Received March 2008
Revised January 2009
May 2009
Accepted July 2009

A study into the effectiveness of quality management training

A focus on tools and critical success factors

Ben Clegg
Aston Business School, Birmingham, UK, and
Chris Rees and Mike Titchen
SigmaPro Ltd, Solihull, UK

Abstract

Purpose – The purpose of this paper is to investigate the effectiveness of quality management training by reviewing commonly used critical success factors and tools rather than the overall methodological approach.

Design/methodology/approach – The methodology used a web-based questionnaire. It consisted of 238 questions covering 77 tools and 30 critical success factors selected from leading academic and practitioner sources. The survey had 79 usable responses and the data were analysed using relevant statistical quality management tools. The results were validated in a series of structured workshops with quality management experts.

Findings – Findings show that in general most of the critical success factor statements for quality management are agreed with, although not all are implemented well. The findings also show that many quality tools are not known or understood well; and that training has an important role in raising their awareness and making sure they are used correctly.

Research limitations/implications – Generalisations are limited by the UK-centric nature of the sample.

Practical implications – The practical implications are discussed for organisations implementing quality management initiatives, training organisations revising their quality management syllabi and academic institutions teaching quality management.

Originality/value – Most recent surveys have been aimed at methodological levels (i.e. "lean", "Six Sigma", "total quality management" etc.); this research proposes that this has limited value as many of the tools and critical success factors are common to most of the methodologies. Therefore, quite uniquely, this research focuses on the tools and critical success factors. Additionally, other recent comparable surveys have been less comprehensive and not focused on training issues.

Keywords Quality management, Lean production, Six sigma, Critical success factors, United Kingdom

Paper type Research paper

Introduction

The purpose of this research was to find out how quality management training can be practised more effectively. This study is timely because the popularity of approaches such as lean thinking (Womack and Jones, 1996) and Six Sigma (Eckes, 2001) have grown dramatically over recent years (Henderson and Evans, 2000; Bendell, 2006) whilst

The authors would like to thank the IET and the BSI for distributing the questionnaire, the respondents and workshops' participants for their inputs, and the reviewers for their perceptive improvement suggestions.

The TQM Journal
Vol. 22 No. 2, 2010
pp. 188-208

1754-2731
DOI 10.1108/17542731011024291

the explicit use of total quality management (TQM) has declined (Clifford, 2001) over the same frame. This maybe because there have been many recent publications about cost savings by major international companies (Hahn *et al.*, 1999; Chowdhury, 2001; Bhuiyan and Baghel, 2006) made using lean thinking and Six Sigma approaches instead of a TQM approach. However, as other companies strive to emulate these successes they often find it is not always as easy to achieve as others may have claimed (Lee-Mortimer, 2006).

In order to emulate previous successes it likely that quality professionals will need to be trained in statistical and heuristic tools as well as in the critical success factors (CSFs) (Rockart, 1979) of quality management (concerning people, implementation, organisational, leadership skills and other softer issues) irrespective of the overall approach named and used (Dahlgaard and Dahlgaard-Park, 2006). Therefore this study emphasises the role and importance of training to make tools and CSFs more effective rather than the high level design and evolution of overall methodological approaches such as TQM, lean management or Six Sigma.

Background

The theoretical and statistical basis for modern quality management is extremely well established and dates back to the first half of the twentieth century (Shewhart, 1939). Since then there have been a several "gurus" instrumental in furthering this body of knowledge (see Nonthaleerak and Hendry, 2006; Bhuiyan and Baghel, 2005) which include, but are not limited to, the works of Ishikawa (1968), Crosby (1979), Feigenbaum (1983), Deming (1986), and Juran (1992). The range and depth of available tools is widespread and the CSFs of good practice are varied (Bicheno and Catherwood, 2005). Tools range from complex quantitative analytical ones (e.g. Taguchi's Design of Experiments (Taguchi *et al.*, 2005)) to simple heuristic ones (e.g. Ishikawa's Cause and Effect diagrams) while CSFs cover a vast array of associated issues (e.g. from leadership, culture and motivation to implementation and acceptance).

A current debate in the quality management literature focuses on which methodological approach is best, the debate specifically focuses on lean thinking (Womack and Jones, 1996), Six Sigma (Eckes, 2001) and TQM (Samson and Terziovski, 1999). Each approach's strengths and weakness have been debated and in-depth comparisons have been made between them (Andersson *et al.*, 2006; Arnheiter and Maleyeff, 2005; Dahlgaard and Dahlgaard-Park, 2006). It is not the intention of this paper to repeat this work, but to build upon its emerging observations which are that:

> [. . .] the principles, concepts and tools of lean production and Six Sigma quality should not be seen as alternatives to TQM but rather as a collection of concepts and tools, which support the overall principles and aims of TQM [. . .] the five principles and the aim of lean production as well as the principles and tools behind the Six Sigma process are embedded in the principles, concepts and tools of the holistic management philosophy called TQM [. . .] It has been shown that the lean production philosophy and the Six Sigma steps are essentially the same, and both have developed from the same root – the Japanese TQM practices (Dahlgaard and Dahlgaard-Park, 2006).

> [. . .] there is a lot to gain if organisations are able to combine these three concepts [. . .] (Andersson *et al.*, 2006).

Arnheiter and Maleyeff (2005) and Bryne *et al.* (2007) also endorse combining, rather than differentiating these approaches. Rich *et al.* (2006), Clifford (2001) and others also

highlight that there is an element of marketing and faddishness to these approaches. The authors concur that there is more to be gained from combining these approaches and using their associated toolsets and CSFs together instead of trying to distinguish and divide them to discuss and use them separately.

This research differs from other recent similar surveys (Anthony and Maneesh, 2005; Ahmed and Hassan, 2003; Neergaard, 1999; Tari, 2005) because it is pitched at evaluating tools and CSFs instead of overall methodological approaches.

Methodology

An initial scoping workshop took place based on the above academic debate; it was conducted with a group of 20 currently practising quality management professionals in a one-day workshop; each professional was from a different company and the service and manufacturing sectors were evenly represented. The professionals each needed to have had at least three years direct and recent experience in quality management teaching or training and were willing to share their materials and insights in order to take part in the scoping workshop. The scoping workshop was used to design and produce a questionnaire able to give insight into some specific empirically driven research questions (detailed in the results section); it had a control section to collect information about the individual respondents (e.g. level of expertise) and their respective organisations (e.g. service or manufacturing); it also contained a list of 30 CSFs and 77 tools used in contemporary quality management practice.

The CSFs used in the questionnaire are shown in Table I; they were compiled from Feigenbaum's (1983) (F) "19 Steps", Ishikawa's (1968) (I) "11 Points", Deming's (1986)(D) "14 Points", Crosby's (1979) (C) "14 Steps" and Juran's (1992) (J) "10 Steps"; these particular gurus were selected as they are all renowned for their comprehensive but concise lists of CSFs relating to quality management. The letter and number in the right hand column states which guru(s) it has originated from and which of their specific points it refers to (e.g. "D5" relates to Deming's point 5).

The respondents were asked to rate the statements using a Likert scale to say:

- How much they "agreed" with it – defined as how significant in theory they thought the statement was (rated from 1-5 where 1 = strongly disagree, 3 = indifference and 5 = strongly agree).
- How much "impact" each has had - defined as how well the statement has actually been implemented (rated from 1-5 where 1 = very low level of implementation, 3 = medium level of implementation, and 5 = very high level of implementation).

A list of tools was also compiled from the 20 different sources provided by the scoping workshop attendees (ten commercial training courses and ten academic syllabi); all of whom were currently actively involved in using them for teaching or training purposes. During the workshop a consolidated list of tools was collectively produced and classified into the Six-Sigma DMAIC framework, which is shown in Figure 1.

Each respondent was asked to rate each of the 77 tools using a Likert scale to say:

- How well they "understood" a tool rating them from 1-5 (where 1 = very low level of understanding, 3 = medium level of understanding and 5 = very high level of understanding).

No.	Critical success factor (CSF) – statement	Guru and factor
1	An environment that encourages the constant improvement of products and services must be developed	D5, C14, J1
2	Defective products and services must be considered as unacceptable	D2, F6
3	It is the responsibility of everybody in an organisation to ensure that quality is built in at the source and that reliance on later inspection is reduced	D3, I3, F19, J8
4	Business improvement must not be judged on the basis of cost and price alone	D4
5	The process that delivers the product and/or service should be constantly improved	I6
6	Constant on the job practical training is important	D6, J4
7	Leadership and resource needs to be given by top management	D7, C1
8	Functional barriers should be broken down and multi-functional teams encouraged	D9, J3
9	Productivity quotas should be set in terms of quality rather than quantities	D11, J2
10	Slogans and fashionable jargon should not be used	D10
11	Barriers that stop people taking pride in their work should be removed	D12
12	A vigorous programme of education and self-improvement should be adopted that encourages learning	D13, I1, C8
13	All people in the organisation are responsible for quality improvement	D14, I5
14	The customer requirements must be fully understood to be able to provide good quality	I2
15	The root causes of problems should be addressed; not the symptoms of them	I4, J4
16	Customer satisfaction is a critical measurement for business improvement	I8
17	Most quality problems can be solved with simple tools	I10
18	Operational data that is presented without variability is false data	I11
19	Quality analysis, improvement and control should be thought of as an ongoing system	F1, J10
20	Focus on quality, and profitability will improve as a result	F5, J6
21	Quality is a total lifecycle consideration	F9
22	Quality improvement must be linked to financial business performance indicators	F5
23	Advanced statistical tools must be used in an improvement system	F17
24	Those who actively participate must be recognised and appreciated	C12, D8, I9, J7
25	The best people must work on the biggest potential areas for improvement	F7
26	A clear and compelling vision for the improvement initiative must be created	D1, I7, C10
27	Clear definitions of roles and responsibilities must be created for every improvement initiative	F4
28	Resistance to change must be actively managed	C13
29	The improvement initiative must be planned involving key stakeholders	C2
30	Data must be used to support and verify the success of the improvement initiative	C3, I11, J9

Table I.
30 CSF statements about quality management practice

- How highly they perceived the practical "impact" of the tool rating them from 1-5 (where 1 = very low impact, 3 = medium level of impact and 5 = very high impact).

Other open ended questions were built into a final section of the questionnaire which focused on future trends, supporting software and contextual issues encouraging respondents to comment freely on issues which were then discussed further in subsequent validation workshops.

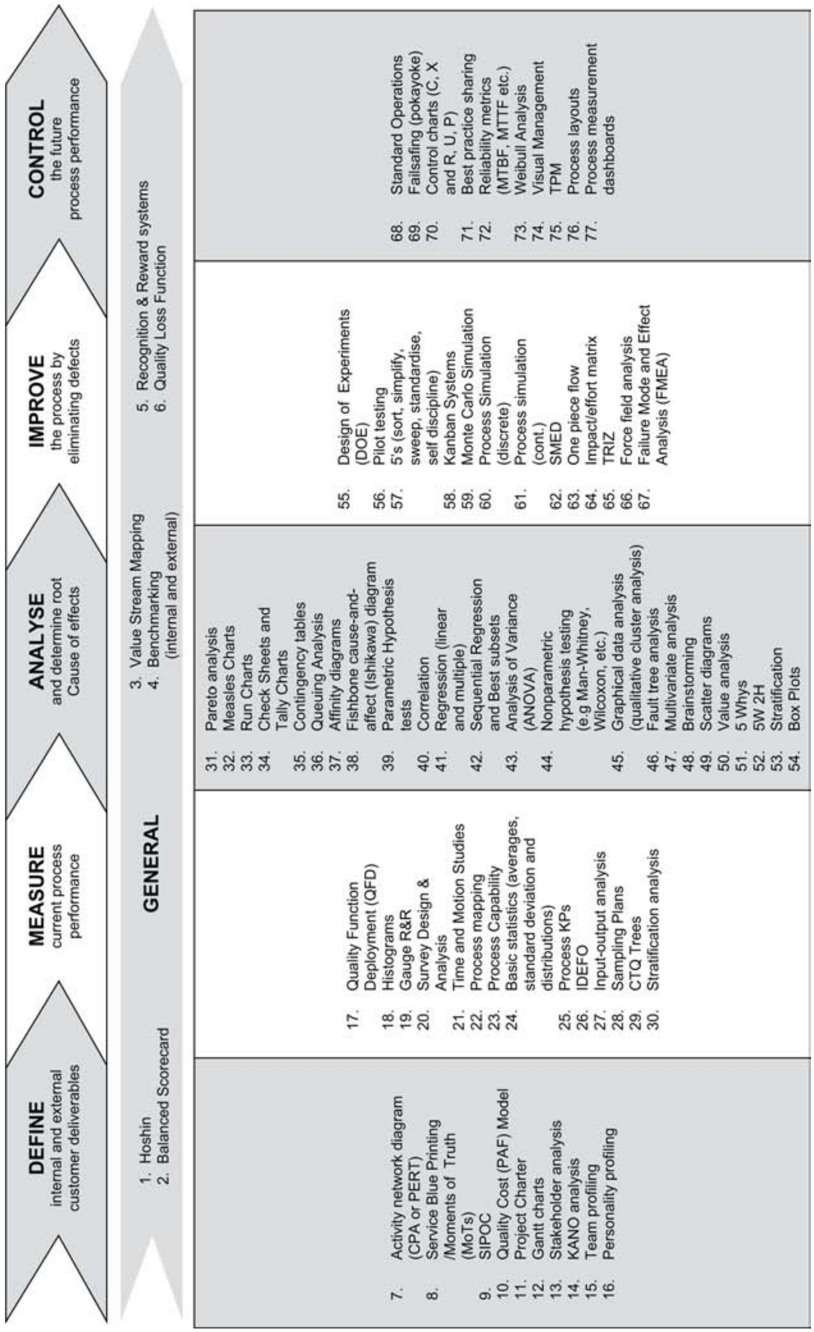

Figure 1.
77 tools used in the survey

The survey was sent to members of professional bodies who had relevant experience in quality management initiatives over the last five years. This was done by e-mailing a hyperlink to the survey to members of the Institute of Engineering and Technology (IET) and the British Standards Institute (BSI); the survey was left online for six months (June-December 2006). Each response was checked to see if the person had had adequate experience to answer the questionnaire credibly. The subsequent dataset was analysed using appropriate quality management tools (supported by the Minitab V.15 software); the analyses were debated during two one-day validation workshops each consisting of 20 different quality management professionals (each workshop had a different set of participants who were also different to the participants in the scoping study). The results are now given below which are discussed further in following sections.

Results and discussion of survey findings

There was an approximate 50 per cent completion rate (79/160) of the questionnaire and an analysis of the respondents" profile (per cent calculations are given to two significant figures) shows that over the last five years:

- 65 per cent of respondents had at least one year's experience in quality management;
- 78 per cent of respondents had been involved in quality improvement projects as sponsors, managers or team members;
- 60 per cent of respondents were involved in quality management projects as part of their every day work; and
- 85 per cent of respondents had Bachelors' or postgraduate-degrees.

A Pareto profile of the respondents also showed that 50 per cent had predominantly worked in the UK, 30 per cent had worked in the USA and Germany and the remaining 20 per cent in other European countries and Canada. The control data collected validated the respondents' credibility and enabled the rest of the dataset to be used for answering the empirically driven research questions below.

Question 1(a). What type of training has been the most popular over the last five years?

Over the last five years Six Sigma and lean thinking approaches accounted for 45 per cent of all training. ISO and own "in-house" approaches accounted for a further 33 per cent whilst the QS9000 and European Foundation for Quality Management (EFQM) approaches did not feature highly (see Pareto analysis in Figure 2). Few claimed to have cited TQM explicitly within the last five years as their main approach to quality management.

Question 1(b), Was training perceived as being successful?

Overall, the data showed that most respondents (73 per cent) thought that initiatives had been a "partial success" (i.e. approximately half of the objectives achieved), and 26 per cent felt that initiatives had been a "complete success" (i.e. all objectives achieved) whilst only 1 per cent had not perceived any improvement at all within their programme (i.e. no objectives achieved) (Figure 3). This was a surprising result as one may have thought that everybody involved in practising quality would have claimed "complete successes" in all aspects; however it appears there is clearly some scope here

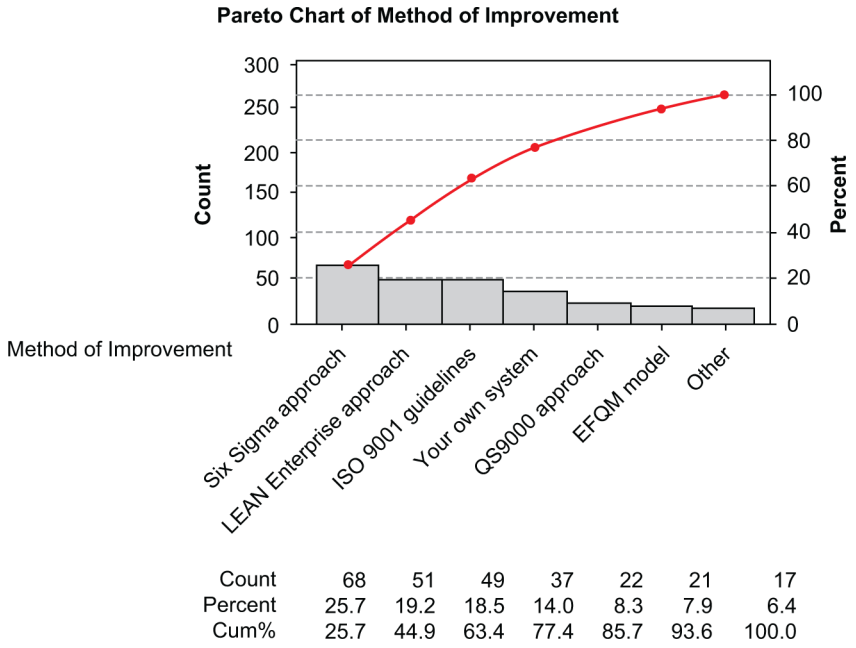

Figure 2.
Type of training over the last five years

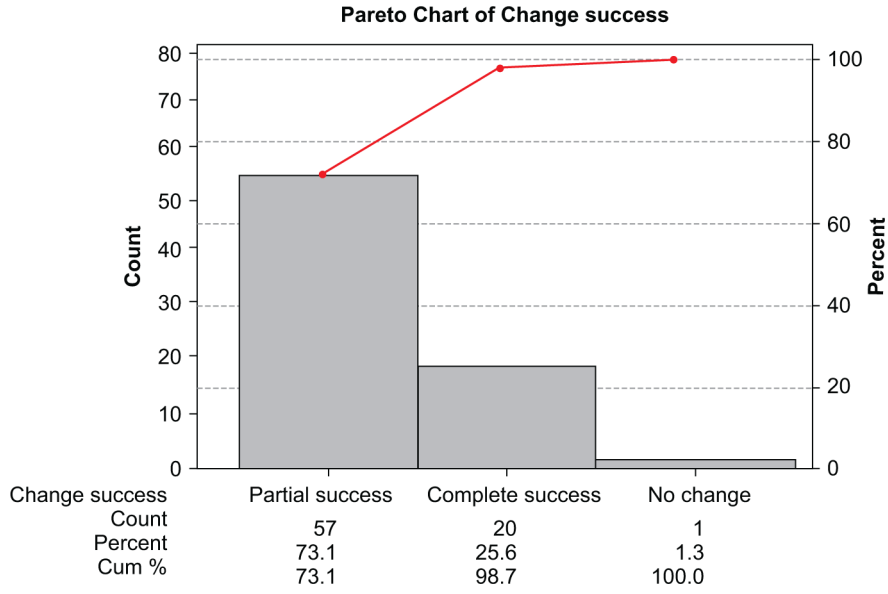

Figure 3.
Declaration of improvement initiative success

to make a big impact in transforming these "partial successes" into "complete successes"; the issue now is how to accomplish this, and which tools and techniques would be most appropriate to do so.

Question 2. Does the role of an individual in a quality initiative affect the way that the success of it is perceived?
The survey suggested that general management (people who were sponsoring/championing the change) are much more likely to describe their deployments as a complete success (65 per cent) than the people who were actively involved in the initiative (35 per cent). This is a statistically significant difference and can be used to infer a general relationship in the population (Fisher's exact test $p = 0.016$ and power approximately 0.97). This could mean that claims of complete successes may not always be substantiated directly by actual data and analyses.

Question 3(a). What is the split in practice between the service and manufacturing sectors?
The data showed that there was a fairly even split between service (51 per cent) and manufacturing deployments in our sample (49 per cent). This is surprising as it is a popular current belief that the service sector uses quality management initiatives far less than the manufacturing sector.

Question 3(b). Is there a difference between the perceived success of quality management projects in the service and manufacturing sectors?
The survey suggested that similar percentages of service (28 per cent) and manufacturing (24 per cent) deployments were perceived to be a complete success. This is also surprising as there is also a popular belief that the manufacturing sector has more successes with quality management initiatives.

Question 4(a). What is the split between strategic and operational deployments?
It was found that the deployment of quality management initiatives were evenly split between those led as part of a strategically endorsed programme (53 per cent), and those led from a bottom-up locally initiated improvement (47 per cent). Although in theory this is thought to be best practice, there has been little evidence to date to suggest this actually happens in practice and that most initiatives were actually practised as top-down deployments by senior management.

Question 4(b). Is there a difference in the method of deployment between service and manufacturing sectors?
The survey suggested that a slightly higher ratio of service deployments were strategic (59 per cent) in comparison to manufacturing deployments (48 per cent). During the validation workshops this was thought to be because the service sector typically had less layers of management that created the illusion that initiatives were always being driven from the top whereas in manufacturing many initiatives were instigated from middle or junior management layers.

Question 4(c). Does the method of deployment affect an initiatives" perceived success?
This was not found to be a significant factor as both methods of deployment claimed that 26 per cent had been perceived as a "complete success". This is interesting to note

as theory concurs with this often stating that both approaches are required simultaneously for overall success of a quality programme.

Question 5(a). Which CSFs do people think are most important?
The distributions of these scores can be examined by means of the box-plots as shown in Figure 4 (the numbers on the horizontal axis relate to the CSFs detailed in Table I). The first and most important fact to note here is that all of the CSFs were rated above 3.0 (i.e. the point at which quality professional agree with the CSF being important). Therefore this validates the founding CSFs of modern quality management as being true and still currently applicable; and whilst this is commonly accepted, there is scant little evidence prior to this survey to actually support it. These results have statistically significant differences between the scores (ANOVA $p = 0.000$) and that individual average differences are also significant (using Fisher's Individual Error Rate = 0.023). The top three highest CSFs ratings were:

(1) The root cause of problems should be addressed not the symptoms of them (15A = 4.87)

(2) It is the responsibility of everyone in the organisation to ensure that quality is built in at the source and that reliance on later inspection is reduced (3A = 4.73)

(3) An environment that encourages the constant improvement of products and services must be developed (1A = 4.72).

Question 5(b). Which CSFs are most effectively implemented?
A ranking of the CSFs by how well they are perceived to have been implemented is given in the box-plot (Figure 5). In contrast to Question 5(a) not all of these are rated positively; most noticeably CSF statements No. 23 (Advanced statistical tools must be used in an improvement system) and No. 10 (Slogans and fashionable jargon should

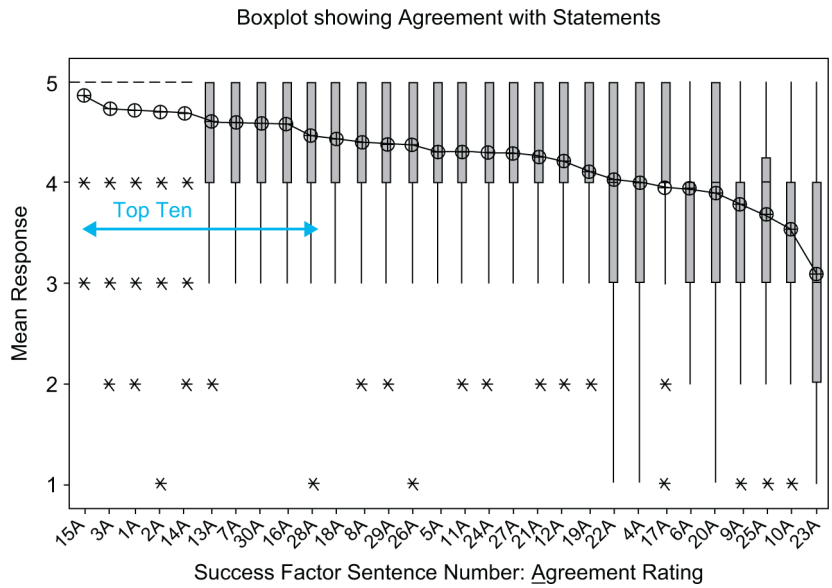

Figure 4.
Box plot of agreement ratings with CSF statements

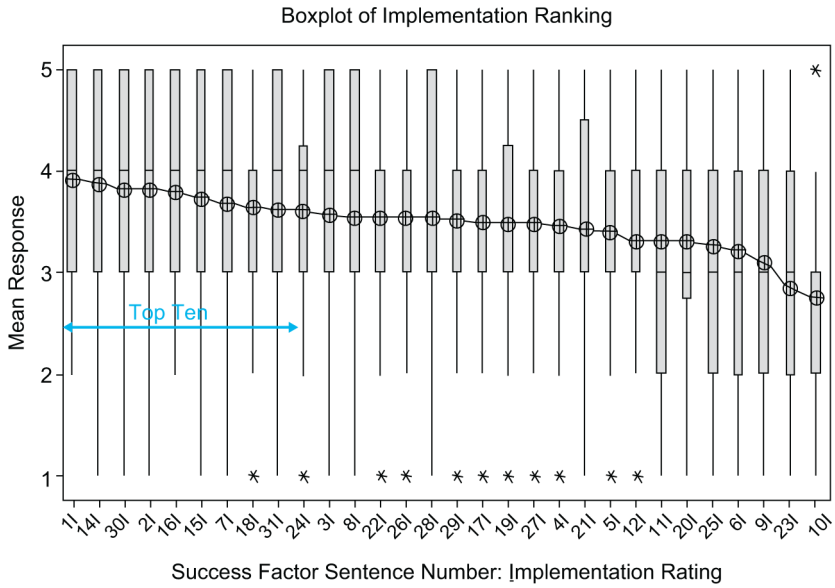

Figure 5.
Box plot of implementation rating for critical success factors

not be used) were not thought to be well implemented. The most effectively implemented CSFs are thought to be No. 1 (An environment that encourages the constant improvement of products and services must be developed), No. 14 (The customer requirements must be fully understood to be able to provide good quality) and No. 30 (Data must be used to support and verify the success of the improvement initiative) (for this data Fisher's Individual Error Rate shows that differences of more than 0.034 are significant and an ANOVA gave a significant reading of $p = 0.000$).

This perhaps means that more emphasis should be placed on training people in relatively advanced tools and only publicising initiatives which have real substance to them. Training should also seek to emphasise the importance of an inclusive environment where customers and employees share data to solve product and process issues.

Question 5(c). Is there any correlation between people agreeing with the CSFs and implementing them?

The data show that there is a strong correlation between respondents agreeing with the CSFs and how well they are implemented, this is shown in Figure 6 (note that this uses broken scales, as all the statements are agreed with albeit to a differing extent). The *R*-squared (adjusted) figure shows that 77 per cent of the variation in implementation can be explained by how much somebody believes in the statement. As all of the plots are within the 95 per cent prediction interval (PI) and an ANOVA of this correlation gives values of $F = 99.73$ and $p = 0.000$; this means that either the implementation of these CSFs relies extensively on getting the buy-in and belief of participants or that people like to believe in what they have done. Either explanation reinforces the need to engage people actively in quality initiatives if they are going to value them as a worthwhile pursuit.

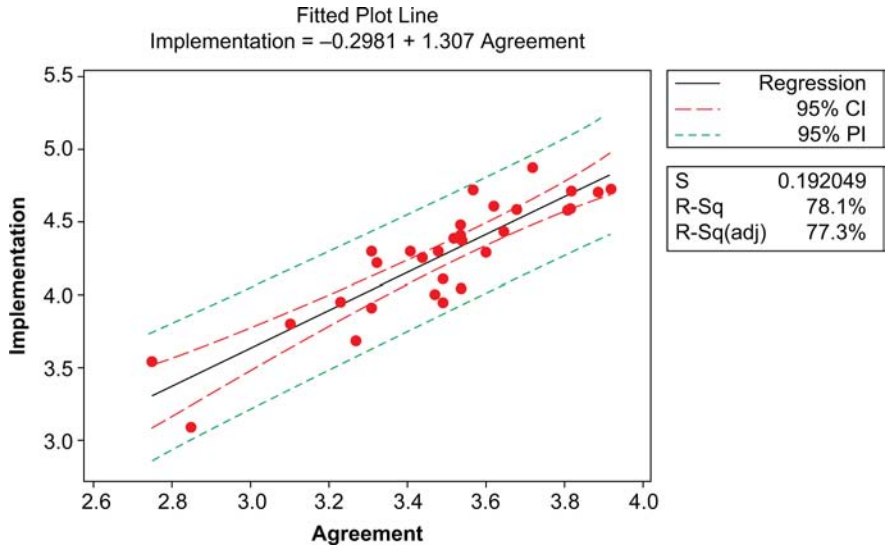

Figure 6.
Correlation between agreeing with a CSF and actually implementing it

Question 5(d). Which type of CSFs contribute most to the successful deployments?
The respondents reported a mixture of completely and partially successful initiatives thus allowing us to highlight the CSFs most likely to turn a partially successful deployment into a completely successful one. Table II shows the top ten CSFs ranked from top to bottom based on the statistically significant differences between the respondents reporting complete success and partial success. Each of the top ten CSFs are also categorised as either "technical quality" or "cultural acceptance" CSFs; this is a classification that is practised by General Electric (GE (attributable to their very successful recent leader Jack Welch)) who stated that an even balance of both was required to ensure a high success rate.

The GE company, under the direction of Jack Welch became famous for effectively practising quality management and had a heuristic for is successful implementation, this was $E = \mathrm{TQ} \times \mathrm{CA}$ (Effectiveness = Technical Quality × Cultural Acceptance) (Andersen and Fagerhaug, 2006)). When this heuristic is applied to these CSFs (see Table II right-hand columns) it can be seen that there is a fairly even split between those that can be classified as pertaining to technical quality (TQ) and those that relate to cultural acceptance (CA) and are therefore concordant with GE's heuristic about successful deployments needing to have a balanced split of technical and cultural aspects. In other words too much technical and statistical analysis without context can be just as ineffective as culturally sensitive programmes devoid of empirically tested data. It is encouraging to see that an even balance is currently being practised.

Question 6(a). Which tools are most widely understood?
Many respondents had either a low understanding of the tools or had not heard of them at all. The left-hand side of Table III shows the breakdown of the mean responses professed for the top ten ranked tools for "expert" respondents (Six Sigma Black Belts (BBs) and Master Black Belts (MBBs)) and "non-expert" respondents (Six Sigma Green Belts (GBs) and uncertified respondents)[1]. As might be expected the advanced

No.	Top 10 rank – success factor statements leading to deployment success	Mean responses shown by level of perceived success Complete	Partial	Difference between complete and partial ratings	Effectiveness = Technical Quality × Cultural Acceptance $t = TQ \times CA$ Technical quality (TQ)	Acceptance (CA)
6	The process that delivers the product and/or service should be constantly improved	3.8	3.3	0.52	✓	✓
29	The improvement initiative must be planned involving key stakeholders	3.9	3.4	0.51	✓	✓
9	Productivity quotas should be set in terms of quality rather than quantities	3.4	3.0	0.40	✓	✓
8	Functional barriers should be broken down and multi-functional teams encouraged	3.9	3.5	0.39		✓
17	Most quality problems can be solved with simple tools	3.8	3.4	0.38	✓	
10	Slogans and fashionable jargon should not be used	3.0	2.6	0.37		✓
24	Those who actively participate must be recognised and appreciated	3.9	3.5	0.36		✓
1	An environment that encourages the constant improvement and products and services must be developed	4.2	3.8	0.36		✓
15	The root causes of problems should be addressed; not the symptoms of them	4.0	3.6	0.35	✓	
30	Data must be used to support and verify the success of the improvement initiative	4.1	3.8	0.35	✓	
					6/10	7/10

Table II.
Types of CSFs leading to complete success rather than partial success

statistical tools were higher up in the "expert" rankings than the "non-experts" although some key tools were noticeably absent (i.e. hypothesis testing, regression, design of experiments, non-parametric testing, sampling plans and Weibull).

This possibly means that training has had a positive impact on the uptake of advanced tools. However, there seems much to do in order to get a critical mass of employees in organisations to become familiar with a range of basic tools.

Question 6(b). Which tools do people perceive to have had most impact?

The left-hand side of Table IV shows the top ten ranking for tools by their perceived impact, this is given for "experts" and "non-experts". Overall, it was considered that tools with a higher impact are higher up the "experts" ranking when compared to the "non-experts" ranking; whilst this may have been suspected there has been previous little work before this survey to support it.

Table III.
Ranking of tool understanding by difference between "expert" and "non-experts"

Rank	Top ten ranking for tool understanding				Top ten biggest differences in tool understanding			
	BB/MB understanding		Others understanding		Understanding difference	Tool	BB/MBB	Others
1	5 whys	4.83	Brainstorming	4.37	1.36	Measles charts	4.75	3.39
2	Fishbone	4.83	KPIs	4.27	1.33	Weibull Analysis	3.75	2.42
3	Pareto	4.83	Process mapping	4.25	1.31	CTQ trees	4.57	3.26
4	5S	4.80	Basis statistics	4.19	1.23	Stratification	4.29	3.06
5	Measles charts	4.75	Gantt chart	4.16	1.19	Regression	4.50	3.31
6	Visual management	4.75	Fishbone	4.14	1.16	Ease/impact	4.50	3.34
7	Histogram	4.71	Benchmarking	4.14	1.13	Contingency tables	4.20	3.08
8	Process mapping	4.71	Recognition and reward	4.13	1.09	Multi-vari analysis	4.17	3.07
9	SIPOC	4.71	Pareto	4.12	1.07	Sampling plans	4.14	3.07
10	Brainstorming	4.67	Histogram	4.11	1.07	Box plots	4.33	3.27

Table IV. Ranking for tools impact by "experts" and "non-experts"

Rank	Top ten ranking for tool understanding				Top ten biggest differences in tool understanding			
	BB/MBB understanding		Others understanding		Understanding difference	Tool	BB/MBB	Others
1	Process layout	4.8	Process mapping	4.23	1.47	Stratification	4.67	3.19
2	Visual management	4.75	KPIs	4.20	1.16	CTQ trees	4.71	3.55
3	What where when . . .	4.75	*Poke yoke*	4.12	1.14	Weibull analysis	4.00	2.86
4	CTQ trees	4.71	Best practice	4.06	1.12	Montecarlo simulation	4.50	3.38
5	Process mapping	4.71	Brainstorming	4.04	1.12	What where when . . .	4.75	3.63
6	Brainstorming	4.67	*Kanban*	4.02	1.07	Charter	4.57	3.50
7	Fishbone	4.67	5S	3.97	1.07	Box plots	4.40	3.33
8	Pareto	4.67	Pareto	3.96	1.06	Reliability matrices	4.25	3.19
9	SMED	4.67	Value stream mapping	3.94	1.06	Visual management	4.75	3.69
10	Stratification	4.67	SIPOC	3.93	0.92	SMED	4.67	3.74

Question 6(c). How has the level of training (defined by certification level) affected the impact ranking?

The right-hand side of Table IV shows the top ten highest differences between "experts" and "non-experts". It should be noted that tools rated as high impact by the "experts" are predominantly more advanced than those rated as high impact by the "non-experts". This signifies that given the choice of all available tools the advanced ones *are* perceived to have a greater impact on performance.

Question 6(d). Is there a correlation between understanding tool and its perceived impact?

Figure 7 shows there to be a strong correlation between respondents understanding a tool and the perceived impact of that tool. The R-squared (adjusted) figure shows that 68 per cent of the variation in ranking can be accounted for by understanding levels (F value = 160.17 and $p = 0.000$ shows statistical significance and most of the tools are within the 95 per cent PI).

The implication for this finding is either that all people involved in improvement initiatives, whether they are tool users or the recipients of their findings, must appreciate how they work in order to increase their overall impact; and tools perceived as high impact need to become better known. In other words "success breeds success" and this should be built on as long as it is based on rational data and analyses rather than hype and conjecture as can sometimes be the case.

Question 6(e). Which tools are likely to transform partially successful deployments into completely successful deployments?

Table V gives a listing of the tools ranked by the difference between scores given by respondents with completely rather than partially successful deployments. This is an important issue because most respondents rated themselves to have had "partial" rather than "complete" success in projects. Therefore the tools that are ranked highest in Table V stand most chance of transforming "partial" successes into "complete" successes and in turn make a substantial impact on quality management training and practice. It can be seen that the majority of these are typically used towards the beginning of a deployment (see right hand column for a typical Six Sigma DMAIC framework classification) emphasising how important it is to make a strong start with any project as the impact of it will be felt throughout a project's duration.

Question 7. What contextual issues concern quality professionals the most?

An analysis of the text-based responses to open-ended questions in the survey revealed that:

- Respondents were applying these CSFs and tools for such things as increasing efficiency, reducing lead-time, proving compliance to regulatory bodies, engaging employees through preventative actions, reducing costs and optimising operational capacity.
- It was thought that early deployments in an overall programme need to get quick results and have clear tangible and financial impacts to set positive foundations for future quality improvements.
- Activities will have more impact if they are highly visible throughout the organisation and beyond (e.g. customers and suppliers).

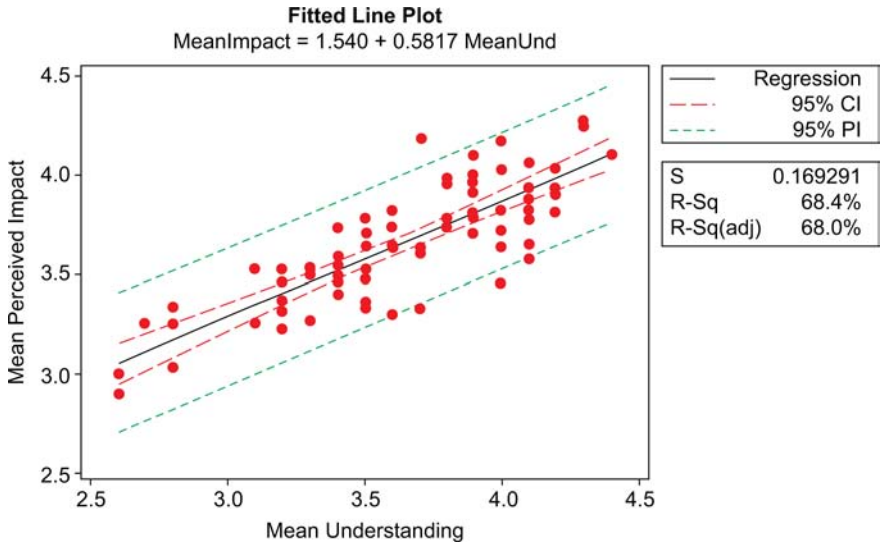

Figure 7.
Correlation between tool understanding and impact

Tool	Complete success	Partial success	Impact difference	Likely DMAIC stage
Sampling plans	3.70	3.07	0.63	M
Montecarlo simulation	3.83	3.33	0.50	I
Survey design and analysis	4.00	3.53	0.47	M
CTQ trees	4.08	3.63	0.46	M
IDEFO modelling	3.11	2.75	0.36	M
Stratification	3.70	3.36	0.34	A
Simulation discrete	3.85	3.55	0.30	I
Moments of truth	3.56	3.26	0.29	D
Histogram	3.94	3.64	0.29	M
Quality function deployment	3.93	3.65	0.28	M
Personality profiling	3.56	3.30	0.27	D
Pareto	4.20	3.98	0.22	A
Scatter plots	3.60	3.39	0.21	A
TRIZ	3.38	3.20	0.18	I
5S	4.17	4.00	0.17	I
Input/output analysis	3.87	3.71	0.16	M
Kano	3.36	3.23	0.13	D
Pilot testing	4.07	3.95	0.13	I
Dashboards	4.08	3.97	0.10	C
Brainstorming	4.18	4.10	0.08	A
Hoshin planning	3.13	3.00	0.04	General
Force field analysis	3.36	3.32	0.04	I
Correlation	3.67	3.63	0.04	A
KPIs	4.25	4.22	0.03	M
Quality loss function	3.62	3.61	0.01	General

Table V.
Tools perceived to help transfer partially successful deployments into completely successful deployments

- Quality management training has had an important impact on productivity and it impact will continue to increase in the future, particularly within services and team-based scenarios.
- Many other tools not mentioned in the survey were suggested as being part of quality management approaches, however on closer inspection these proved to be very similar to those already included or just the same tools known by another name.
- There should be more emphasis on quality if Western countries are to meet rising quality levels from low cost producers in the Far East.

Further discussion raised in validation workshops

The above findings were presented during two validation workshops to two different set of domain experts, and a structured facilitated discussion led to a consensus about the following points:

- CSFs should all be adopted whenever possible, and if too many of these are neglected then a quality management initiative can be in jeopardy. The implication is therefore to make people well aware of all of them and embed them into the culture of an organisation.
- There is a great need to select the correct tools for a particular project and to realise that they will alter with the size and complexity of any particular project. The implication is that an evident lack of practical experience in the field suggests there is a need to create a "road-map" style guide to steer inexperienced users into making the right choices. This is especially apparent in small and medium sized organisations where the cost of appointing an in-house "expert" is often prohibitive.
- Quality "experts" valued advanced tools more so because they perceived them to have a higher potential impact on operational performance. In contrast "non-expert" users were inclined to say that advanced tools were not necessary - even though they did not understand them fully. This implies that it is important to clearly demonstrate the benefits of advanced tools so that their utilisation rate increases amongst the "non-expert" user community and new "experts" be developed for the future.
- Some CSFs relate to cultural acceptance (CA) by the workforce whilst other CSFs relate more to the technical quality (TQ) of an initiative. These findings imply that it is equally important for an organisation to use an even balance of both types of CSFs within a programme if it is going to be considered a complete success rather than just a partial success.
- The urgency of a quality management project rather than its complexity is often seen as a significant factor in the selection of appropriate tools. This implies that many tools are often misapplied and advanced tools are underused, misunderstood and wrongly maligned.
- In general the initial definition of a quality problem and the classification and measurement of a project's success are both highly subjective issues which make comparisons between projects and organisations hard to draw. These findings imply that more standardisation of practice across the profession would be beneficial.

- The majority of businesses who said they were using Six Sigma were more interested in improving their current performance levels than actually reaching a Six Sigma level (<3.4 defects per million opportunities). Some professionals reported that between four and five sigma was adequate to satisfy customer requirements and that the costs of achieving higher levels of quality conformance was considered prohibitive. The implication here is that many organisations needlessly set themselves up for failure from the onset without even realising it.
- A cultural multiplicity can often arise when organisations have safety critical processes (such as surgical operations in hospitals, or bomb detections by the military) running alongside processes that are able to run at lower capability levels (e.g. administration or inventory management). Such disparities need to be clearly detailed in an organisation's improvement objectives to avoid confusion amongst the workforce
- Public service organisations have different mission objectives to private sector organisations and the different cultural and contextual values need to be considered (e.g. in the military cost saving is less important than process and procedural conformity, and in the NHS patient mortality rates are more important than efficiency); this needs to accounted for when selecting projects' objectives.
- Quality projects are sometimes too internally focused. The implication is that practitioners should be aware that projects need to be driven either by the voice of the external customer (VOC) or by an organisation's key stakeholders.
- It did not matter to the participants what the overall approach was called (e.g. Six Sigma, lean management, lean Six Sigma, TQM or something else entirely) so long as it worked and was seen to be working. This implies that it is more important to focus upon the cultural acceptance and technical quality of quality management programmes rather than its methodological name.

Overall, it was found that the latest practice of quality management is still based on the classic principles that have been around for decades, but the expectation of higher tolerance limits and increased competition has made the implementation of programmes and the role of training in areas such as lean thinking and Six Sigma increasingly important.

Summary

In conclusion, this study has given a detailed insight into contemporary quality management practice. Whilst some of these findings may have been expected, it was previously very hard to find any actual evidence to support them. This survey is unique as it provides new evidence to support them and has done so by focusing on the components (i.e. tools and CSFs) of quality initiatives rather than their overall methodological approaches. Most importantly it provides a positive validation that the original foundations of quality management (i.e. the CSFs) are still considered relevant and useful today and are still used within the latest evolutions of quality approaches. It also endorses many of the tools (both advanced and simple) currently used; and supports the idea that a mixture of strategically and operationally led deployments are commonly practised and perceived to be effective.

The survey also shows evidence to suggest that some common beliefs are not true, such as:

- Quality management is not practised widely or successfully in the service sector like it is in the manufacturing sector.
- Those that practise quality always say it works well all of the time; this survey suggests that practitioners say it only works mostly, most of the time and are discerning critics of its deployment.
- Training is often ineffective.

However, the study also implies that they are many points still to be addressed if quality management is to maximise its full potential; many of these revolve around the accurate measurement and selection of projects, the comparison and declaration of delivered benefits and the cost of resources consumed to achieve them. In addition training needs to focus on the initial understanding of tools, the endorsement of classical CSFs and the subsequent deployment of them within a suitable methodological framework.

Further work is focusing on building a larger sample by administering the questionnaire within specific companies rather than across companies to facilitate benchmarking and standardisation of practice; it is hoped that a situational roadmap to increase the effectiveness of quality management training and deployment will emerge form this.

Note

1. Six sigma certification level was used as other approaches do not have an equivalent accreditation system

References

Ahmed, S. and Hassan, M. (2003), "Survey and case investigations on applications of quality management tools and techniques in SMIs", *International Journal of Quality & Reliability Management*, Vol. 20 No. 7, pp. 795-826.

Andersen, B. and Fagerhaug, T. (2006), *Root Cause Analysis: Simplified Tools and Techniques*, 2nd ed., American Society for Quality, Quality Press, Milwaukee, WI.

Andersson, R., Eriksson, H. and Torstensson, H. (2006), "Similarities and differences between TQM, Six Sigma and lean", *The TQM Magazine*, Vol. 18 No. 3, pp. 282-96.

Anthony, J. and Maneesh, K. (2005), "Six Sigma in small and medium-sized UK manufacturing enterprises", *International Journal of Quality & Reliability Management*, Vol. 22 No. 8, pp. 860-74.

Arnheiter, E.D. and Maleyeff, J. (2005), "The integration of lean management and Six Sigma", *The TQM Magazine*, Vol. 17 No. 1, pp. 5-18.

Bendell, T. (2006), "A review and comparison of Six Sigma and the lean organisation", *The TQM Magazine*, Vol. 18 No. 3, pp. 255-62.

Bhuiyan, N. and Baghel, A. (2005), "An overview of continuous improvement: from the past to the present", *Management Decision*, Vol. 43 No. 5, pp. 761-71.

Bhuiyan, N. and Baghel, A. (2006), "A sustainable continuous improvement methodology at an aerospace company", *International Journal of Productivity and Performance Management*, Vol. 55 No. 8, pp. 671-87.

Bicheno, J. and Catherwood, P. (2005), *Six Sigma and the Quality Toolbox VI*, PICSIE Books, Buckingham.

Bryne, G., Lubowe, D. and Blitz, A. (2007), "Using a lean Six Sigma approach to drive innovation", *Strategy & Leadership*, Vol. 35 No. 2, pp. 5-10.

Chowdhury, S. (2001), *The Power of Six Sigma*, Dearborn Trade, Chicago, IL.

Clifford, L. (2001), "Trend spotting – why you can safely ignore Six Sigma", *Fortune*, Vol. 143 No. 2, January, p. 140.

Crosby, P. (1979), *Quality Is Free: The Art of Making Quality Certain*, Mentor Executive Library, New York, NY.

Dahlgaard, J.J. and Dahlgaard-Park, S.M. (2006), "Lean production, Six Sigma quality, TQM and company culture", *The TQM Magazine*, Vol. 18 No. 3, pp. 263-81.

Deming, W.E. (1986), *Out of the Crisis*, MIT/CAES, Boston, MA, pp. 18-96.

Eckes, G. (2001), *The Six Sigma Revolution*, Wiley, New York, NY.

Feigenbaum, A. (1983), *Total Quality Control*, McGraw-Hill, New York, NY (originally published in 1951).

Hahn, G., Hill, W., Hoerl, R. and Zinkgraf, S. (1999), "The impact of Six Sigma improvement – a glimpse into the future of statistics", *The American Statistician*, Vol. 53 No. 3, pp. 208-15.

Henderson, K. and Evans, J. (2000), "Successful implementation of Six Sigma benchmarking: General Electric Company", *The International Journal of Benchmarking*, Vol. 7 No. 4, pp. 260-82.

Ishikawa, K. (1968), *Guide to Quality Control*, Quality Resources, White Plains, NY.

Juran, J.J. (1992), *Juran on Quality by Design*, Free Press, New York, NY.

Lee-Mortimer, A. (2006), "Six Sigma: a vital improvement approach when applied to the right problems, in the right environment", *Assembly Automation*, Vol. 26 No. 1, pp. 10-17.

Neergaard, P. (1999), "Quality management: a survey on accomplished results", *International Journal of Quality & Reliability Management*, Vol. 16 No. 3, pp. 277-88.

Nonthaleerak, P. and Hendry, L.C. (2006), "Six Sigma: literature review and key future research areas", *International Journal of Six Sigma and Competitive Advantage*, Vol. 2 No. 2, pp. 105-61.

Rich, N., Bateman, N., Esain, A., Massey, L. and Samuel, D. (2006), *Lean Evolution: Lessons from the Workplace*, Cambridge University Press, Cambridge.

Rockart, J.F. (1979), "Chief executives define their own data needs", *Harvard Business Review*, Vol. 57 No. 2, March-April, pp. 81-93.

Samson, D. and Terziovski, M. (1999), "The relationship between total quality management practices and operational performance", *Journal of Operations Management*, Vol. 17 No. 4, pp. 393-409.

Shewhart, W. (1939), *Statistical Method from the Viewpoint of Quality Control*, Graduate School, Department of Agriculture, Washington, DC.

Taguchi, G., Chowdhry, S. and Wu, Y. (2005), *Taguchi's Quality Engineering Handbook*, Wiley, Hoboken, NJ.

Tari, J.J. (2005), "Components of successful total quality management", *The TQM Magazine*, Vol. 17 No. 2, pp. 182-94.

Womack, J. and Jones, D. (1996), *Lean Thinking, Banish Waste and Create Wealth in Your Corporation*, Simon & Schuster, London.

About the authors

Ben Clegg has been a practising Quality, Project and Operations Manager, and now consults, trains, researches and teaches widely in the area. He has a BSc(Hons) in management science from Loughborough University, a PhD from De Montfort University in systems engineering. He spent a year as a visiting scholar at Stanford University (USA) researching into business simulation, organisational and operational improvement and worked for a spin-out company. He is a chartered engineer. Ben Clegg is the corresponding author and can be contacted at: b.t.clegg@aston.ac.uk

Chris Rees is Director of UK Operations for SigmaPro. He is an experienced Trainer and Business Adviser. His consulting activities include the implementation of ISO9001 management systems, running lean programmes for large and small organisations, and developing business strategies. Before moving into consultancy, Chris worked for several European-wide manufacturing and service companies as a quality improvement manager. He has an MBA from Aston University and a BSc in Mechanical Engineering from the University of Birmingham.

Mike Titchen has an MBA from Oxford Brookes University. He has over ten years' experience as a quality management consultant, manager and trainer and a further ten years' experience in a variety of manufacturing, engineering and service industries as an operations manager; he has led hundreds of quality improvement projects.