SIX SIGMA AT A CROSSROADS

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Abstract

Six Sigma as a quality improvement framework has taken industry by storm for almost a quarter of a century. Its extensions and derivatives such as Design for Six Sigma and Lean Six Sigma, as well as problem-solving applications ranging from manufacturing to service sectors, have continued to attract widespread interests globally. However, voices from time to time that questioned claims on Six Sigma's efficacy made by its proponents, and academic organizations generally do not embrace Six Sigma as a prescription for excellence. In this paper, a critical examination is made of the nature of Six Sigma, with an application-oriented and realistic analysis of its potential and limitations in practice. It is pointed out that Six Sigma and its variants are actually at a crossroads at this juncture; whether they will remain relevant in the years to come depends very much on an in-depth, objective understanding and rational applications of related tools, with new techniques and applications that respond to tangible societal needs. Some examples are given to illustrate the need for innovative developments. On the other hand, if Six Sigma does morph in time into a label for a self-serving "certification" industry, it would have lost its customer-centric orientation and would inevitably reach the declining phase of a product cycle, sliding into oblivion or at best a footnote in future textbooks.

Key words: Six Sigma, Black Belts; performance improvement, quality management; process control; statistical thinking

1. Introduction

Since its appearance outside the Six Sigma Institute of Motorola in the 1980s, Six Sigma has enjoyed an unprecedented period of popularity in industry. For almost a quarter of a century the subject has been discussed, reviewed, and extended for process and product improvement applications – see Brady and Allen (2006), Goh (2002,2010), Goh and Xie (2004), George(2002), Gremyr (2005), Hahn (2005) Pyzdek and Keller (2009), Tennant (2002) for example. While there had been detractors of

Six Sigma – see, for example Lee (2001), Mika (2006), Morris (2006) and Schrage (2001) – from time to time, the general trend has been that more and more organizations are looking to it for improvements, especially from a business perspective rather than in a narrower quality consideration. Together with this growing interest is the proliferation of Six Sigma related (for example Lean Six Sigma) training and certification schemes; aside from a myriad of commercial establishments, many well established professional societies such as the American Society for Quality and Society for Manufacturing Engineers are actively promoting their certification programs. Interestingly, almost all such certification offerings are for individuals and not for organizations a la ISO 9000 and the like. Therein lies a very important issue; is Six Sigma all about an individual's competence, or an organization's capabilities? The reasoning leading to the answer to this – if indeed there is a definitive answer – would be food for thought concerning the future of Six Sigma from this juncture on.

This paper examines the background of Six Sigma and its derivatives and extensions (for convenience, only the term "Six Sigma" will be used), and explore possible directions for its development in industry in the light of its past development. It is important that organizations do not embrace Six Sigma or any of its variants without realistic perspectives on its potential and limitations. Can Six Sigma be the Holy Grail so sought after by businesses for so long? Some commercial consultants seem to allude to the affirmative; however, whether this is indeed the case cannot a simple "yes" or "no" but would perhaps be conditional on several considerations raised in this paper.

2. Merits of Six Sigma

With the abundance of descriptions of Six Sigma - see Harry and Schroeder (1999) and Brady and Allen (2006) for example – it is not necessary to describe the details of the mechanics here. As pointed out in Goh (2010), the effectiveness of Six Sigma has in no small part been dependent on the following major attributes:

1. Use of a tangible metric for comparison of performance across different processes or even industries, and for marking progress in improvement projects; in particular, a chosen metric (commonly known as CTQ, or critical-to-quality) is more often than not defined with respect to customer requirements than an organization's internal needs;
2. Clear assignment of roles and responsibilities of problem-solving and improvement personnel, in particular the common designation of roles via the Champions-Master Black Belt- Black Belt-Green Belt hierarchy;
3. Logical alignment and integration of statistical tools – this is the answer to the perception of academics that there's "nothing new" in Six Sigma; in other words Six Sigma offers a good illustration that "the whole is larger than the sum of the parts";
4. Integration of analysis and synthesis techniques with modern information technology both in software (user-friendly statistical software packages) and hardware (personal computers, notebook computers and various convenient devices). Thus the burden of number-crunching and understanding of theories are no longer obstacles to decision making on the basis of results of data analysis, i.e. fact-based procedures.

Another interesting feature of Six Sigma is that, unlike many other improvement ideas, it is not the product "of academia, by academia, for academia". Six Sigma was the outgrowth of the need to improvement product quality in order to maintain business competitiveness. It is therefore not unusual to hear, for example people from some university's Statistics Department that there is "nothing new" in it. From an academic point of view, there indeed is "nothing new" in the individual techniques in the so-called "body of knowledge" required of Six Sigma professionals, namely the Black Belts. However, the attractiveness of Six Sigma does not lie in the application of statistical tools *per se*; the middle two columns (Before SS and Current SS) in Table I summarize the cultural changes brought about by the implementation of Six Sigma including what might be expected in the future.

Table I Cultural changes associated with Six Sigma (SS) and its derivatives

Background	Before SS	Current SS	Future SS
1. Outlook	Immediate situation (management by fire fighting)	Short to medium term achievements (management by analytics)	Long term (knowledge-based management)
2. Focus/aim	Acceptable product	Good or optimal process	Designed-in excellence
3. People	Seen as liability (need to be told "Do things right the first time!)	Seen as an asset when trained	Source of creativity and innovation
4. Analysis	Experience-biased	Statistical analysis of internal data	Using both internal and external data
5. Training	Ad hoc and viewed as a luxury	Conscious investment approved by the top	Routine requirement
6. Quality	Cost burden in business	Expected return on investment	Pre-requisite for competitiveness
7. Behavior	Reactive	Proactive	Pre-emptive
8. Problem-solving	Addressing emerged problems	Revealing and dealing with root courses of problems	Eliminating or preventing problems

Thus instead of the traditional exhortations such as "Do things right the first time" and "Quality is everybody's business", Six Sigma does not depend on slogans, tag-lines, sound-bites and so on – essentially public relation proclamations – but stresses on hard techniques to rectify poor performance and aim at improvements, in a project-by-project manner by trained personnel.

3. Current state of Six Sigma

With the passage of time and difference of perspectives, Six Sigma has evolved in different directions, resulting in differences in understanding, application and expectations. These different interpretations may be broadly classified as follows:

1. A toolbox of statistical techniques
2. A process performance procedure
3. A management discipline

In the first interpretation, the use of Six Sigma is mostly tactical. For example, some CTQ is defined and, if its current value is found unacceptable, statistical techniques are used to find ways of improving it. This could constitute a Six Sigma project in a company, and could be presented for purposes such as "Black Belt certification" since quite likely the prescribed DMAIC (Define-Measure-Analyze-Improve-Control) roadmap is faithfully adhered too. While many of such projects are valuable, they are basically tactical in nature and may or may not have long-term ramifications.

The second interpretation is most widespread. With a broader perspective, DMAIC could be deployed for system improvement studies and this is where Six Sigma in service industries could be useful. Traditionally, quality management procedures have been developed mainly with reference to manufacturing processes; with the growing importance of service industries, the quantitative

techniques in DMAIC would be superior to judgment and experience based manoeuvres so commonly seen in non-manufacturing situations.

Today, many organizations have proclaimed themselves to be "Six Sigma companies", even though there is little evidence of ongoing Six Sigma projects. Strictly speaking, a company ceases to be a "Six Sigma company" where there is no DMAIC project. However some would take exceptions, stating for example if the company strives for customer satisfaction all the way, then it is a manifestation of Six Sigma. That would be the loosest application of the concept of Six Sigma at the worst, and the most strategic appreciation of Six Sigma if seen another way. For example, a particular company may, in the spirit of Six Sigma, invest in a totally new process or abandon an existing product line because it sees what would the next generation of customers would want.

Here is an illustration, though somewhat simplistic. A slide-rule manufacturing company (or part of a larger group of companies) may have Six Sigma projects to improve the accuracy of the slide rules it produces, using an array of statistical indicators. It may also turn its attention to wood procurement, processing, plant layout and marketing, with improved performance throughout. However, with the global prevalence of electronic calculators and computers, top management may want to switch the business of the company altogether, and such strategic decision is certainly beyond any clever ways of improving the *dpmo*! Thus Six Sigma can be manifested in various forms at various levels, and is not some magical formula that, as many would have heard, fetches "as much as $175,000 per project and $1 million per year per Black Belt'' (Harry, 1998).

This leads to another point, that today there are managers that engage Six Sigma consultants or send employees for Six Sigma Black Belt training out of "greed and fear" more than anything else: "Greed" because of claims of large savings possible with Six Sigma that can be promised but never scientifically supported; "fear" because too often commercial outfits use arguments such as "99% is not good enough" to persuade managers to subscribe to their services. On top of these, there is a myriad of "certification" schemes for individuals, seemingly to imply that if one is "certified" by taking a training program, then one is qualified to be put in a position related to whichever interpretation of Six Sigma listed at the beginning of this section.

4. Where may Six Sigma go from here?

"Would you tell me, please, which way I ought to go from here?" asked Alice. "That depends a good deal on where you want to get to," said the Cat.-- That is a well known quote from *Alice's Adventures in Wonderland* (Chapter 6) (Lewis Carroll,1865). In a way this applies to Six Sigma as well. By virtue of the fact that Six Sigma is still popular and pertinent at this point, it has proven itself not just "flavour of the month" or management fad; on the other hand every product has its cycle and how long a cycle Six Sigma may enjoy depends very much on the Six Sigma community of today. Some pertinent observations are as follows.

1. The continuation of the "greed and fear" motive. The high Six Sigma returns on investment (i.e. paying the high fees) depicted by commercial consultants, coupled with allusions of disasters if Six Sigma is not used, can only lead to disappointment if not disillusionment later on. The truth is that Six Sigma has sufficient merits in itself, and industry should not be lured into it by unscientific statements and promises. If this path continues, Six Sigma will soon reach its end.
2. For too long Six Sigma has been touted to work wonders for the like of Motorola, General Electric, Johnson and Johnson, Federal Express, and so on. This could actually be counter-productive as smaller organizations may get the idea that Six Sigma is only for large organizations. Thus the adoption rate of Six Sigma in medium and small enterprises could be lower just due to this misconception alone. Further elaboration on this issue can be found in Goh (2011).
3. The growth of the "certification" industry. As pointed out, there are more and more certification programs for Black Belts, Green Belts are so on being offered by various

sources. While there is merit in the idea of qualifying or recognizing levels of competence, the backgrounds of the certifiers themselves are seldom questioned. More importantly, the original concept of Six Sigma being an organizational initiative for increased customer satisfaction degenerates into a label seeking exercise to enrich an individual's resume. In fact one would wonder: is it more important to have Six Sigma deployed, or to have more Six Sigma Black Belts certified? Also, would a day come when "Six Sigma auditors" come a-knocking much like ISO9000 auditors?

4. Even if the above items are unnecessary worries, there is still a question of how Six Sigma could sustain its attractiveness. The fact is, Six Sigma has been constantly on the lips of managers because of its capability to grow: from the basic DMAIC to DFSS (Design for Six Sigma) and LSS (Lean Six Sigma , thereby aligning itself with other techniques such as Robust Design and Lean Manufacturing, offering even more comprehensive packages. To be viable, Six Sigma needs to continue this trend. The recent surge of business analytics (see Laursen and Thorlund, 2010 for example) could offer an opportunity for Six Sigma to engage itself in business applications and integrate them with process optimization
5. The above relates to methodological aspects. Then there is the application aspect. Again, Six Sigma is able to extend its application to realms that were not seriously handled by quality professionals before: government, healthcare, education, finance, tourism and so on. As long as there are unchartered fields, Six Sigma professionals will find roles to play. However, this also means, for example, the Black Belt "body of knowledge" (Hoerl, 2001), must expand correspondingly; for example, queuing theory, dependent data analysis and various simulation and optimization techniques are hardly if ever seen in most training programs; these are however essential to studies aimed at improving service systems.
6. Beyond the above is the need to discard the mindset that Six Sigma professionals acquire only tools developed by theoreticians, and apply them to only to known areas. For example, statistical process control charts are well established tools, but when it comes to service systems such as healthcare or finance, could there be better ways of analysis and presentation of process data? The recent "circle chart" (Xie *et al*, 2011) offers an answer. Also, do DMAIC and DFSS address the individual needs of customers, or are they useful only for mass production? Innovative applications with mass customization concepts (Piller and Tseng, 2010) could be a useful direction to pursue, with opportunities for the incorporation of academics' insights and expertise for strengthening Six Sigma.

5.Concluding remarks

After a quarter of a century, this is an appropriate time for Six Sigma to take stock of its position and define its direction for the coming years. To be viable, Six Sigma cannot freeze its contents and its reach for applications; even more importantly, it should not morph into a certification industry –either for individuals, or for organizations – because that is not where Six Sigma's strengths lie. Like a light source, Six Sigma does not exist for itself but to shed light for others' benefit; but if it is to remain relevant and wanted, it has to keep strengthening (by developing and incorporating more tools) and rejuvenating (by expanding its applicability and application areas) itself. The other option is hold on to its seeming popularity, do more of the same, promote individuals to subscribe to trainings for personal certificates that have no accredited status, and one day realize Six Sigma has outlived its usefulness in a world of increasingly changing lifestyles, cultural norms, demography, communication and business practices (see, for example, Conti *et al*, 2003).

In summary, six points are suggested for Six Sigma professionals to pursue, in the interest of continued relevance of Six Sigma in the coming years. These are:

1. Shed the "greed and fear" paradigm for the adoption of Six Sigma
2. Promote the use of Six Sigma in smaller organisations
3. Beware of the certification trap which basically puts the cart before the horse
4. Align or integrate Six Sigma with other frameworks for business excellence
5. Enrich the body of knowledge of Six Sigma in professional training and applications
6. Be innovative and sensitive to changes in extending the applications of Six Sigma.

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