IS SIX SIGMA APPROPRIATE FOR NEW ZEALAND ORGANISATIONS?

Dr Nigel Grigg[1] and Dr Venkat Pulakanam[2]

[1]Senior Lecturer in Quality and Industrial Statistics
Coordinator, Graduate Diploma in Quality Systems
Institute of Technology and Engineering, Massey University, Private bag 11 222, Turitea Campus, Palmerston North, New Zealand
Tel: + 64 (0)6 350 5799 ext 7399, Fax: + 64 (0)6 350 5604,
E-mail: N.Grigg@massey.ac.nz

[2]Senior Lecturer and MBA Director,
College of Business and Economics, University of Canterbury, Private Bag 4800, Christchurch, New Zealand
Tel. +64-3-3642638, Fax. +64-3-3642925,
Email:venkat.pulakanam@canterbury.ac.nz

INTRODUCTION: WHAT IS SIX SIGMA?

Six Sigma refers to a set of tools and techniques, within an improvement cycle, developed by Motorola to guide the process of continuous improvement of product quality. The term itself refers to a level of process capability. Sigma (σ) is the Greek alphabet equivalent of the letter s, and is used to denote *standard deviation* in statistics. Any group of values resulting from a numerically-based process measurement activity will have an average or mean value (σ) denoting its 'centre', and a standard deviation (σ) denoting its degree of inherent variability. Standard deviation is itself a measure of the accumulated differences between a group of values and their average. Traditional quality control theory has always held that having the upper or lower specification limits for a product or component equate to three standard deviations from the mean for the process would result in acceptably low levels of nonconforming product (66,807 defects per million opportunities, or 6.7% of production, assuming that processes are subject to disturbances that could cause the process mean to shift by as much as 1.5 standard deviations off the target). In Six Sigma thinking, the process is improved to the extent that specification limits lie six standard deviations from the process mean, and thereby achieve 3.4 defects per million opportunities (or 0.00034% of production). Figure 1 compares the two situations graphically. The means to achieving this level of performance are through application of a collection of long standing management and statistical tools, systemically applied within a cycle of improvement known as DMAIC (standing for Define - Measure - Analyse - Improve - Control).

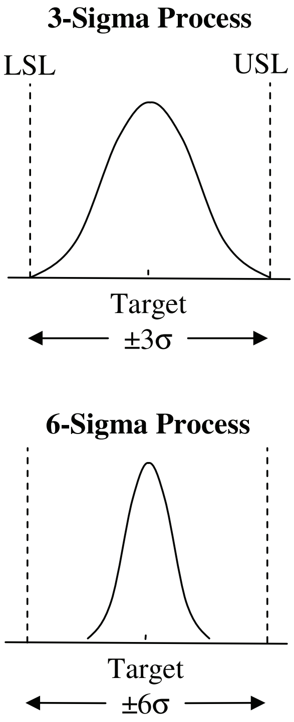

Figure 1
Comparing 3-sigma and 6-sigma processes

In terms of Six Sigma literature the following points are made in narrowing down a definition. Six Sigma has two major perspectives, or 'lenses' through which it can be viewed (Kwak and Anbari, 2006). Firstly, it originates from statistics and statisticians, and has a specific, technical and probabilistic definition as given in the previous paragraph. Secondly, it is viewed as a business strategy or strategic change approach to improve business profitability, through improving the effectiveness and efficiency of all operations to meet or exceed customers' needs and expectations (Antony and Banuelas 2001), i.e. it is a statistical methodology for operational improvement. Anbari (2002) proposes that Six Sigma is more comprehensive than prior initiatives such as TQM and continuous improvement through having: more explicitly measured and reported financial results; additional and more advanced data analysis tools; greater use of project management tools; and a stronger customer focus. Schroeder, Linderman, Liedtke & Choo (2007) argue further that Six Sigma tools and techniques are similar to previous TQM approaches, but that Six Sigma provides an organisational structure not previously seen in TQM.

SIX SIGMA DEVELOPMENT: HISTORY AND GROWTH OF SIX SIGMA

As is now largely common knowledge, Six Sigma was pioneered by Motorola in the 1980s, this process beginning in 1982 when the CEO asked his corporate managers to cut quality costs by 50% in that year, and then continued making the same demand in subsequent years. By 1984, it had become clear further improvement would involve more and better analytical methods coupled with product design. The emphasis then focused on design quality and a number of advanced quality tools were employed which became Six Sigma (Hendericks and Kelbaugh 1998).

While the original emphasis was upon manufacturing processes, the Six Sigma approach soon spilled over into the support processes such as distribution, marketing and customer order processing (Smith 1993). Motorola eventually developed a Six Sigma curriculum and created practitioner qualifications. These early efforts led the company to winning the Malcolm Baldrige Award in 1988. Following the success of Motorola, the early proponents of Six Sigma included Texas Instruments, Allied Signal, Eastman Kodak, General Electric, Borg-Warner Automotive, GenCorp, Navistar International and Siebe plc.

Six Sigma has grown more ubiquitous over the past several years. Six Sigma has grown more ubiquitous over the past several years. The publication *Industry Week* in conjunction with the Manufacturing Performance Institute conducts an annual census of US manufacturers, to which over 600 manufacturers routinely respond. Figure 2 shows the data from 2003, 05, 06 and 07 in relation to the use of improvement methods and approaches. The data show that lean leads the way by a very clear margin, while all other methodologies are similarly enjoying a marked upswing from 2006 to 2007.

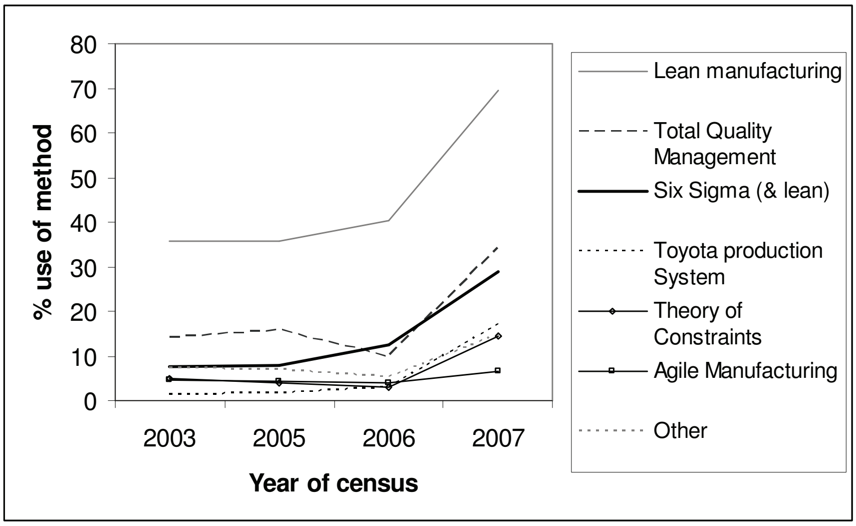

Figure 2
Change in use of improvement methods among US manufacturers over five years (2004 data missing). From data published by *Industry Week*.

A 2004 American Society for Quality (ASQ) survey of 600 CEO's in the manufacturing (180), service (220), healthcare (100) and education (100) sectors reported by Weiler (2004) revealed the pattern of awareness and use of certain quality techniques and practices summarised in figure 3. Six Sigma scored just under 50% in terms of awareness, and 15% in terms of use.

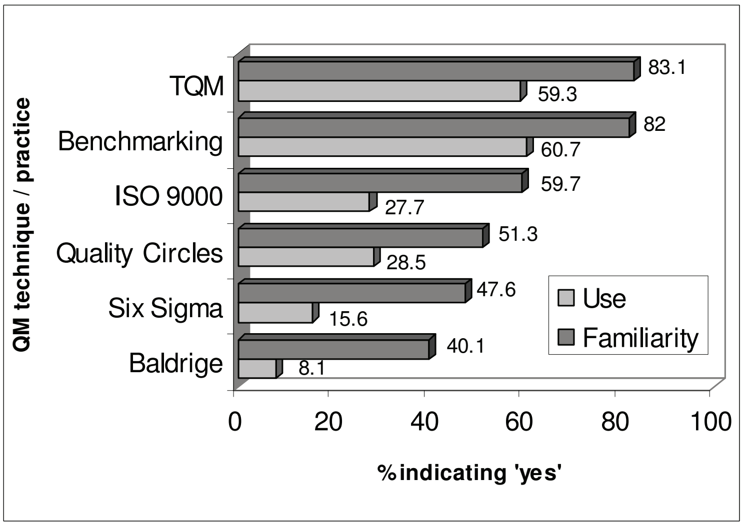

Figure 3
Awareness and use of quality techniques and practices (from Weiler, 2004)

A 2005 survey by ASQ confirmed that around 40% of US top executives were aware of Six Sigma (Okes 2006): figure 4 shows general awareness of various tools resulting from this study.

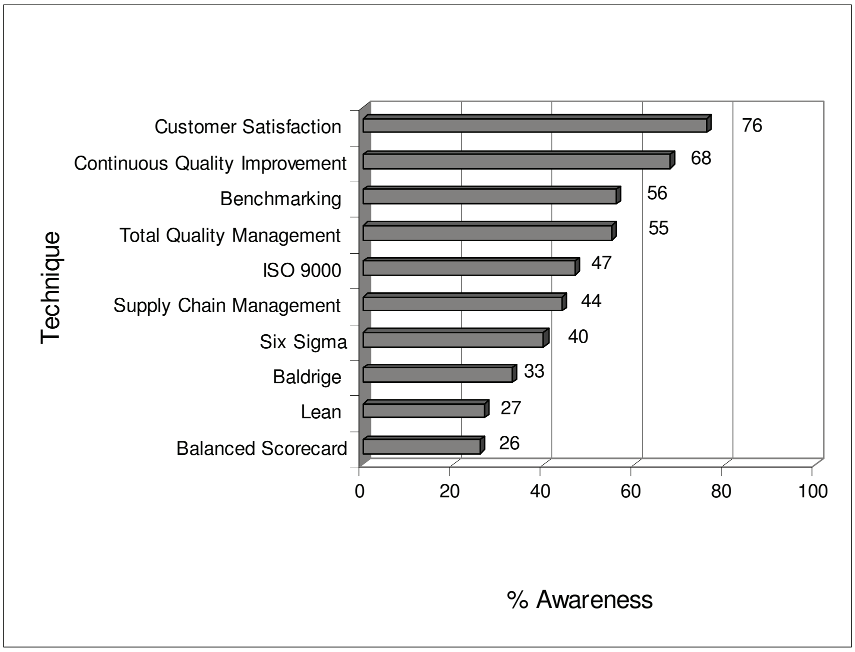

Figure 4
Top executive awareness of key improvement tools (Okes, 2006)

In a survey of 418 enterprises undertaken in UK, a significant percentage of survey participants (52%) claim to be implementing Six Sigma (Aberdeen Group 2006), and in another survey of SMEs carried out in UK, 27% of the participants have claimed that they are implementing Six Sigma (Antony, Kumar & Madu, 2005).

Within New Zealand the authors are aware of a number of companies in the electronics, banking and postal sectors who have been implementing Six Sigma since as early as 2001.

HOW IS IT DONE? IMPLEMENTING SIX SIGMA

A facet that distinguishes Six Sigma from previous quality control approaches is the adoption of martial arts-style belts determining a practitioner's grade of knowledge and experience. These vary from yellow, green, black and master black belt. Progressing up the ranking requires demonstration of more project experience and greater monetary savings.

Black belts typically lead customer focused project teams using a systematic problem-solving methodology, change and project management skills and analytical techniques to drive fact-based decision-making. The Six Sigma problem-solving framework is commonly referred to as DMAIC:

Define what needs to improve.
Measure the current state against the desired state.
Analyse the root causes of the gap in performance.
Improvement solutions are brainstormed, selected and implemented.
Controls for long-term sustainability are implemented

Table 1 summarises the business strategies, techniques and tools used in Six Sigma methodology (Adapted from Kwak and Anbari, 2006 and Antony, Escamilla & Caine, 2003).

Table 1
Strategies, Tools And Techniques Used Within Six Sigma

Six Sigma business strategies and principles	**Six Sigma tools and techniques**
Project management Data-based decision making Knowledge discovery Process control planning Data collection tools and techniques Variability reduction Belt system (master, black, green, yellow) DMAIC Change management	Statistical Process Control process capability analysis Measurement system analysis (e.g. R&R studies) Design of experiments Robust design Quality Function Deployment Failure Mode and Effect Analysis Regression analysis Analysis of means and variances Hypothesis testing Root cause analysis Process mapping

According to Harry (1998) the average black belt project will save a company US$175,000. Black belts, with 100% of their time allocated to black belt projects, can execute five or six projects during a 12-month period, adding approximately US$1 million to annual profits (Harry 1998).

FACTORS FOR SIX SIGMA SUCCESS

A panel discussion involved panellists with a total of some 200 years of R&D experience and was hosted by the Industrial Research Institute's Process Effectiveness Network in 2001 to discuss Six Sigma in R&D (Johnson 2002). The panellists identified the most important factors for success with Six Sigma as being:

1. The people at the top of the organisation must provide commitment and leadership;
2. Project selection and management processes must involve rigorous project administration, commitment management, control of costs, schedules, changes, and production, as well as quality assurance and configuration management;
3. The customer`s value proposition must be understood very early in the process;
4. Metrics available and used to prove and track performance;
5. A common language for improvement must be learned and used;
6. Adequate funding for improvement efforts must be made available and maintained.

EVIDENCE ON THE SUCCESS OF SIX SIGMA INITIATIVES

There is evidence that application of Six Sigma can produce measurable financial results and improving operational performance measures. These are the most commonly reported benefits resulting from Six Sigma initiatives (Aberdeen Group 2007). Other (less frequently) reported benefits include employee satisfaction, customer satisfaction and appreciation of stock price.

Antony and Banuelas (2002) summarise the major achievements of the Six Sigma pioneering organisations as follows:

Motorola (1987-1994)
Reduced in-process defect levels by a factor of 200.
Reduced manufacturing costs by $1.4 billion.
Increased stockholders share value four-fold.

Allied Signal (1992-1996)
Reduced new product introduction time by 16 per cent.
Reduced manufacturing costs by more than $1 billion.

General Electric (1995-1998)
Company wide savings of over $1 billion.

Since then there have been a plethora of reported cases showing a range of financial and operational benefits, across a range of sectors and process types. The benefits of implementing Six Sigma depend, however, on the level of implementation. One can expect a net savings of at least 0.8% of revenues with 'true' rigorous Six Sigma implementation (Waxer, 2008). Table 2 provides a summary of revenues, investment and returns for some of the organisations which are well known for their impressive successes with Six Sigma (Waxer, 2008). Table 3 summarises a further selection of cases that illustrate a variety of Six Sigma programme benefits.

While these cases appear to present compelling argument, it will be observed that they mostly relate to larger US organisations with available resources and a pre-existing good level of quality maturity. They are also mostly trade press articles that are intended to act as marketing for the case organisation or their consulting firm as much as to report case studies of good or best practice for the common interest. The early successes of Motorola and GE have by now been repeated so often that they have by now become almost part of a contemporary mythology (definable as "*a set of stories, traditions, or beliefs associated with a particular group or the history of an event, arising naturally or deliberately fostered").* The implication of those who present these success stories is that the benefits experienced by these organisations as a result of using this methodology will also be, by extension, experienced by the audience member's organisation.

'True' Six Sigma programmes have stringent quality goals, structured problem solving approach, dedicated training and prioritised projects. However, according to Aberdeen Group survey (2006) only 16% of Six Sigma programmes are 'true' programmes. Individual projects at these "true" Six Sigma firms produced an average savings of US$238,000 compared to average savings per project of US$144,000 across all Six Sigma companies in the Aberdeen Group survey (2006).

'True' Six Sigma organisations also understand the benefits of Six Sigma and manage the programmes effectively to achieve the financial and operational benefits. Organisations who implement Six Sigma only to mimic other organisations are likely to achieve modest or no benefits.

Table 2
Costs and Benefits of Implementing Six Sigma (Waxer, 2008)

Company	Year	Revenue ($B)	Invested ($B)	% Revenue Invested	Savings ($B)	% Revenue Savings
Motorola	1986-2001	356.9 (e)	ND	-	16.0	4.5
Allied Signal	1998	15.1	ND	-	0.5	3.3
GE	1996	79.2	0.2	0.3	0.2	0.2
	1997	90.8	0.4	0.4	1.0	1.1
	1998	100.5	0.5	0.4	1.3	1.2
	1999	111.6	0.6	0.5	2.0	1.8
	1996-1999	382.1	1.6	0.4	4.4	1.2
Honeywell	1998	23.6	ND	-	0.5	2.2
	1999	23.7	ND	-	0.6	2.5
	2000	25.0	ND	-	0.7	2.6
	1998-2000	72.3	ND	-	1.8	2.4
Ford	2000-2002	43.9	ND	-	1.0	2.3

$B = US $ Billion
(e) = Estimated
ND = Not disclosed

Table 3
Case Evidence of Successes Resulting from Six Sigma Initiatives

Authors	Sector	Process	Organisation	Country	Claimed Benefit(s) as resulting in whole or in part from Six Sigma
(Anonymous 2002)	Food manufacture	Specific and complex Quality issues	Dairy Crest`s Spreads	UK	Savings on the use of metered water of around 120,000L per year, and eliminated overfilling in production of a product and saved around 5,000L per year. These savings more than offset implementation and training costs. Following this success the project teams were set a number of new projects to tackle productivity and quality issues. The Six Sigma process is now seen as the vehicle to deliver major productivity improvements at the plant in the years ahead
(Bolick 2007)	Manufacturing	Corporate culture change	Honeywell	US	Effective culture change achieved
(Lazalier 2007)	Power generation	Power restoration	Ameren Corporation	US	Considerable improvements in productivity and quality
(Daniels 2007)	Healthcare	healthcare intensive case management (ICM) programme	Cigna Corporation	US	A 53% decrease in re-admissions - Savings of some US$ 33,000 per patient and a 49% decrease in total in-patient care costs - A 14.9% improvement in the rate of patients taking medications as prescribed. NE Quality Council 2007 award for quality excellence.
(Bhatt, Dhingra *et al*. 2006)	Manufacturing	Waste reduction	Reliance industries	India	Raw materials cost (down 10%), recycled waste use (up 15%), chemicals cost (down 20%), production cost (down 11%). Productivity, process capability, and plant yield increased appreciably. Market complaints (down 70%), product quality (up 3%), product exports (up 50%). US$4 million pa in monetary benefits. Intangible benefits including increased awareness of stakeholder needs, increased employee morale, and a positive effect on society. Gold Award at the 2006 International Team Excellence Award Competition.
(Tinham 2006)	Service	supply chain management services	Unipart	UK	Improvement of supply chain procedures with the aim of enhancing customer experiences. Strong foundations were created including good business process models and management practices, use of skilled people a full spectrum of operational techniques and a strategically designed technical platform. Rich functionality was provided clients using browser based online catalogues, and other services.
(Park and Gil 2006)	Manufacturing	Research & Development	Samsung	Korea	In 2004, 80% R&D projects reached commercialisation, compared with 61% in 2002 and 18% 1997
(Drickhamer 2006)	Mail	Mail	Canada Post Corp. (CPC)	Canada	- 96.8% on-time delivery rate for letter mail for target of 96%, and - 10 consecutive years of profitability.
(Caldwell, Brexler *et al*. 2005)	Healthcare	Emergency Department (ED)	Morton Plant Medical Centre	US	Within a year ED patient satisfaction improved by 50% topping the 90th percentile, ED length of stay dropped 25%, and cost of quality recovery exceeded US$5 million
(Esimai 2005)	Healthcare	Medication Administration Records (MAR) error rate	Mid-sized hospital (anonymous)	US	Errors were dramatically reduced by 55%. Reversal of OE errors from an increasing to a downward trend for most types of errors; A decrease in the total error rate to 0.14% in five months; Estimated labour cost reductions of $550,000 (annualized at $1.32 million); Increased patient satisfaction; Improved employee morale and better relationships between nurses and pharmacists
(Cox and Bossert 2005)	Banking	Customer satisfaction improvement	the Bank of America Corporation	US	The project directly contributed a 6% increase in the online banking channel`s customer satisfaction performance. Online banking was also recognised as a `Best of Six Sigma finalist`, in the Bank of America associate recognition program.
(Daniels 2005)	Food manufacture (Pie making)	Quality and productivity improvement	Bama Companies Inc.	US	Product improvement, scrap reduction and cost reduction leading to savings in excess of $17.3 million since 2002. Overall customer satisfaction for the company`s national accounts has increased from 75% in 2001 to 100% in 2004, far above the food manufacturing benchmark of 85%. The company was a Malcolm Baldrige National Quality award winner in 2004
(Voehl 2004)	State Government: Community service	Meals-on-wheels community service improvement	Orange County, Fla	US	As a result of better control and management practices food delivery cycle times were improved by 50% or more and a continuous Improvement process was implemented

SHOULD YOU IMPLEMENT SIX SIGMA?

Assuming 'true' Six Sigma companies invest 0.4% of revenues on SSQ and assuming that the net savings are 0.8% of revenues, the following table (Table 4) shows the investment required and the expected savings in dollars for different organisational sizes (in terms of revenues).

Table 4
Organisational Size Vs Cost and Benefits

Revenue	**$1 M**	**$5 M**	**$10 M**	**$50 M**	**$100 M**	**$500 M**
Investment in SSQ (0.40% of revenue)	$4,000	$20,000	$40,000	$200,000	$400,000	$2 M
Net Savings (0.80% of revenue)	$8,000	$40,000	$80,000	$400,000	$800,000	$4 M

M = Million

Implementing Six Sigma takes time and costs money (see Table 4), both of which SMEs could ill afford. If they venture into it and subsequently do not adequately fund the project or do not spend enough time on the project, the implementation may fail. In this sense for SMEs implementing Six Sigma can be risky. While larger organisations can afford to invest on Six Sigma and if the programme fails to achieve the desired benefits, they can write off the losses, if any.

According to Harry (1998), companies can achieve a 6% cost reduction each year when the ratio of black belts to employees is at its ideal of one black belt for every 100 employees. Given this, we believe Six Sigma may not be suitable for organisations with either less than 50 employees or less than $50M annual turnover. As at 2002, 98.98% of the total 282,339 New Zealand businesses fell in this category (StatsNZ, 2007). This is summarised in Figure 5. Recent reports indicate there are now 463,380 NZ businesses (StatsNZ, 2008), but the current size demographic breakdown is not yet available.

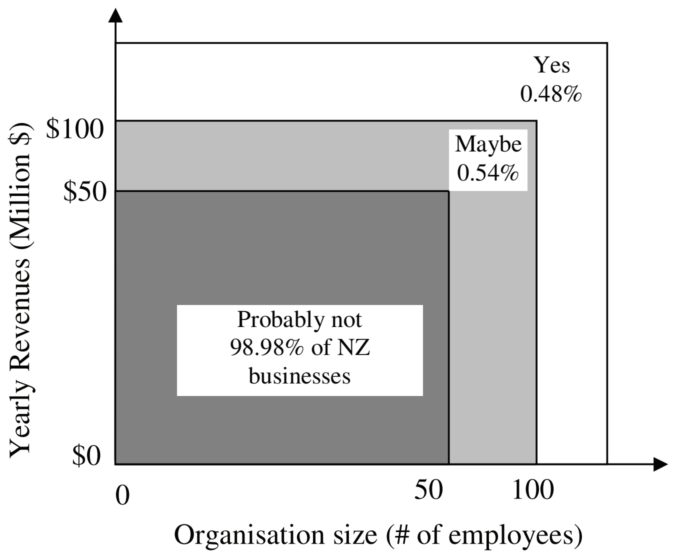

Figure 5
Should You Implement Six Sigma?

Larger organisations with at least 100 employees or at least $100 million annual revenues, can afford to, and can benefit most out of implementing Six Sigma. In 2002, 1337 (0.48% of) organisations in New Zealand fell in this category. In fact these organisations, whether they are service or manufacturing, public or private, will be missing an opportunity to be competitive through cost savings and productivity improvement if they do not implement Six Sigma. Typical organisations that fall in this category include large banks, manufacturing companies and health service providers.

The remaining organisations which are not too small and not too big may consider implementing Six Sigma depending on their circumstances (competition in their industry, opportunity to improve, etc.). About 2,500 New Zealand organisations fall in this category.

According to StatsNZ (2007) New Zealand businesses with 100 or more employees generated over $163 billion revenues, which account for 48% of the total country sales revenues. Assuming organisations implementing Six Sigma can save 0.8% of revenues, together these businesses potentially can save $1.3 billion per year by implementing Six Sigma!

Six Sigma programmes typically have formal management structures with Master Black belts, Black Belts and Green belts with Black Belts working full-time on business problems. This formal Six Sigma structure can provide significant financial results in large organisations, but typically exceeds the resources available to smaller companies. Hence Six Sigma is less popular with SMEs. Even so a number of SMEs have implemented Six Sigma with great success (Antony *et al*. 2005, Gnibus and Krull 2003, Dahl 2007).

In one New Zealand Company (with over 400 employees and $400 million turnover) where Six Sigma programme was implemented, there was initial commitment from senior management. But despite this initial commitment, as little as two years later, the programme was effectively dead. As part of Six Sigma initiative this company completed two projects with an annual savings of NZ$88,000 for one and NZ$500,000 for the other. However, there were hardly any company-wide benefits.

HOW IMPERATIVE IS SIX SIGMA?

Toyota does not implement Six Sigma. They don't have Green Belts or Black Belts. They don't use measures like DPU, DPO, DPMO, Rolled Throughput, etc. They don't use DMAIC methodology, although they use simple seven step problem solving methodology more extensively. They keep things simple and use very few complex tools. For example asking "why?" five times is one of the most commonly used tool to find the root cause of the problem! Yet, they produce the highest quality cars with the fewest defects of any competing manufacturer in the world. And they are doing this for decades. Closer to home we have another such company, Macpac Wilderness Equipment Ltd, a Christchurch based clothing and outdoor equipment company. Macpac is an iconic New Zealand company whose products and services are of highest quality. Yet, they never formally implemented ISO9000, TQM or Six Sigma! So, is Six Sigma imperative? The answer is no. However, how many organisations have organisational culture like Toyota or Macpac? In the absence of such a culture we believe implementing Six Sigma is better than doing nothing.

Organisations planning to implement Six Sigma are well advised to read the following example extracted from Liker's book The Toyota Way (Liker, 2004).

"The CEO of a large automotive parts supplier wanted the Six Sigma program because of great success of GE and Jack Welch. He worked with a group of senior managers and executives to pick the right consultants to do the training and determine how many certified Six Sigma black belts were needed. The leadership team reasoned that recent college graduates with high gradepoint averages would be best suited to learn the complex statistical methods that are part of Six Sigma and decided to recruit bright young stars to become black belts. They recruited aggressively offering a five-digit bonus and a brand-new car when they completed the Six Sigma program and achieved the required dollar savings. Needless to say, they attracted some topnotch young recruits.

Unfortunately, these young recruits had little if any manufacturing experience and stepped into these rust-belt factories with the mission to "fix processes" when these factories had been operating for decades with a well-established culture. Word got out about the hefty incentives for the recruits, which caused some *managers and engineers to wonder why they should help these "youngsters" successfully complete a project when there wasn't any payoff for them. The employees with an affinity for lean claimed that the projects being turned in as Six Sigma projects were actually lean projects – cells, pull, etc.*

In my view, by treating lean and Six Sigma as two tool kits and when setting up a situation in which different groups in the company go to war over whose tool kit is bigger and better, the company created a self-defeating improvement program. In this particular case, there was enough dissent over the large incentives for the Six Sigma recruits, as well as the awareness that experienced employees were actually helping them, that management ended up not giving out any of the cars. In the end, the company turned current employees into additional black belts. There still remained an uneasy tension between lean and Six Sigma, especially with internal lean zealots who viewed Six Sigma merely as tool kits. And the plant managers wondered what to do with the young black belts when they needed to move them into operational jobs, as their salaries were too high for the lower-level positions they were really suited for based on experience."

CONCLUSIONS AND KEY RECOMMENDATIONS

Based on the foregoing discussions, we would answer our initial question (and conclude this paper) by making the following points in relation to Six Sigma programmes as they pertain to the New Zealand context.

Point 1 Six Sigma – problem with the programme

In the case of TQM, JIT, Lean and certain other interventions designed to bring about optimisation or improvement, the problem of failed attempts to implement them lies not with the programmes themselves but with the way the organisations use them.

The goal must be doing better than in the past / better than the competition.
Most companies focus on form (mechanics of JIT, etc.) rather than the substance applicable to all organisations (Hayes and Pisano 1994)

In the case of Six Sigma, the problem lies more with the programme itself. The Six Sigma method in its entirety, with belts and implications for organisational structure, is simply not transferable to smaller organisations, such as those that typify the New Zealand demographic. They utilise jargon that can be confusing and require a level of process analysis that is simply unnecessary for an organisation at the early stages of its quality maturity. This leads us to point 2.

Point 2 Low hanging fruit first

Welch (1992) also talks about where a company is in terms of its quality levels. He believes if a company is just short of attaining 100% compliance (the 'Wisdom' or 'Certainty' stages of Crosby's Quality Management Maturity Grid; Crosby, 1980), it needs a very sensitive approach to complete its objective. He believes that final few percent need to be placed under a 'magnifying glass.' Six Sigma is the 'Magnifying glass.' In other words, if your quality levels are below 3-sigma level and the cost of poor quality is in excess of 40 percent of sales, then it is cheaper to collect 'low hanging fruit' first using simple quality management principles (See Table 5).

Figure 6
Low Hanging Fruit First

Table 5
Quality Maturity Level (Crosby 1980) Vs Need for Six Sigma

Quality Maturity level	**Uncertainty**	**Awakening**	**Enlightenment**	**Wisdom**	**Certainty**
Cost of Quality (COQ)	>40% of sales			<10% of sales	
Implement Six Sigma?	No	Maybe		Yes	

Point 3 High investment but the benefits are uncertain return

The cost of training green belts and black belts can be high. The argument is always that this cost is immediately off set by the improvements which black belts achieve in the projects that are necessary for their certification. Can every organisation claim to have experienced these benefits from employees trained as black belts? Additionally, in a country the size of New Zealand, trained black belts will become valuable to other employers on both sides of the Tasman. There is a high risk of investing only to lose your champion.

Point 4 New Zealand organisations are small (90% less than ten employees?)

SMEs need to adopt Six Sigma according to the needs and availability of resources. For example they could implement Six Sigma with White and Yellow belt approach which is less costly, requires less overhead structure and can be implemented at their own pace. The potential savings per project with white and yellow belts is expected to be about $25,000 (Antony, Kumar & Madu, 2005). When SMEs adapt Six Sigma this way, they are sometimes able to achieve faster and more impressive benefits than larger organisations.

Point 5 There is a lack of accreditation in Six Sigma training

The most fundamental irony about Six Sigma is that while it is a methodology with the absolutely fundamental aim of variability reduction, the worldwide provision of training lacks consistency, and there is no single accreditation body governing the process of awarding yellow, green and black belts. Thus if training has high variability, it is to be reasonably expected that the knowledge of trainers and of recipients will be highly variable, and the success with which Six Sigma is implemented in organisations will be highly variable.

The American Society for Quality (ASQ) offers certification to green and black belt. Other organisations offer belt accreditation, although there is variability in the quality of training and grading, and the prospective trainee should be aware of the level to which the trainer him or herself is qualified in the techniques or approach that he/she is delivering, and of the degree to which the training is nationally or internationally valid.

Point 6 General understanding of the term

It is important to note that Six Sigma is not something that an organisation can 'do' or 'not do' / 'have' or 'not have', any more than an organisation can truly 'do' or 'have' zero defects. Six Sigma refers to the desired end-state resulting from the systematic application of the constituent techniques. An organisation might achieve this end-state on one or several process measures, but will never achieve this level of control on all measures relating to all of its core and support processes. It is therefore virtually impossible to ever *be* a Six

Sigma organisation. Even if an organisation were to achieve genuine Six Sigma capability on a process, then by that stage there is a reasonable likelihood that the customer or regulatory specifications would have narrowed, or standard industry practice evolved so that the organisation finds itself slipping once again at a level of capability lower than Six Sigma. The somewhat hypothetical argument illustrates the (very real) danger of becoming fixated with the technical definition. We have heard of at least one organisation demanding that their suppliers become Six Sigma compliant in order to continue trading with them. This is an impossible request that belies a quite dangerous level of ignorance. There is no point of achievement or accreditation.

To conclude, Six Sigma incorporates methods that are tried and tested and appropriate to organisations of all sizes. It also contains a number of methods which are of no possible use to many organisations. The training still lacks accreditation and consistency, and there is likely to be considerable variability of knowledge between green belts, black belts etc. Organisations should attempt to develop their own experts, and use what they find useful, discard what is unlikely to be of practical benefit.

References

Aberdeen Group (2006), The Lean Six Sigma benchmark report. 24pp. Boston, Mass. http://www.minitab.com/resources/stories/aberdeensixsigmareport.pdf. (last accessed July 08)

Anbari, F. T. (2002). Six Sigma method and its application in project management. Proceedings of the Project Management Institute Annual Seminars and Symposium, San Antonio, Texas, Project Management Institute, Newton Square, PA.

Antony, J. Kumar, M. Madu, C.N. (2005). Six Sigma in small- and medium-sized UK manufacturing enterprises: Some empirical observations, The International Journal of Quality & Reliability Management. Vol.22, No.8/9, pp.860-875.

Antony, J. and R. Banuelas (2001). "A strategy for survival." Manufacturing Engineer Vol.80, No.3, pp.119-121.

Antony, J. and R. Banuelas (2002). "Key ingredients for the effective implementation of Six Sigma program." Measuring Business excellence Vol.6, No.4, pp.20-27.

Antony, J., Escamilla, J.L., Caine, P. (2003). "Lean sigma." Manufacturing Engineer Vol.82, No.4, pp.40-42.

Crosby (1980), Chapter 3, the Quality Management Maturity Grid, in *Quality is Free*, McGraw-Hill, New York

Dahl, D. (2007). 'Black belt' quality control may give small firms an advantage, Lawyers USA. Boston: Jun 18, pg.1

Gnibus, R.J., Krull, R. (2003) Small Companies See the Money. Quality Management. Aug. Vol.42, No.8, pg.48

Harry, M.J (1998). Six Sigma: A breakthrough strategy for profitability. Quality progress. May. pp.60-64.

Hayes, R. H. and G. P. Pisano (1994). Beyond World-class: The New Manufacturing Strategy, Harvard Business School Publishing.

Hendericks, C. and R. Kelbaugh (1998). "Implementing Six Sigma at GE." The Journal for Quality and Participation.

Johnson, A. (2002). "Six Sigma in R&D." Research Technology Management Vol.5, No.2, pp.12-16.

Kwak, Y. H. and F. T. Anbari (2006). "Benefits, obstacles, and future of Six Sigma approach." Technovation Vol.26, pp.708-715.

Liker, J.K. (2004) The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer, McGraw-Hill.

Okes, D. (2006). "Promoting Quality In Your Organization." Quality Progress. Vol.39, No.5, pp.36-40.

Schroeder, R. G., Linderman, K., Liedtke, C., Choo, A.S. (2008). "Six Sigma: Definition and underlying theory." Journal of Operations Management 26 (4): pp536-554.

Smith, G. (1993). "Benchmarking success at Motorola." Copyright Society of Management Accountants of Canada.

StatsNZ (2008). New Zealand Business Demography Statistics (Business Dynamics): February 2007. http://www.stats.govt.nz/.../rdonlyres//nzbusinessdempgraphystatisticsdynamicsfeb07mr.pdf

StatsNZ (2007) New Zealand Business Demographic Statistics (as at February 2002), Statistics New Zealand website. http://www2.stats.govt.nz/ (last accessed June 2008).

New Zealand Business Demographic Statistics (as at February 2002), Statistics New Zealand website. http://www2.stats.govt.nz/ (last accessed June 2008).

Waxer, C (2008). Six Sigma Costs AND Savings, The financial benefits of implementing Six Sigma at your company can be significant. http://www.isixsigma.com/library/content/c020729a.asp (last accessed July 2008)

Weiler, G. (2004). "What Do CEOs Think About Quality?" Quality Progress Vol.37, No.5, pp.52-56.

Welch, John F. Jr. (1992). Working out of a tough year. Executive Excellence. Vol.9, No.14