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Abstract

Purpose – Six Sigma has been part of our business lexicon for more than a decade. Debates on its emergence as a strategic initiative have created critics who consider it as an old wine in a new bottle. Is Six Sigma a management fad? This article presents some common myths and realities of Six Sigma business strategy. The paper provides an excellent resource for those people who would like to know whether Six Sigma is just a management fad or fact.

Design/methodology/approach – The paper discusses some common myths and realities of Six Sigma by critically reviewing the existing literature on Six Sigma and also provides a greater insight into the viewpoints of leading academics and practitioners.

Findings – Six Sigma is neither a fad nor just another quality initiative. It relies on factual data coupled with hard work and is a disciplined and structured problem-solving methodology. The authors strongly argue its integration with other continuous/breakthrough improvement initiatives for sustaining the merits of Six Sigma in the twenty-first century. The paper also elucidates the role of academia in further developing and establishing the best practices of Six Sigma management strategy. Six Sigma will evolve over time like many other initiatives – however, the key concepts, the principles of statistical thinking, tools and techniques of Six Sigma, will stay for many years, irrespective of whatever the "next big thing" will be.

Practical implications – In the authors' opinion, Six Sigma will continue to grow as a powerful management initiative for achieving and sustaining operational and service excellence. However, what will eventually determine whether Six Sigma is viewed by businesses as just a passing management fad or not, largely depends on the leadership and success of its execution. The authors believe that organisations developing and implementing Six Sigma should not view it as an advertising banner for promotional purposes.

Originality/value – The paper yields a great value to both researchers and practitioners of Six Sigma in dispelling the myths of Six Sigma, which have been quite prevalent in the business fraternity.

Keywords Six sigma, Myths, Futures markets, Integration

Paper type Viewpoint

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Introduction

In the world of globalisation and growing cut-throat market environment, the quality, skills and knowledge give competitive advantage to any organization. The global market is very competitive, and to survive, organizations need to produce products and services of high quality to achieve customer satisfaction and loyalty to stimulate top-line business growth. In an attempt to manage this change, industry leaders embraced Six Sigma business strategy as a framework and solution for pursuing continuous improvement in process, customer satisfaction and also organizational profit. This approach to reducing defects has made substantial impact on many organisations, resulting in enhancement of performance and a vast improvement in business profits, employee morale, quality of products and customer loyalty (Snee, 2004; Antony *et al.*, 2005a,b; Kumar *et al.*, 2006a,b; Antony, 2007).

Six Sigma is a well-established approach that seeks to identify and eliminate defects, mistakes or failures in business processes or systems by focusing on those process performance characteristics that are of critical importance to customers (Snee, 2004). Ever since its conception at Motorola in mid 1980's, Six Sigma program has grown in leaps and bounds worldwide (Antony, 2007; Antony *et al.*, 2005a,b). At the time of its conception, it was envisioned to be a quality improvement program that sought to deliver a near-perfect (3.4 defects per million opportunities) quality to Motorola through the use of the DMAIC (define-measure-analyse-improve-control) improvement strategy coupled with the deployment of a structured set of quality tools (Kumar *et al.*, 2006a,b).

With more than two decades of successful implementation of Six Sigma methodologies at major corporations, the success and benefits possible with Six Sigma are well documented. Although Six Sigma initiatives have grown in popularity due to its highly publicized reports of success, the strategy is not the panacea that some insist, i.e. Six Sigma still has its limitations. News keeps cropping up about the efficacy of the Six Sigma business strategy from its critics, as a management fad – a fashion that sweeps the world with great excitement for a brief period of time, usually less than a year, and then disappears (Swinney, 2005). A fad is often characterised as being an initiative that is adopted widely by companies and often falls from grace when the hope for benefits fail to materialize. Debates on its emergence as a strategic initiative have created critics who consider it as an old wine in a new bottle. In the last few decades, there existed many programs that have purported to be the answer to industry's process management problems. These include zero defects, management by objectives, quality circles, total quality management (TQM) and business process reengineering (BPR) (Marsh, 2000). While these initiatives enjoyed some success, in the long run most of them were considered as a passing fad by the management and staff of different corporations.

Companies around the world are facing today the harsh realities of a competitive environment. Companies do not have time to wait and bring about evolutionary changes in their organisation. Instead, they are instituting revolutionary changes meant to have impact within a very short time frame (Henderson and Evans, 2000). Six Sigma can prove to be a powerful strategy for companies to compete globally on the basis of the quality of product and service rendered to its customers. On the other hand, there are companies that may put their Six Sigma initiatives to a halt if it takes a long time to realize tangible bottom-line benefits. Thus for them Six Sigma is not their

business solution and is just a fad, like many other business improvement initiatives. This article presents some myths and realities of Six Sigma business strategy. Authors of the article present their viewpoints as why Six Sigma is not a management fad or fantasy and discuss some of the common realities of Six Sigma.

Six Sigma: some myths and realities

Some common myths of Six Sigma

There is a pervasive perplexity and misinterpretation of what "Six Sigma" is about. Is "Six Sigma initiative" just an old wine in a new bottle, or has it one or more important learning points, which should be remembered and practiced (Dahlgaard and Dahlgaard-Park, 2006). Is Six Sigma dead, or at least waning in popularity? Is it just a "fad", which can be ignored like most other fads or should companies begin to understand the common realities of Six Sigma. When Six Sigma was introduced to many organisations, the initial reactions varied from a lot of enthusiasm to an absolute scepticism (Antony, 2004a,b), with the latter mood reflected in comments such as:

- *Six Sigma is the flavour of the month*. Senapati (2004) perceives Six Sigma as a fad with the same tools as employed in many other quality initiatives offered, e.g. total quality management. Authors strongly purport that contemporary industry has been plagued with an overdose of sick (Six) Sigma, a concept in a new clothing bearing resemblance to statistical process control. Dalgleish (2003) views Six Sigma as another repackaged quality trend that will come and go and is of no help to his company. The author considers Six Sigma as an expensive distraction that requires paying a consultant to walk into an organisation and teach a selected number of people "the newest best way" of problem solving.
- *Six Sigma is all about statistics*. There is another common perception that Six Sigma focuses on only training in various statistical tools and techniques and almost ignores the human factor (building of company culture by everybody's involvement and commitment for continuous improvement. This myth derives from the name itself, where sigma represents the standard deviation. The statistical terminology "sigma" provides an impression of Six Sigma being a statistics and measurement program.
- *Six Sigma is only for manufacturing companies*. Six Sigma originated in Motorola in mid 1980's and was promoted by manufacturing giants like General Electric (GE) and Allied Signal, giving an impression that it can be deployed only in manufacturing companies. The most common reason service-oriented organisations stay away from Six Sigma is that they see it as a manufacturing solution.
- *Six Sigma works only in large organisations*. As Six Sigma originated in Motorola and popularised by GE and Allied Signal, it is believed that its application is restricted to large organisations only because of their endless resources and large teams. Small companies might have a more difficult time effectively implementing Six Sigma, says Thomas Pyzdek, a Quality Digest columnist and Six Sigma consultant (Dusharme, 2001). Although Six Sigma has been implemented with success in many large corporations, there is still less documented evidence of its implementation in smaller organisations.

- *Six Sigma is same as total quality management (TQM)*. Reed (2000) contends that there is nothing at all new about Six Sigma and that it "has been around for many years, just called something else". She goes on to say that Six Sigma "could be called problem solving, team building, SPC, plan, act, do, check, whatever you want . . . ". Six Sigma does employ some of the same tried-and-true tools and techniques of TQM. Many companies make the mistake of setting up Six Sigma as a quality initiative, putting it in the same category as TQM. "Show me where Six Sigma involves anything new", is a common phrase often said by TQM proponents. Six Sigma has often been referred to as TQM on steroids (Seddon, 2005).
- *Six Sigma requires strong infrastructure and massive training*. Deploying Six Sigma in an organisation requires new skills, and this primarily means training the Black Belts and Green Belts who will guide and manage the improvement projects and programs. Employees in the small businesses and public sectors are of the opinion that Six Sigma demands massive training costs and additional effort (Six Sigma SPC, 2005; Smith, 2005).
- *Six Sigma is not cost-effective*. This is another common myth prevalent in the industrial world. It is presumed that deploying Six Sigma requires massive investment with meagre profit or return on investment (ROI). Critics are of the opinion that there are huge risks in heavy investment in this business strategy as it takes a long haul before reaping any tangible benefits (Senapati, 2004).

Myths demystified

Six Sigma is the flavour of the month. The latest assertion of being a fad or a magic pill to fix organisation's problems is not what Six Sigma is assumed to be. Let us first have a better picture of how fad has been defined. It is imperative to define the term "fad" before putting forward any statement or assertion of Six Sigma being a fad.

The Chambers Dictionary (2003) defines fad as "a hobby or interest intensely pursued at first, but soon passed over for another". While there is no standard definition of what constitutes a management fad, faddish ideas tend to be simple, prescriptive and transient. They are adopted widely by companies but quickly fall from favour when the hoped-for benefits fail to emerge (London, 2003). The exploitation of the literature on fad started during last two decades when the business world was being bombarded with the addition of new management terminology to the business lexicon by different management Guru's. Hesseling (1984) defined fad as a new popular finding that bursts onto the scene and fades away after a short period of time. This definition is supported by many researchers in the past who explored the subject of fads (Eccles and Nohria, 1992; Huczynski, 1993; Abrahamson, 1996; Kieser, 1997; Micklethwait and Wooldridge, 1997).

A fad is not simply good or bad. It is rather a matter of how it is put to use. A fad can survive and become a "fit" only when the idea from the original fad becomes incorporated into the day-to-day fabric of the organization and affects its overall management system and the work ethics of every employee (Hesseling, 1984). The concept of Six Sigma seems to have survived for nearly two decades despite the fact that many reports have classified it as a "management fad" (Snee, 2004; Antony *et al.*, 2005; Kumar *et al.*, 2006a,b; Henderson and Evans, 2000). Stories of success and dramatic improvement in business profitability of many organizations reflect the efficacy of this management strategy and can be considered as a classic example of

"fit" rather than "fad". The difference in impact of Six Sigma business strategy is the degree of discipline in the sequencing and use of tools, upper management active involvement, linkage to strategy, and measurement of results tied to the bottom line. Larry Bossidy, CEO of Allied Signal, imbibed Six Sigma within the organisational culture and has the following opinion about this business strategy:

> The fact is, there is more reality with this than anything that has come down in a long time in business. The more you get involved with it, the more you are convinced (Jones, 1998).

Since its inception in late 1980s, the popularity of Six Sigma has grown by leaps and bounds. Today an internet search will generate hundreds of thousands of hits on Six Sigma articles, books, conferences and jobs (Walters, 2005). As quoted by a leading quality expert: "Six Sigma has been very successful-perhaps the most successful business improvement strategy of the last 50 years" (Montgomery, 2005). Companies embracing Six Sigma have witnessed a cultural transformation that affects every aspect and level of organisations- from shop floor employees to middle managers to top level management, and thus transforming companies, people and processes. Six Sigma can only become a real fit with the normal way of managing a business when the key persons within the organizations are highly motivated for this to happen.

Six Sigma is all about statistics. Six Sigma utilizes statistics as one of its tools to analyse, interpret and present data. Organisations require not just statistics to achieve Six Sigma quality level but more importantly requires changes in organisational culture and commitment from top management permeating the entire organization (Antony *et al.*, 2005a,b; Pande *et al.*, 2000). Six Sigma is more about changing the mindset of people, making a shift from a traditional approach of problem solving (i.e. fire fighting) to a proactive approach, based on facts and the correct analysis of business data for decision-making purposes. The tools and techniques of Six Sigma are used for collecting, analysing, and interpreting data to drive decisions. Computer software is available to analyse the data, which can be done by one or two members in the Six Sigma team, thus speeding up the improvement process. Engineers and managers do not need to be experts in statistical methodology. They need to be wise in terms of when the use of statistical methodologies can provide more efficient, effective information on sources of variation in product or process (Sanders and Hild, 2000).

Six Sigma is not just about statistics. The Six Sigma drive for defect reduction, process improvement and customer satisfaction are based on the "statistical thinking" paradigm, a philosophy of action and learning based on process, variation and data. Statistical thinking provides practitioners with the means to view processes holistically. There is a logical thought progression from process-variation-data to define-measure-analyse-improve-control (DMAIC) (Hare, 2005). This is contrasted with statistical methods and theories, which are primarily about variation and data and the aggregate of statistical methods themselves (Snee, 2004; Hare, 2005). Examination of process encourages a holistic process view in which the process is first defined using flow diagrams to provide a common understanding, a key to variation reduction from the start. Next, a focus on variation leads to the establishment of systems to measure and analyse variation, and the subsequent focus on data leads to continuous improvement and holding the gains once attained (Hare, 2005). Statistical thinking, therefore, is fundamental to the methodology because Six Sigma is action-oriented,

focuses on processes used to serve customers, and defect reduction through variation reduction and improvement goals (Snee, 2004).

Six Sigma is only for manufacturing companies. The relevance of Six Sigma extends beyond manufacturing to services, government and public sector, healthcare and non-profit organizations (Antony *et al.*, 2005a,b; Montgomery, 2005; Pande *et al.*, 2000; Pyzdek, 2003; Breyfogle, 1999). Motorola developed Six Sigma and implemented it first in manufacturing. From 1990 onwards, they started implementing it to their non-manufacturing areas of the company. It was reported at the European Quality Forum in Berlin that Motorola managed to save $5.4 billion in non-manufacturing processes from 1990 to 1995. According to George (1992):

> Improving non-manufacturing processes (or non-primary service processes for service companies) is one of the weakest areas in the quality system of nearly every company.

In terms of expanding the horizons of Six Sigma, the two application areas that seem to be rising to the top of the heap are healthcare and financial services (Hoerl, 2004). The popularity of Six Sigma as a means of improving the quality of service and customer satisfaction is growing exponentially in the last couple of years in the European service industry. Six Sigma offers a disciplined approach to improve service effectiveness (i.e. meeting the desirable attributes of a service) and service efficiency (i.e. time and costs). The objective of a Six Sigma strategy in service processes is to understand how defects occur and then to devise process improvements to reduce the occurrence of such defects, which improve the overall customer experience and thereby enhance customer satisfaction (Antony, 2004a,b).

GE Capital, the financial division of GE, was one of the first financial institutions applying this methodology in order to increase their profitability and customer satisfaction (Antony *et al.*, 2006). After this, various financial institutions and banks have followed such as Bank of America, Citicorp, American Express, UBS, Lloyds TSB, HSBC, Zurich Financial, and Bank One (George, 2003). The first health-care organization to implement Six Sigma fully into its culture was Commonwealth Health Corp. (CHC) in partnership with General Electric (Thomerson, 2001). CHC has realized improvements in excess of $1.2 million, improved radiology throughput by 33 per cent and decreased cost per radiology procedure by 21.5 per cent (Thomerson, 2001). Following CHC, many health-care organizations embraced the Six Sigma challenge within their processes, examples include Mount Carmel Medical Centre (Columbus Ohio), Charleston Area Medical Centre (WV), Palomar Pomerado Health (San Diego, California), the University of Michigan Medical Center, and Wellmark Blue Cross Blue Shield (CA), to name a few (Sehwail and DeYong, 2003).

Experts agree that the most common reason service-oriented organisations stay away from Six Sigma is that they see it as a manufacturing solution. One of the major hurdles service-oriented organisations must overcome is the notion that, because their company is human-driven, there are no defects to measure. This is wrong, say the experts (Antony *et al.*, 2007a,b).

It is quite a common view among many people engaged in service organisations that Six Sigma requires complicated statistical tools and techniques. The truth is that Six Sigma is not about a collection of statistical tools and techniques. In fact, service organisations do not simply need many of the tools and techniques of the Six Sigma toolbox. The majority of the process and quality related problems in service

organisations can be readily tackled using the simple problem-solving tools of Six Sigma such as process mapping, cause and effect analysis, Pareto analysis, control charts and so on.

Six Sigma works only in large organisations. It is a myth that Six Sigma works only in large companies. GE treated its business as many small business units integrated together. Six Sigma is about problem solving, and problems are everywhere. It does not matter what type or size of business this problem solving methodology is applied to. You might be a wholesaler, a retailer, a manufacturer, or a service organisation. No matter whether it is a 300 employee company or a ten employee family business, Six Sigma will work as long as you follow the process effectively (Brue, 2006).

Six Sigma has evolved into a business strategy in many large organisations and its importance in small and medium sized enterprises (SMEs) is growing everyday because of the growing significance of supply chain issues (Antony *et al.*, 2005a,b, 2007). A recent study has revealed that strong leadership and undying commitment from top-level management are critical to the success of Six Sigma (Kumar *et al.*, 2008). This study clearly indicates that there are significant differences in the performance of Six Sigma against non-Six Sigma SMEs.

Taking into consideration of the problem complexity and resources limitation, the SMEs do not require an extensive role system where Master Black Belts, Black Belts are involved in projects as are applied to large organizations (Kumar *et al.*, 2006a,b). It is highly advisable in the authors' opinion to develop a White Belt system for SMEs instead of heavily investing in Black Belt system. The White Belt definition provided by Harry and Crawford (2005) is not realistic and achievable. Twelve projects in a year for a White Belt are too ambitious. We suggest that the White Belts may carry out between six to eight process or quality improvement related projects using the DMAIC methodology. The expected savings from a white belt project can be around £5,000 per project. In our opinion, a company of size 100 should plan for about ten to 15 white belts, trained for a week on basic Six Sigma methodology.

Snee and Hoerl (2003) argue that there is nothing inherent in Six Sigma that makes it more suitable for large companies. They also suggest that the greatest barrier to implementation in small companies to date has been the way the major Six Sigma training providers have structured their offerings. More recently, as more and more sets of deployment guides and training materials have become available, the pricing structures have begun to change. Further, excellent on-line self-paced Six Sigma training from authoritative sources at reasonable costs is becoming widely available. This is a very good way for smaller organizations to start a six sigma training activity. It is also possible for SMEs to obtain good external resources through collaboration with local universities. For example, the Centre for Research in Six Sigma and Process Improvement (CRISSPI) at Glasgow Caledonian University provides yellow belt and white belt training to SMEs in UK at a competitive price and through rigorous research and case studies. Arizona State University provides green belt and black belt training in both live classroom and internet class formats.

No doubt deploying Six Sigma will cost organization some money and time, but it will be worth expending time, money and effort to achieve real measurable financial results. Organizations face myriad of problems in their day-to-day functions. Six Sigma can be applied where there is a problem, irrespective of type or size of business (Brue, 2006). Six Sigma can act as a catalyst for changing SMEs in the quest for business

excellence by mobilising their intellectual capital, provided there is total commitment. In order to assist SMEs with the implementation of Six Sigma, the authors are recommending a Six Sigma user group (SSUG) to share and exchange experiences of successful Six Sigma projects within SMEs as well as with similar companies, which embark on Six Sigma programme. Six Sigma will facilitate the SMEs, like large organizations, to support their organizations' strategic direction and increasing the needs for coaching, mentoring and training.

Six Sigma is the same as TQM. It is often said by engineers and managers in small and big companies that there is nothing really new in Six Sigma compared to other quality initiatives witnessed in the past (Antony, 2004a,b). Companies that have embraced Six Sigma within their working culture previously made improvements through the use of TQM or Crosby's Zero Defects or Quality Circles (Walters, 2005). However, these programs obviously did not address all of their needs. Otherwise these same organisations would not be spending additional time and money to implement Six Sigma. Deming, one of the quality Gurus of the 20th century, argued that TQM is terminologically vague, stating:

> . . . the trouble with total quality management, the failure of TQM, you can call it, is that there is no such thing. It is a buzzword. I have never used the term, as it carries no meaning (Deming, 1994).

The CEO of 3M, Chris Galvin, believes Six Sigma has changed their way of doing business:

> Six Sigma is not a program or an initiative. It is our game plan. It will challenge all of us, as a company and in collaboration with our customers, to be the very best. Motorola was open to sharing the risk, which allowed us to develop an outstanding partnership (McShea *et al.*, 2004).

There are three aspects of the Six Sigma strategy that are not emphasised in total quality management (TQM). First of all, Six Sigma is result-oriented and therefore places a clear focus on bottom-line business impact in hard dollar savings. No Six Sigma project will be approved unless the team determines the savings generated from it. Second, Six Sigma methodology DMAIC links the tools and techniques in a sequential manner. Finally, Six Sigma creates a powerful infrastructure for training of Champions, Master Black Belts, Black Belts, Green Belts and Yellow Belts (Snee, 2004; Antony *et al.*, 2005a,b; Pande *et al.*, 2000; Harry and Schroeder, 1999; Adams *et al.*, 2003).

In the quest for business excellence, Six Sigma should be viewed more as a holistic business strategy than as a quality program. While many organisations have embraced numerous quality improvement programs, most fail to deliver the result that Six Sigma consistently identifies as tangible and quantifiable increase in shareholder value. Six Sigma provides us with a common language as it reduces things to a common denominator – 3.4 DPMO and sigma capability level, thus providing the ability to benchmark ourselves against like production, processes, and practices.

Six Sigma has changed the outlook and practices of everyone in the organization by permeating into departments, functional groups, and all levels of management. The decision making process is more objective, utilizing tools/techniques to identify the root causes of defects at all levels of the organisation, thus generating real-world results (Snee, 2004). The five phase DMAIC methodology uses a collection of tools and techniques, acting as logic filter to lead the team to the vital few factors affecting process outcomes.

As compared to other quality initiatives, the cultural change in Six Sigma organisation is facilitated by key players known as Champions and Black Belts, who act as agents to facilitate the change. These change agents harness the power of knowledge to achieve enhanced performance, customer satisfaction and profitability, which is what Six Sigma is all about (Pyzdek, 2003; Brue, 2002). Companies that have implemented Six Sigma have achieved outstanding financial results and developed disciplined, pragmatic plan and approach for improved financial performance and growth.

Six Sigma requires strong infrastructure and massive training. Deploying Six Sigma in an organisation requires new skills, and this primarily means training the Black Belts and Green Belts who will guide and manage the improvement projects and programs (Lee-Mortimer, 2006). Real benefit and return on investment in Six Sigma is conditional and should be deployed from the top down. The leaders of the company must first understand the basics of Six Sigma and develop a company-specific deployment strategy before building a Six Sigma infrastructure and beginning Black Belt and Green Belt training. Understanding of Six Sigma should include not only its value as a quality improvement methodology but also as a management and leadership strategy and methodology supported with a variety of tools/techniques. The measure of success for an investment in Six Sigma should be based on the successful completion of projects that give significant business value and the results obtained from those projects.

A company can start with Six Sigma deployment by identifying a manageable number of critical projects that are top priority for the organisation and can be successfully completed within few months (two-five months). This will involve fewer resources and can win top management commitment and faith in the initiative. One should focus on type of business, complexity of processes, availability of resources and develop an organizational infrastructure required for the company. It is not necessary that for large organisation having 1,000 employees, there should be 100 Black Belts or 300 Green Belts. The rule of thumb is that the mature Six Sigma organization will develop about 1 per cent of its work force as full-time Black Belts, although it is not uncommon to start with about 0.5 per cent (Keller, 2005). In this way, the deployment is effectively scaled based on the number of employees. Company culture, organizational structure and facility location may also influence the number of Black Belts. For example, Black Belts may be selected so that the needs of each facility, or each segment of the business, are adequately met.

Six Sigma demands massive training costs and additional effort has become another misconception among many employees in the service sector. It is true that Six Sigma requires some investment at the outset for training the most talented people in the organisation and converting them into the so called "change agents". However, the benefits obtained from Six Sigma implementation outweigh the investment costs (Antony *et al.*, 2006).

Since SMEs face constraint in training and deploying Black Belt to full time projects, it is advisable for SMEs to collaborate or develop some sort of consortium with local universities and get their best people trained up as Yellow Belts and White Belts to tackle their day-to-day problems. Academic institutions should help SMEs to meet their customer or stakeholder needs and assist them in creating value for their key customers. This will ensure development of stable, long-term and cost-effective

relationship between the organization and academic institution. The training should focus on how to select the right projects and how to form the right teams so that the company's limited resources are effectively utilized.

Six Sigma is not cost effective. Six Sigma is a powerful "weapon" for delivering business improvement and many businesses are naturally drawn by the continual reports of its ability to help companies generate huge cost savings, customer satisfaction and improved profitability (Lee-Mortimer, 2006). Six Sigma has been launched all over the world and many companies have testified to its pivotal role in their success (Hutchins, 2000). Six Sigma business management strategy has been exploited by many world class organisations such as GE, Motorola, Honeywell, Bombardier, ABB, Sony, to name a few from the long list and resulted in billions of dollar of bottom-line savings (Snee, 2004; Antony *et al.*, 2005a,b).

The reason of Six Sigma's popularity in the business world is because many corporations have seen how Six Sigma generated substantial return on investment in its implementation (Szeto and Tsang, 2005). It is reported that the savings achieved by Motorola reached $1 billion in 1998 and $16 billion in 2005 (Ingle and Roe, 2002; Brett and Queen, 2005). Dow Chemicals, which implemented Six Sigma on a corporate-wide basis in 2000, achieved its target of $1.5 billion in cumulative EBIT (earnings before interest and taxes) gains by the end of 2002 (Motwani *et al.*, 2004). Volvo Cars in Sweden have generated over 55 million euro to the bottom line from Six Sigma programme (Magnusson *et al.*, 2003).

Sustainable merits of Six Sigma in the twenty-first century

About 20 years have passed since the birth of Six Sigma in Motorola. Now the important question is "Is Six Sigma sustainable in the twenty-first century? How long?". We believe that Six Sigma is quite sustainable, and will last quite for a long time. The reasons are already stated in explanation of "myths demystified" section. Besides the reasons mentioned, we want to add two more important aspects of Six Sigma as follows.

Six Sigma provides bottom-line benefits and customer-oriented management

Linking customers to continuous improvement of products and services is a key response by world-class companies, which are employing Six Sigma. In many organizations, the quality improvement initiative is driven by the voice of customers or by the latest managerial issues (Peterka, 2005). Projects selected for investment should be aligned with the customers needs and should have the potential to significantly improve the bottom-line. Organisations embracing Six Sigma can achieve better quality and efficiency in the flow of information and interaction between people, especially interaction with customers. Six Sigma identifies the voices of customers and maps it in the form of matrix (cause and effect matrix) or house of quality (quality function deployment).

One of the greatest benefits of Six Sigma aside from improving product-to-market times is how it engages employees and customers in greater dialogue in a way that both energizes and unites the company. Problems are analysed, and solutions are implemented not only between the business and its employees but also between the business and its customers. A shared language develops focusing on customer goals and metrics (Henderson and Evans, 2000).

Six Sigma matches well to knowledge-based information society

This twenty-first century is often called knowledge-based information society, and knowledge management is very important for any organization to survive in this century. In knowledge management the CSUE cycle (Park *et al.*, 2005) is recommended just like the DMAIC cycle in Six Sigma. The CSUE cycle is creating and capturing, storing and sharing, utilization, and evaluation. It means that knowledge should be created or captured at the beginning, and then it should be stored and shared. Next, it should be utilized for process improvement, and then it should be evaluated for further use later.

The DMAIC cycle can be practically useful for knowledge management, and it can be linked well with the CSUE cycle as follows.

- Define – fact finding.
- Measure – data gathering.
- Analyze – information creation and capturing.
- Improve – knowledge sharing and utilization.
- Control – knowledge maintaining and evaluation.

We believe that Six Sigma matches well to knowledge management, and this is one of the reasons why Six Sigma may last long in this century. Six Sigma will be evolved in several different dimensions in the future. Definitely Six Sigma and knowledge management can be combined, and so-called knowledge-based Six Sigma (Park, 2003) can be one direction. Similar cue may be taken from Man (2002) to integrate Six Sigma with lifelong learning for the "adult learners" within their organization and personal lives. Man (2002) draws a parallel between the characteristics and norms that define an adult learner with the DMAIC methodology of Six Sigma. Six Sigma can be used to generate the triggers that induce learning and the creation of new technologies. However, single loop type of learning with a focus on technical aspects and problem solving should be avoided (Savolainen and Haikonen, 2007). More focus should be on linking the Six Sigma initiative to enhance the learning cycle of employees.

Agenda for future research

Six Sigma, a systematic framework for quality improvement and business excellence, has been widely publicized in recent years as the most effective means to combat quality problems and win customer satisfaction (Goh, 2002). However, some researchers have argued that the focus of Six Sigma has been too narrow, the research not being well developed, and too much research has been focused on descriptions of practice rather than on theory development that is of use to managers and scholars.

Here, academia can play a critical role in bridging the gap existing between the theory and practice of Six Sigma. It has been observed that very few universities in UK and rest of Europe are engaged in teaching and research on Six Sigma. This needs to be changed in the future so that collaborative Six Sigma projects between the academic and industrial world must be established in both engineering and business schools. Six Sigma has made a huge impact on the industrial world, but its impact on the academic community is limited. It will therefore be incumbent on academic fraternity to carry out well- grounded research to explain the phenomena of Six Sigma. The academic world

has indeed a crucial role to play to bridge the gap between the theory and practice of Six Sigma and to improve the existing methodology of Six Sigma (Antony, 2008).

The role of Six Sigma in promoting the concept of statistical thinking for both engineers and business leaders is imperative. Statistical thinking – consisting of core principles such as process, variation and data – may be used to create a culture that should be deeply embedded in every employee within any organisation embarking on Six Sigma programmes.

Some of the emerging research trends of Six Sigma include: integration of Six Sigma with lean manufacturing, agile manufacturing, quick response manufacturing, and theory of constraints; development in new application areas such as healthcare, finance, sales, human resources, software engineering; integration of Six Sigma with other quality improvement initiatives such as ISO 9001:2000, and EFQM Excellence Model; selection of Design for Six Sigma (DFSS) strategy over Six Sigma – based on a number of variables such as risk, technology, customer demands, time, cost and complexity; tailoring the existing Six Sigma DMAIC methodology for SMEs; the relationship between Six Sigma and organisational culture and learning; integration of eco-effective design into the DFSS processes to foster healthy and prosperous conditions for humans and ecological systems by reusing materials and components in natural biological or technical cycles; integration of DFSS with lean thinking, may be called as "Design for lean Sigma".

There is a paucity of literature on Six Sigma Project Selection, a topic that goes unnoticed in most organisations, and different techniques or methodologies that can be used for project selection, e.g. analytical hierarchy process (AHP), pugh matrix, failure mode and effect analysis (FMEA), quality function deployment (QFD), project prioritization matrix, fuzzy logic, etc. The results from the informal poll conducted by Pande *et al.* (2000) identified project selection as the most critical and most commonly mishandled activity in launching Six Sigma. The success or failure of Six Sigma deployment in a business process hinges on selecting projects that can be completed within reasonable time span (four to six months) and will deliver tangible (quantifiable) business benefit in financial terms or customer satisfaction (Antony, 2004a,b). Identification of high-impact project at the initial stage of programme will result in significant breakthrough in rapid timeframe. This is another area, which needs an immediate focus for continued development of Six Sigma.

Six Sigma will keep on building its momentum in almost all type of industries, irrespective of the size and turnover, with no signs of giving up in the immediate future. The challenge for all organisations is to integrate Six Sigma into their core business processes and operations rather than managing it as a separate initiative. In our opinion, Six Sigma will continue to grow as a powerful management initiative for achieving and sustaining operational and service excellence. It might evolve into a "new package" when it fails to achieve significant returns to the bottom-line. However, the sound principles and key concepts of Six Sigma will stay with it for many years. In future, the Six Sigma toolkit will be enriched by the continuous emergence of new useful tools and techniques, especially in the software, finance and healthcare applications. Authors believe that organisations developing and implementing Six Sigma strategy should not view it as an advertising banner for promotional purposes.

Concluding remarks

Organisations that implement Six Sigma have benefited from it in three major ways: reduced defect rate; reduced operational costs; and increased value for both customers and shareholders (Antony, 2008). Six Sigma has been part of our business lexicon and has maintained momentum for more than a decade (Snee, 2004; Noble, 2007). It is now more than hype; it is a recognized methodology for solving process and quality related problems in modern organizations (Antony, 2008). The interest in it is still very strong with lot of air left in its sail and no signs of letting off. This may be attributed to the fact that over the past decade Six Sigma has shown great flexibility and bottom-line benefits in its application beyond its root in manufacturing. Six Sigma like other business initiatives can become fad in the eyes of the management team if not implemented correctly. A review of literature on the critical success factors (CSFs) of Six Sigma explicitly states that commitment and support from top management is most important for its successful deployment as well as sustaining the improvement achieved from its implementation (Antony and Banuelas, 2002).

The answer to the question "Is Six Sigma a passing fad?" is clearly no. Six Sigma is neither a fad nor just another quality initiative. It is a "way of life". It is a business strategy based on objective decision making and problem solving, relying on meaningful and real data to create actionable goals, analyzing root cause(s) of defects, and thus suggesting the ways to eliminate the gap between existing performance and the desired level of performance. Becoming a Six Sigma organization means embracing the fundamentals of statistical thinking (an area that need to be further explored):

- All work occurs in a system of interconnected processes.
- Variation exists in all processes.
- Understanding and reducing variation are the keys to success.

The right Six Sigma training and information will help people to understand that Six Sigma is significantly different from other quality improvement initiatives of the past. Six Sigma is about using common sense to make things easier rather than making things more difficult (Peterka, 2005). However, what will eventually determine whether Six Sigma is viewed by businesses as just a passing management fad or not, largely depends on the leadership and success of its execution. Management is responsible for the success of Six Sigma teams, they have to provide the environment that is conducive for the employee to succeed, i.e. make the time and resources available (Nest, 2003). Successful Six Sigma program are built on a solid organizational foundation. The organizational system and structure need to be clearly identified and communicated to the entire organization to successfully implement Six Sigma. Setting up a successful Six Sigma organization requires careful planning and training of employees. Employee roles and responsibilities must be established and clearly communicated to all.

While Six Sigma methodology is experiencing widespread adoption among a variety of business and industry, there is an inherent drawback of its misapplication if adequately trained personnel, with the proper foundational background, are not available. Under this contextual setting, academia has a critical role to play. Six Sigma lacks theoretical under-pinning and hence academics need to take up the responsibility to bridge the gap in the theory and practice of Six Sigma. The article culminates with the following quotes from Walters (2005):

Six Sigma has similarities to quality programs of the past because it contains many of the same ideas and philosophies that have been taught for years, but it is vastly different in scope and complexity because it teaches practical method of achieving these ideas and philosophies. Six Sigma not only tell us what to do, but more importantly how to do it.

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