Total quality management through six sigma benchmarking

A case study

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Abstract

Purpose – This paper aims to explore the best strategy for Turkish SMEs to obtain world class manufacturing status.

Design/methodology/approach – A questionnaire was used as a reaserch tool. From the results of a questionnaire, a factor analysis is used to reduce 42 quality management practices into a smaller set of dimensions. The resulting dimensions (factors) were used as independent variables for multiple regression analysis, which is used to evaluate whether relationship(s) exist between company's exporting, being ISO 9000 certified, and the belief that ISO 9000 guarantees the quality of the product or service supplied.

Findings – The ten dimensions resulting from the factor analysis was information analysis, quality results, strategic planning, customer satisfaction, leadership, management process quality, business outcome comparative and human resource utilisation. The first finding from the multiple regression analysis identified a relationship between exporting and paying attention to quality results plus documenting technical quality of their product or service as compared to other companies. The second result was that the application of the quality management practices does not depend on being ISO 9000 certified. The third finding was proving the relationship between the belief of ISO 9000 guaranteeing the quality result and leadership. Finally, the paper concludes with the best strategy for the local SME's to become a world-class manufacturer and this was found to be "six-sigma benchmarking."

Research limitations/implications – The questionnaires was distributed to only Turkish SME's in the electric-electronic industry. The number can be enlarged and also new industries can be added to the research.

Practical implications – A very useful guide for the companies who want to be a world-class manufacturer.

Originality/value – This paper does not only give information on the industry but also shows the path towards being a world-class manufacturer.

Keywords Benchmarking, Turkey, Small to medium-sized enterprises, Continuous improvement, Six sigma, World class manufacturing

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Introduction

To remain competitive without the need for large new investments is difficult for companies to deal with, even within the developed world. Consider how difficult it must be for companies in the developing nations of the world. What is their best strategy to survive? How can they compete or even surpass their western counterpart? Many of the regulated economies are now opening their doors to external competition and many developing countries have embraced quality management concepts in order to improve their productivity and competitiveness in international markets.

Quality concepts will spread rapidly if open competition is introduced among manufacturing companies.

Current practice is that companies must attain ISO 9000 approval as a general requirement (Jeng, 1998), which has provided significant benefits for SMEs (Quazi and Padibjo, 1998). An encouraging outcome is that a number of SME's see ISO 9000 series certification as a useful first step in the quality journey with a view to moving forward in the direction of a broader quality management (Brown *et al.*, 1998). On the other hand, a survey conducted by Laszlo (1998) in Canada stated that although ISO 9001 had been an effective guide for a good quality system in order to serve the interests better a broader definition of quality would be needed. Jeng (1998) stated that managers do not overwhelmingly believe that ISO 9000 approval is an effective strategy for improving performance. Jeng also added that in Taiwan at least, 30 percent of managers do not regard the procedure of ISO 9000 as the best way or the necessary approach for improving organizational performance. Rather than using a short-term approach like ISO 9000 approval, they may prefer using a long-term strategy like total quality management (TQM) principles to improve quality and total organizational performance. Many smaller enterprises face strong pressure to gain certification due to either customer requirements or to maintain their competitive position in the industry when other companies are also moving in this direction (Brown *et al.*, 1998). According to Brown, the implementation and certification of a quality management system to in the ISO series, has come under strong criticism from some sections due to its cost and in many cases limited benefits, particularly for smaller enterprises.

SMEs form the majority of the Turkish industry, and quality has become the main concern for the SMEs operating in Turkey. This paper reports on the results of a pilot study conducted among a sample of local SME's, within the electric-electronic industry. This paper aims to answer the following questions:

- Which quality management practices determine the company's quality strategy?
- What is the relationship between implementation of quality management practices and exporting?
- What is the relationship between implementation of quality management practices and ISO 9000 certification?
- What is the relationship between implementation of quality management practices and believing that ISO 9000 certification guarantees the quality of the product or service supplied?
- What is the best strategy for the local SMEs in order to become a world manufacturing company?

Analysis method

In order to achieve a proper understanding of the concept and a concrete evaluation of the above-mentioned targets, a literature review has been carried out. As a result, a questionnaire was constructed and used in this study. The questionnaire was adopted from the article written by Quazi and Padibjo (1998), which report on SMEs in Singapore. Their questionnaire uses the "5 Likert Scale". The sample group chosen for this study was the electric-electronic industry. The questionnaires were collected by

using primary data techniques and face-to face interviews with key personnel within the electric-electronic industry.

Our questionnaire is structured in three parts. One part relates to the general position of the business, the second on 42 variables associated with quality management practices, which were also divided into eight subheadings, and the last part on information concerning the respondent. A factor and reliability analysis is used for the analysis of the 42 variables associated with quality management practices. Factor analysis; is a method of transforming the original variables into new, non-correlated variables, called factors. This is used to identify key points emerging from the questionnaire; the reliability analysis tests the validity of these key points, which are then used to formulate a number of hypotheses. In addition, a regression analysis is also used to evaluate the direction and effect of the relationship between ISO 9000 and the key points resulting from the factor analyses relating to the quality management practices.

Empirical results and analysis

General profile of the firms included in the research

The general profile of the firms included in the research is given in Table I.

A high number, 84.3 percent of companies believe that ISO 9000 standard guarantees the quality of a product or service supplied. According to the figures 80 percent of the companies were exporting. While 48.8 percent were ISO 9001 certified; 29.7 percent were ISO 9002 certified; 2.3 percent were ISO 14000 certified and only 12.8 percent were not certified to any standard. Among all the 172 companies only

Variables	*n*	Percentage	Variables	*n*	Percentage
Certification date			*Certification time*		
1990-1992	11	6.4	Less than 1 year	97	56.4
1993-1994	28	16.3	1-2 year	43	25.0
1995-1996	22	12.8	2-3 year	5	2.9
1997-1998	26	15.1	More than 3 years	5	2.9
1999-2000	33	19.2	Missing answer	22	12.8
2001-2002	23	13.4	Total	172	100
No certification	22	12.8			
Missing answer	7	4.0			
Total	172	100			
Quality certificate			*Firms exporting*		
ISO 9001	84	48.8	Yes	138	80.2
ISO 9002	51	29.7	No	34	19.8
ISO 14000	4	2.3	Total	172	100
ISO 9000-2000	11	6.4			
No certificate owned	22	12.8			
Total	172	100			
Firms having ISO 9000-2000 certificate	11	6.4	*ISO 9000 guarantees quality*		
Not yet	161	93.6	Yes	145	84.3
Total	172	100	No	12	7.0
			Missing answer	15	8.7
			Total	172	100

Table I.
General profile of the firms

6.4 percent have upgraded their certificate to ISO 9000-2000. An interesting point was that 56.4 percent of the companies were only certified for less than 1 year.

Results of the factor analysis related with quality management practices

The quality management practice criteria had a general reliability (Cronbach α) which relates to the variation of 96.67 percent. The 42 variables associated to quality management practices were reduced into a new set of salient variables by the factor analysis.

Factors with eigenvalues greater than 1.0 are retained. Inspection of scree plot and eigenvalues enabled the analysis to reduce the 42 quality management variables into eight factors. The resulting rotated component factor matrix is given in Table II. Table III shows the factors and corresponding quality management practices.

According to the rotated component matrix (Table II) and the table Quality management practices and corresponding factors (Table III) the factors were formalized as follows:

- *Factor 1: information analysis*. As shown in Table III the first factor is named as "Information Analysis." The highest loading was given to B6, which is about carefully collecting data on all facets of the business. The second highest loading was given to B1, which is related with personally conducting regular reviews of quality performance on the product/service. These two loadings show that the electric-electronic companies value the importance of the information and data collected.
- *Factor 2: quality results*. The highest loading is given to documenting the financial performance of their business. The second highest loading is given to documenting the technical quality of their product/service. These two components infer that electric-electronic firms have the ability to compare their technical quality and financial performance to other businesses in the same industry. They are also using these comparisons as quality indicators for continuously improvement.
- *Factor 3: strategic planning*. The third factor is related to strategic planning. The highest loadings are given to the components related to this topic. The highest loading given was for regular strategic planning, and the second highest loading was for linking the strategic plan to quality values.
- *Factor 4: customer satisfaction*. The highest loading is for systematically asking customers what they expect in the product/service. This shows that the electric-electronic industry in Turkey have started to become customer focussed.
- *Factor 5: leadership*. The highest loading is for being trained in TQM and the second highest loading is to monitor all production processes and introduce continuous improvement whenever possible. The loadings show that the leaders are all educated for TQM and they are always trying to continuously improve.
- *Factor 6: management of process quality*. The two components shown in Table III infer that the employees in the electric-electric industry are motivated to take innovative action.
- *Factor 7: business outcome*. All three of the components (Table III) are loaded above 0.7, which is very high. According to these components the analysed

	1	2	3	4	5	6	7	8
B1	0.689							
B2	0.599							
B3					0.606			
B4		0.574						
B5					0.694			
B6	0.751							
B7	0.580							
B8	0.565							
B9			0.743					
B10			0.506					
B11			0.654					
B12			0.581					
B13								0.564
B14								0.689
B15								
B16								
B17			0.597					
B18								
B19			0.513					
B20								0.520
B21								
B22						0.717		
B23						0.751		
B24					0.666			
B25								
B26								
B27								
B28		0.714						
B29		0.598						
B30								
B31		0.755						
B32				0.620				
B33				0.758				
B34				0.713				
B35								
B36		0.503						
B37		0.516						
B38								
B39								
B40							0.893	
B41							0.877	
B42							0.780	

Table II.
Rotated component factor matrix

Note: Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization, a rotation converged in 12 iterations

businesses had compared themselves with their past and recognised that quality has helped them to improve.

- *Factor 8: human resource utilisation*. It is clear that there is good communication between the staff and the managers. The companies give importance to training

Factor	Quality management practices
Factor 1	(B1) I personally conduct regular reviews of quality performance on my product/service
	(B2) I always maintain close contact with customers
	(B6) I carefully collect data on all facets of my business
	(B7) I analyze all the work processes in my business
	(B8) Key performance figures are always available to my managers for decision making
Factor 2	(B4) I give quality issues top priority as criteria when making decisions
	(B28) I can document the technical quality of my product/service as compared to other competitors
	(B29) If we implement a new business/operational procedure, we collect and monitor information to determine the extent to which it is better than the previous procedure
	(B31) I can document the financial performance of my business compared to other businesses in the same industry
	(B36) I look for the cause when I loose a customer
	(B37) A customer is adequately satisfied if they continue to use my product/service
Factor 3	(B9) I do regular strategic planning
	(B10) My business has clear quality goals
	(B11) My strategic plan is linked to quality values
	(B12) My planning process includes continuous quality improvement
	(B17) Each member in my business is encouraged to develop new ways to do their job
	(B19) I ensure that all my staff are focused on continuous improvement effort in all areas
Factor 4	(B32) I collect data to monitor changes in my customer satisfaction
	(B33) I systematically ask a customer what they expect in my product/service
	(B34) I systematically ask my customers if they are satisfied with the product/service they purchased from me
Factor 5	(B3) I enforce TQM to all my staff in all operations
	(B5) I am trained in TQM
	(B24) I monitor all production processes and introduce continuous improvement whenever possible
Factor 6	(B22) In the past year, I have introduced at least one new product/service to my customers
	(B23) I have improved at least one feature of my product/service in the past year
Factor 7	(B40) The profitability of my business has increased in the past three years primarily due to our quality consciousness
	(B41) Owing to our quality improvement effort the revenue dollars from my business have increased in the past three years
	(B42) The number of customers in my business has increased in the last three years, primarily because our product/service quality has improved
Factor 8	(B13) We work as a team with clear goals
	(B14) My staff is aware of my long-term business goals
	(B20) All my staff receives appropriate training and are able to do more than one task

Table III.
Quality management practices and corresponding factors

their staff. The highest loading is for being aware of long-term business goals, while the second highest loading is for working as a team with clear goals. This shows that the electric-electronic companies have clear-cut goals and value team work and educated in order to be successful in the global market regardless of what they are providing.

Multiple regression analysis

Multiple regression analysis involves a single dependent variable and two or more independent variables. This is used to determine which of the independent variables (the eight factors computed after the factor analysis) explain a significant variation in the dependent variable, which was to indicate whether a relationship exists. In our case, the dependent variables are the need for exporting companies to be ISO certified, and the idea that ISO certification guarantee's quality. It was also useful in determining how much of the variation in the dependent variable can be explained by the independent variables, which relates to the strength of the relationship.

The general multiple regression model is as follows (Malhotra, 1999):

$$Y_c = a + b_{yxz}X + b_{yzx}Z$$

where: $a =$ represents the expected value of Y when X and Z are zero; $b_{yxz} =$ represents the expected change in Y when X is changed by one unit but Z is held constant; $b_{yzx} =$ represents the expected change in Y when Z is changed by one unit but X is held constant; $Y_c =$ represents the expected value of Y for predicted values of X and Z.

The aim of multiple regression analysis is to predict the values of a, b_{yxz}, b_{yzx}. These values are known as the interpretation of partial regression coefficients. When the coefficients are analysed, the useful predictors are calculated by selecting the t-values below -2 or above $+2$ (Malhotra, 1999). These values indicate which independent variable has an impact on the dependent variable.

The hypotheses tested in this paper are listed and analysed as follows:

Hypothesis 1:

H_0. There is no relationship between implementation of quality management practices and exporting.

H_1. There is a relationship between implementation of quality management practices and exporting.

Hypothesis 2:

H_0. There is no relationship between implementation of quality management practices and being ISO 9000 certified.

H_1. There is a relationship between implementation of quality management practices and being ISO 9000 certified.

Hypothesis 3:

H_0. There is no relationship between implementation of quality management practices and the belief that ISO 9000 guarantees the quality of a product or service supplied.

H_1. There is a relationship between implementation of quality management practices and the belief that ISO 9000 guarantees the quality of a product or service supplied.

Evaluation of hypothesis 1

According to Table IV (ANOVA table), the significance value is equal to 0.05, which is calculated to be 0.025. This value indicates that the independent variables do a good job in explaining the variation of the dependent variable.

According to the coefficients shown in Table V, F2 has a *t*-value greater than +2. This factor relates to quality documentation and results of within the electric-electronic companies. It includes six components and is contributing to the 10.503 percent variance.

The estimated regression equation for companies doing export is:

$$\text{Export} = 1.198 + (9.2 \times 10^{-2})\text{F2}$$

Evaluation of hypothesis 2

For the second hypothesis, Table VI shows the results of an ANOVA analysis, which reflects the relationship between quality management practices and ISO 9000 certificate. The ANOVA Table VI shows that the significance value is greater than 0.05. This value indicates that the independent variables do not explain the total variation very well according to the dependent variable.

ANOVA*						
Model		Sum of squares	df	Mean square	*F*	Sig.
1	Regression	2.374	8	0.297	1.942	0.057**
	Residual	24.905	163	0.153		
	Total	27.279	171			

Notes: *Dependent variable: A4; **predictors: (constant), REGR factor score 8 for analysis 1, REGR factor score 7 for analysis 1, REGR factor score 6, for analysis 1, REGR factor score 5 for analysis 1, REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1

Table IV.
ANOVA table for companies exporting

Coefficients*						
		Unstandardized coefficients		Standardized coefficients		
Model		*B*	Std. error	β	*t*	Sig.
1	(Constant)	1.198	0.030		40.184	0.000
	REGR factor score 1 for analysis 1	1.5×10^{-2}	0.030	0.037	0.488	0.626
	REGR factor score 2 for analysis 1	9.2×10^{-2}	0.030	0.231	3.093	0.002
	REGR factor score 3 for analysis 1	-7×10^{-4}	0.030	−0.002	−0.023	0.982
	REGR factor score 4 for analysis 1	-1×10^{-2}	0.030	−0.025	−0.329	0.743
	REGR factor score 5 for analysis 1	-3×10^{-2}	0.030	−0.085	−1.130	0.260
	REGR factor score 6 for analysis 1	-1×10^{-2}	0.030	−0.026	−0.344	0.731
	REGR factor score 7 for analysis 1	-5×10^{-2}	0.030	−0.132	−1.769	0.079
	REGR factor score 8 for analysis 1	-3×10^{-2}	0.030	−0.078	−1.048	0.296

Note: *Dependent variable: A4

Table V.
Coefficients table for companies exporting

According to the coefficients table (Table VII), F3 has a *t*-value greater than +2. This factor relates to the 9.672 percent variance. Even though the significance value stated in the ANOVA Table VI is not less than 0.05, it is seen that when each factor is analysed separately, F3 has a *t*-value of 2.286, which is greater than +2. In addition to this, F3 has a significance value of 0.024, which is less than 0.05. These two F3 outputs indicate that the relationship between quality management practices and ISO 9000 certification has a very important role.

The estimated regression equation for hypothesis 2 is:

$$\mathrm{ISO} = 1.163 + 7.8 \times 10^{-2}\mathrm{F3}$$

ANOVA*						
Model		Sum of squares	df	Mean square	*F*	Sig.
1	Regression	2.657	8	0.332	1.651	0.114**
	Residual	32.785	163	0.201		
	Total	35.442	171			

Notes: *Dependent variable: A5; **predictors: (constant), REGR factor score 8 for analysis 1, REGR factor score 7 for analysis 1, REGR factor score 6 for analysis 1, REGR factor score 5 for analysis 1, REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1

Table VI.
ANOVA Table for ISO 9000

Coefficients*						
		Unstandardized coefficients		Standardized coefficients		
Model		*B*	Std. error	β	*t*	Sig.
1	(Constant)	1.163	0.034		34.003	0.000
	REGR factor score 1 for analysis 1	1.0×10^{-2}	0.034	0.022	0.296	0.767
	REGR factor score 2 for analysis 1	5.7×10^{-2}	0.034	0.125	1.662	0.098
	REGR factor score 3 for analysis 1	7.8×10^{-2}	0.034	0.172	2.286	0.024
	REGR factor score 4 for analysis 1	-2×10^{-2}	0.034	−0.051	−0.673	0.502
	REGR factor score 5 for analysis 1	-4×10^{-2}	0.034	−0.083	−1.101	0.272
	REGR factor score 6 for analysis 1	-4×10^{-2}	0.034	−0.098	−1.295	0.197
	REGR factor score 7 for analysis 1	-9×10^{-3}	0.034	−0.019	−0.252	0.802
	REGR factor score 8 for analysis 1	-5×10^{-2}	0.034	−0.099	−1.313	0.191

Note: *Dependent variable: A5

Table VII.
Coefficients table for ISO 9000

Evaluation of hypothesis 3

Tables VIII and IX relate to the third hypothesis. Table VIII indicates the relationship between the quality management practices and the companies' belief in ISO 9000 guaranteeing the quality of the product or service supplied.

According to the ANOVA Table VIII, the significance value is less than 0.05, which indicates that the independent variables do a good job in explaining the variation according to the dependent variable.

According to Table IX, F2 has a *t*-value of 2.323, which is greater than +2. In addition, F5 also has a *t*-value of −2.206, which is greater than −2, which means that the independent variables (F2 and F5) do a good job in explaining the variation according to the dependent variable (ISO 9000 guaranteeing the quality of the product or service supplied).

ANOVA*

Model		Sum of squares	df	Mean square	*F*	Sig.
1	Regression	79.457	8	9.932	2.046	0.044**
	Residual	791.241	163	4.854		
	Total	870.698	171			

Notes: *Dependent variable: A9, **predictors: (constant), REGR factor score 8 for analysis 1, REGR factor score 7 for analysis 1, REGR factor score 6, for analysis 1, REGR factor score 5 for analysis 1, REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1

Table VIII.
ANOVA table of ISO 9000 guaranteeing the quality of the product/service supplied

Coefficients*

Model		Unstandardized coefficients *B*	Std. error	Standardized coefficients β	*t*	Sig.
1	(Constant)	1.767	0.168		10.521	0.000
	REGR factor score 1 for analysis 1	-2×10^{-2}	0.168	−0.008	0.113	0.910
	REGR factor score 2 for analysis 1	0.391	0.168	0.173	2.323	0.021
	REGR factor score 3 for analysis 1	0.312	0.168	0.138	1.850	0.066
	REGR factor score 4 for analysis 1	0.250	0.168	−0.111	−1.486	0.139
	REGR factor score 5 for analysis 1	−0.372	0.168	−0.165	−2.206	0.029
	REGR factor score 6 for analysis 1	-5×10^{-2}	0.168	−0.024	−0.317	0.752
	REGR factor score 7 for analysis 1	-7×10^{-2}	0.168	−0.033	−0.443	0.658
	REGR factor score 8 for analysis 1	-7×10^{-2}	0.168	−0.030	−0.405	0.686

Note: *Dependent variable: A9

Table IX.
Coefficients table of ISO 9000 guaranteeing the quality of the product/service supplied

The estimated regression analysis for hypothesis 3 is as follows:

$$G = 1.767 + 0.391\text{F2} - 0.372\text{F5}$$

Summary of the multiple regression analysis

From the multiple regression analysis it can be shown that companies:

- exporting have a higher emphasise on quality practices;
- are monitoring and documenting the financial performance of their business; and
- have a high emphasise on documenting the technical quality of their product or service as compared to other companies.

The second result evaluated from the multiple regression analysis is that the application of the quality management practices has no relationship with being ISO 9000 certified or not. But when the coefficients were analysed it was seen that only F3 had a relation with ISO 9000, which is the factor related with strategic planning. This indicates that strategic planning plays an important role in ISO 9000 certification for electric-electronic companies.

The third and last result of the multiple regression analysis is that F2 and F5 play an important role in the belief of ISO 9000 guaranteeing the quality of the product or service supplied. These two factors relate the quality documentation and leadership. This also indicates that electric-electronic companies are paying attention to quality documentation and results.

Best business strategy for electric-electronic industry in Turkey: "six-sigma benchmarking"

Turkish industries will need to achieve world-class manufacturer status. For companies to grow, prosper, and become a national asset to generate wealth, companies in Turkey must go global and operate internationally. For this to become real, they must first start with the best practice, which is stated to be benchmarking. According to the literature review, it is seen that the only way to survive is to continuously improve and benchmarking offers this. Therefore, the next step is continuous improvement. For continuous improvement, the best tool is six sigma, as it is not a simple quality program but is a set of statistical tools for continuous improvement. Many world manufacturers' have adapted six sigma as a benchmark standard. Six sigma benchmarking is a very difficult task for Turkish SMEs, as the main problems for these company's is to reduce defects and increase customer expectations and finally to continuously improve, in order to compete in the global market. Six-sigma is used for reducing variation. This term is under the quality umbrella of continuous improvement. Six-sigma quality is a statistical measure that equates to nearly perfect quality and has become a recognized quality program based on the goal of virtually perfect quality (Russell and Taylor, 2003).

Hoerl *et al.* (2004) indicated that six sigma began in manufacturing and added that this is a narrow view because six-sigma is a generic improvement methodology that can be applied anywhere. They also stated that some use six sigma as their QMS, however, they believe that it should be made clear to experienced quality professionals that six sigma is an improvement methodology, not a holistic QMS. For example, it

does not replace ISO 9000, Baldrige or customer service hotlines. Hoerl *et al.* also indicated that six sigma is the current phase of improvement methodology that has been evolving in the business world for the last 100 years, beginning with the work of Frederick Taylor and continuing through statistical quality control, quality circles, quality assurance, statistical process control, TQM, ISO 9000, reengineering and finally six sigma. Six sigma can provide leaders with the strategy, methods and tools to change their organisation. This is a key leadership skill that has been, until now, missing from leadership development. There are many studies that agree with these points, for example, Camgoz-Akdag (2004), Stauffer (2003), Dalgleish (2003), and Thawani (2004) are a few.

Six sigma is seen as the basis for a "best-in-class" philosophy and a long-term business strategy that measures quality improvement. Six sigma is to focus on improvement and variance reduction in every process and transaction within a company. The companies adapting six-sigma believe in that with the help of six sigma, waste and cost are driven out as quality improves, and customer satisfaction and loyalty, and thus profits, are increased through the continuous improvement of quality. The results of the factor analysis support the benefit of six sigma for the Turkish electric-electronic industry. As the first four factors being: information analysis, quality results, strategic planning and customer satisfaction. The electric-electronic companies are in a suitable position for adapting six-sigma. These companies give high importance to the key points, which is helpful for adaptation of the six sigma quality tool.

Conclusion and implication for further research

This paper aimed to answer five questions. The first question was answered via factor analysis. Factor analysis reduced the 42 quality management practices into 8 important factors, which were use for setting the best strategy for the Turkish electric-electronic SMEs to become world-class manufacturers. These factors being: information analysis, quality results, strategic planning, customer satisfaction, leadership, management process quality, business outcome comparative and human resource utilisation.

The second, third and the fourth questions were answered by the multiple regression analysis. Three hypothesizes were used to evaluate each relationship asked in the questionnaire.

The first finding from the multiple regression analysis identified a relationship between exporting and paying attention to quality results plus documenting the technical quality of their product or service as compared to other companies. The second result was that the application of the quality management practices does not depend on being ISO 9000 certified. This result was found when the explanation of the total variation was analysed. When analysed in detail, the only factor having a relation with ISO 9000 certification was to have strategic planning. The third finding was proving the relationship between the belief of ISO 9000 guaranteeing the quality result and leadership.

The last question, what is the best strategy for the local SMEs to become a world-class manufacturer was found to be "six-sigma benchmarking." The above findings are also support this strategy, that is six-sigma together with benchmarking will be helpful and useful for the Turkish electric-electronic SMEs.

In addition to the findings stated above, this paper was restricted to SMEs (for comparative purposes), however, this study should be expanded to larger companies and to other companies operating in different industries to see if the results show similarities. Another recommendation is that a pilot study should be carried out on a group of SMEs by applying the strategy stated in this paper and evaluating the results.

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Appendix. Survey questionnaire on the quality management practices in Turkish SME's

Part I: company background information

(1) Name of the company: . . . . . .

(2) Number of full-time employees: . . . . . .

(3) Type of business/industry: . . . . . .

(4) Are you exporting your products?
1. () Yes 2. () No

(5) Are you ISO 9000 certified?
1. () Yes 2. () No 3. () Working on it

(6) Which certification do you have?
1. () ISO 9001 2. () ISO 9002 3. () ISO 9003 4. () ISO 14000

(7) When did you receive the certification? . . . . . .

(8) How long did it take to receive the certification?
1. () Less than 1 year 2. () 1-2 year 3. () 2-3 year 4. () More than 3 year

(9) Do you think that if a company has adopted the ISO 9000 standard this guarantees the quality of a product or service supplied?
1. () Yes 2. () No

Part II: information depending on quality management practices
The explanation of each scale is as below:

(1) Strongly disagree;

(2) Disagree;

(3) Not sure (neither agreeing nor disagreeing);

(4) Agree; and

(5) Strongly agree.

Leadership					
(1) I personally conduct regular reviews of quality performance on my product/service	(1)	(2)	(3)	(4)	(5)
(2) I always maintain close contact with customers	(1)	(2)	(3)	(4)	(5)
(3) I enforce TQM to all my staff in all operations	(1)	(2)	(3)	(4)	(5)
(4) I give quality issues top priority as criteria when making decisions	(1)	(2)	(3)	(4)	(5)
(5) I am trained in TQM	(1)	(2)	(3)	(4)	(5)
Information analysis					
(6) I carefully collect data on all facets of my business	(1)	(2)	(3)	(4)	(5)
(7) I analyse all the work processes in my business	(1)	(2)	(3)	(4)	(5)
(8) Key performance figures are always available to my managers for decision making	(1)	(2)	(3)	(4)	(5)
Strategic planning					
(9) I do regular strategic planning	(1)	(2)	(3)	(4)	(5)
(10) My business has clear quality goals	(1)	(2)	(3)	(4)	(5)
(11) My strategic plan is linked to quality values	(1)	(2)	(3)	(4)	(5)
(12) My planning process includes continuous quality improvement	(1)	(2)	(3)	(4)	(5)
Human resource utilization					
(13) We work as a team with clear goals	(1)	(2)	(3)	(4)	(5)
(14) My staff is aware of my long-term business goals	(1)	(2)	(3)	(4)	(5)
(15) I encourage personal growth of my staff	(1)	(2)	(3)	(4)	(5)
(16) I reward staff who help improve my product and service quality	(1)	(2)	(3)	(4)	(5)
(17) Each member in my business is encouraged to develop new ways to do their job better	(1)	(2)	(3)	(4)	(5)
(18) All staff in my business understand how their tasks fit into an overall plan of things	(1)	(2)	(3)	(4)	(5)
(19) I ensure that all my staff are focused on continuous improvement effort in all areas	(1)	(2)	(3)	(4)	(5)
(20) All my staff receive appropriate training and are able to do more than one task	(1)	(2)	(3)	(4)	(5)

Management of process quality					
(21) I continually make improvements in my products and services	(1)	(2)	(3)	(4)	(5)
(22) In the past year, I have introduced at least one new product/service to my customers	(1)	(2)	(3)	(4)	(5)
(23) I have improved at least one feature of my product/service in the past year	(1)	(2)	(3)	(4)	(5)
(24) I monitor all production processes and introduce continuous improvement whenever possible	(1)	(2)	(3)	(4)	(5)
(25) I use statistical control to monitor my production processes	(1)	(2)	(3)	(4)	(5)
(26) I always incorporate quality factors in my product/service design	(1)	(2)	(3)	(4)	(5)
(27) I make sure that the integration of prevention and correction is always included in my daily business operations	(1)	(2)	(3)	(4)	(5)
Quality results					
(28) I can document the technical quality of my product/service as compared to other competitors	(1)	(2)	(3)	(4)	(5)
(29) If we implement a new business/operational procedure, we collect and monitor information to determine the extent to which it is better thatn the previous procedure	(1)	(2)	(3)	(4)	(5)
(30) We have information on which suppliers always deliver on time and always fill orders correctly	(1)	(2)	(3)	(4)	(5)
(31) I can document the financial performance of my business compared to other businesses in the same industry	(1)	(2)	(3)	(4)	(5)
Customer satisfaction					
(32) I collect data to monitor changes in my customer satisfaction	(1)	(2)	(3)	(4)	(5)
(33) I systematically ask a customer what they expect in my product/service	(1)	(2)	(3)	(4)	(5)
(34) I systematically ask my customers if they are satisfied with the product/service they purchased from me	(1)	(2)	(3)	(4)	(5)
(35) We record all customers' complaints	(1)	(2)	(3)	(4)	(5)
(36) I look for the cause when I lose a customer	(1)	(2)	(3)	(4)	(5)
(37) A customer is adequately satisfied if they continue to use my product/service	(1)	(2)	(3)	(4)	(5)
(38) I know what my customers expect from me	(1)	(2)	(3)	(4)	(5)
(39) I use customer complaints to improve my product/service	(1)	(2)	(3)	(4)	(5)
Business outcome comparative					
(40) The profitability of my business has increased in the past three years primarily due to our quality consciousness	(1)	(2)	(3)	(4)	(5)
(41) Owing to our quality improvement effort the revenue dollars from my business have increased in the past three years	(1)	(2)	(3)	(4)	(5)
(42) The number of customers in my business has increased in the last three years, primarily because our product/service quality has improved	(1)	(2)	(3)	(4)	(5)

Part III: information concerning the person who complete the questionnaire:

Name surname: . . . . . .

Position at the company: . . . . . .

How long have you been working at this company: . . . . . .

How long have you been working at the present position: . . . . . .

Education information (final degree attained): . . . . . .

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