognitive and affective domains

<table>
<thead>
<tr>
<th>Cognitive objectives (recall or recognition of knowledge, development of intellectual abilities and skills)</th>
<th>Affective objectives (attitude, feelings, emotion, accepts/rejects)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Remember</td>
</tr>
<tr>
<td>Comprehension</td>
<td>Understand</td>
</tr>
<tr>
<td>Application</td>
<td>Apply</td>
</tr>
<tr>
<td>Analysis</td>
<td>Identify implications</td>
</tr>
<tr>
<td>Synthesis</td>
<td>Combine and transfer</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Judge</td>
</tr>
</tbody>
</table>

The affective domain includes objectives that deal with attitudes and feelings. Affective objectives range from simple passive attention, through willing response, to enjoyment and pleasure in participating and total commitment. The psychomotor domain includes objectives that deal with muscular skill and manipulation of materials and things or some act that requires a neuromuscular coordination.

Whilst the ASQ body of knowledge for black belts is restricted to the cognitive domain it is important to bear in mind that a successful and sustained application of Six Sigma also requires a continuing willingness to participate and the maintaining of a high degree of personal commitment and focus. This involves consideration of objectives in both the cognitive and affective domains [Truscott (99)].

**2.14.2 Translation process** [Burton et al (17)]

<table>
<thead>
<tr>
<th>Practical Problem</th>
<th>Mathematical Model</th>
<th>Statistical Problem</th>
<th>Statistical Solution</th>
<th>Practical Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define</td>
<td>Measure</td>
<td>Analyze</td>
<td>Improve</td>
<td>Control</td>
</tr>
<tr>
<td>Δ Problem Definition</td>
<td>□ CTQs, FDM</td>
<td>□ DFMEA / PFMEA</td>
<td>Δ Screen Experiments</td>
<td>□ DOE</td>
</tr>
<tr>
<td>Δ Objectives</td>
<td>□ KPIVs, KPOVs</td>
<td>Δ Sampling Plan</td>
<td>□ Shanin, Multi-vari</td>
<td>□ EVOP, RSM</td>
</tr>
<tr>
<td>Δ Scope</td>
<td>Δ Updated Objectives</td>
<td>Δ Initial Data Collection</td>
<td>□ Hypothesis Tests</td>
<td>Δ Implement Changes</td>
</tr>
<tr>
<td>Δ Boundaries</td>
<td>Δ Quantified Problem</td>
<td>□ Basic Stats</td>
<td>□ Regression, Correlation</td>
<td>□ Replication Experiments</td>
</tr>
<tr>
<td>Δ Preliminary Analysis</td>
<td>Δ Improvement Goals</td>
<td>□ Box, Dot Plots</td>
<td>□ DOE Design</td>
<td>Δ Handoff Plan</td>
</tr>
<tr>
<td>Δ Initial Benefits</td>
<td>Δ Project Team</td>
<td>□ Causal Paretos</td>
<td>□ DOE Experiments</td>
<td>□ Lean, 5S, Poka-Yokes</td>
</tr>
</tbody>
</table>
2.15 The psychology of six sigma [Harry et al (36)]

Reward and recognition are an important part of the process in supporting Black Belts and others who deploy the Breakthrough Strategy, and, in many instances, *costs nothing more than time on the part of senior leadership*. Employee motivation is a complex science, but it rests upon the principle that people need recognition for their successes – particularly people implementing Six Sigma, where they step outside of established roles to take on assignments beyond the scope and structure of their existing jobs.

The nature of being a Champion, Master Black Belt, or Black Belt allows employees the authority to make and execute important decisions without top-down interference. Successful Six Sigma organizations encourage autonomy and trust, and expect people at all levels to take full responsibility for their work and for the organization’s performance. In other words, they take the success of Six Sigma personally. However, those involved in the daily grind of implementing and moving the initiative forward need to be recognized and rewarded in three distinct areas if they are to sustain the intensity of the job a Black Belt demands. In a sense, Black Belts are no different from customers. They need to be asked what kinds of rewards are meaningful to them. The answers range from money to recognition, promotion, and increased corporate autonomy.

### 2.15.1 Black belts need financial compensation

While money isn’t always at the top of their reward list, most Black Belts expect and need to be acknowledged and compensated for their work. Reward and recognition are an organization’s guide to encouraging or reinforcing desired behavior among employees.
Compensation and reward mechanisms send messages. Jack Welch, who nearly left GE in 1961 after receiving a meager, but standard, salary raise of $1,000, believes that rewards drive behavior. Welch demands that the bonuses disbursed by managers be highly differentiated and based on performance rather than some present formula. To emphasize the importance of the Six Sigma initiative, Welch weights 40 percent of the bonus compensation for managers on the intensity of their efforts and their measurable progress toward Six Sigma quality in their operations. The result of Welch’s attention on people is that GE employees know that their boss is a fierce believer in the power and potential of his employees.

One of the central challenges is finding a way to align rewards with the key drivers behind an organization’s success. Management has the power to create financial outcomes for Black Belt performance that reinforce the importance of the Breakthrough Strategy initiative. The reward strategy and resulting performance should create an overall link between strategy and action. Linking rewards to strategy lets employees better understand the organization’s strategy, and is critical to achieving Six Sigma levels of quality. When employees better understand an organization’s reward strategy, organizations are better able to change culture and behaviors.

Watson Wyatt Worldwide, a global human resources consulting firm, in a 1998 study of 1,000 publicly traded North American companies, found that 61 percent of top-performing companies link their rewards to their business strategies, while lower-performing companies create minimal linkage. Watson Wyatt also found that 56 percent of top-performing companies link employee compensation to employee performance, while only 38 percent of lower-performing companies do. Watson Wyatt defines “top performers” as those companies whose performance rating can be verified by an independent source that tracks financial data on publicly traded companies.

Financial compensation is a powerful reinforcement tool in helping organizations implement the Breakthrough Strategy and retain their Six Sigma players. Compensation levels tell employees what management considers important, and is a way for senior management to reinforce their words and show commitment to a vision. When the Breakthrough Strategy is implemented, financial compensation should encourage commitment to the organization’s goals and priorities and underscore only those actions, attitudes, and accomplishments that help move an organization toward Six Sigma. The needs of the individual are aligned to the needs of the organization.

2.15.2 Black belts need the promise of promotion

Black Belts, driving scores of Six Sigma projects throughout a company, epitomize the best that people can be, and companies that treat Black Belts as heroes create the stage for these individuals to redefine how the work of the organization gets done. At GE, pioneers of the Six Sigma Black Belt movement have been rewarded with leadership positions in various divisions of the business. These promotions include positions such as general manager, director of finance, vice president of sales, vice president of the audit staff, and president of GE Mexico. As GE puts it, these Six Sigma leaders have moved into the “big jobs.” Not all high performers, however, want management positions. The
best situations occur when a Black Belt is promoted and still remains an individual contributor. Those companies postured with a technical ladder that complements the management ladders are in excellent positions to allow Black Belts this opportunity.

2.15.3 Black belts need written and verbal recognition

Too often, companies underestimate the power of recognition. Recognition isn’t solely what employers reward their employees with, but how they reward them. People want their accomplishments to be recognized. Verbal and written recognition is inexpensive and simple, whether done privately or in an open and public way. Jack Welch never sends form letters when acknowledging accomplishments – whether to directors in the GE boardroom, executives, managers, or employees. Personalized notes, accompanied by a phone call, are his favorite forms of communicating a job well done. His handwritten notes to everyone from senior executives to hourly workers carry enormous impact because they are heartfelt and spontaneous. They are written to inspire and motivate as often as they are to stir and demand action.

Motivation is highest when success is acknowledged. When major contributions to an organization are ignored, disillusionment sets in. People flourish when their accomplishments are celebrated in ways that are personal. Ritual recognition is not nearly as meaningful as a thirty-second phone call from the company president acknowledging the value of someone’s work. Sometimes recognition can be something as simple as being mentioned in the company newspaper. People need to feel that what they are doing is important and making a difference. Another Watson Wyatt Worldwide study revealed that although 50 percent of employees felt satisfied with their compensation programs, only 34 percent thought their companies did a good job recognizing performance. After presidential speechwriter Peggy Noonan received a draft of one of her speeches back from President Reagan with the words “very good” scrawled across the top of the first page, she claims that she cut the words off and taped the paper to her blouse. Like a second-grader given a gold star for a book report well done, she wore the note for the rest of the day.

2.15.4 Understanding human motivation

Psychologist Abraham Maslow published his pioneering theory of human motivation in 1943. Maslow believed that actualization is the driving force of human personality. One of Maslow’s greatest insights was to place actualization into a hierarchy of motivation. Maslow believed that self-actualization is a fundamental need, but before that need can be met, other needs – such as hunger, safety, and belonging – must be filled. Maslow pointed out that the hierarchy is dynamic, and that the dominant need is always shifting. For example, artists may become lost in the self-actualization of their art, but will eventually become tired and hungry enough that they have to stop to eat and sleep. Moreover, a single behavior may combine several levels. Eating dinner can fulfill both physiological and social needs. The hierarchy does not exist by itself but is affected by the situation and the general culture. Satisfaction is relative. A satisfied need no longer motivates. For example, a hungry man may be desperate for food, but once he eats a good meal, the hunger is no longer the motivating factor.
meal, the promise of food no longer motivates him. The point is that once Black Belts have had the first three needs on Maslow’s chart met and have reached the fourth level of esteem or ego, they want to know that their contributions are valued and that their jobs add meaning to their lives. According to Maslow, this is when motivation is at its highest.

2.15.5 Maslow’s hierarchy of needs [Harry et al (36)]
2.15.6 Employee satisfaction

The relevant literatures on employee satisfaction are important in this context. [Matzler et al (56)] mentions that the growing importance of employee satisfaction has led to an increasing interest in studying the antecedents and consequences of the construct. Especially in the TQM literature, a number of studies investigate the drivers of employee satisfaction [Eskildsen et al (28), Eskildsen et al (29), Martensen et al (54), Westlund et al (101)]. From a managerial perspective, it is crucial to know what factors influence employee satisfaction. Companies, however, are constrained by limitations on the resources available to them. Each firm must therefore decide how best to deploy scarce resources to achieve the highest level of satisfaction. In practice, the Importance-Performance Analysis (IPA) [Eskildsen et al (29)] is a widely used and effective method of setting priorities. It analyses satisfaction attributes on two dimensions: their performance level (satisfaction) and their importance to employees. [Matzler et al (56)] also mentions that factors evaluated high both in satisfaction and explicit importance represent opportunities for gaining or sustaining high employee satisfaction. In this area, a firm should ‘keep up the good work’. Low satisfaction on highly important job factors demands immediate attention. In order to enhance employee satisfaction, a firm should concentrate on these factors; ignoring them poses a serious threat to the firm. Factors both low in satisfaction and importance are of ‘low priority’. It is not necessary to focus additional effort here. Finally, job factors rated high in satisfaction but low in importance indicate a ‘possible overkill’.