CHAPTER V

DATA ANALYSIS

This chapter will identify the analysis of responses derived from two sets of self-administered questionnaires. The responses of the first set of questionnaire reflect relative weights or importance of quality criteria and subcriteria of the assessment models (as explained in chapter IV), which affect the achievement of successful quality management system. The responses of the second set of questionnaire represent scores received by ABC Electronic Ltd. against each quality subcriterion's requirements. The weights and scores are then synthesised together to yield an achievement value of each criterion's requirements for the company. Therefore, such criteria can be rated in order and then the strength and weaknesses of the company's quality system are recognised.

5.1 Data collection of the 1st questionnaire

5.1.1 Questionnaire development

The development of this set of questionnaire was based on two assessment models adapted from two international quality standards: ISO9000 and the Baldrige Award. It comprises three main parts: introduction, instruction and question. The introduction part provides a brief discussion on the objectives and benefits of this study; whereas, the instruction part gives how to answer the questionnaire. Finally, the question part deals with a number of closed questions as well as the definition of all related criteria and subcriteria (for the common understanding of all respondents). To see the complete questionnaire, look at Appendix 1.

To answer all these questions is to make pairwise comparisons between criteria or subcriteria in a hierarchical manner. The questions use 1 - 9 rating scale (as seen in Figure 5.1) according to the Analytical Hierarchy Process (AHP).

Figure 5.1 An example of the question

criteria	standard scale for pairwise comparison	criteria
A71	+9+8+7+6+5+4+3+2 1-2-3-4-5-6-7-8-9	A72
A71	+9+8+7+6+5+4+3+2 1-2-3-4-5-6-7-8-9	A73
A71	+9+8+7+6+5+4+3+2 1-2-3-4-5-6-7-8-9	A74
A72	+9+8+7+6+5+4+3+2 1-2-3-4-5-6-7-8-9	A73
A72	+9+8+7+6+5+4+3+2 1-2-3-4-5-6-7-8-9	A74
A73	+9+8+7+6+5+4+3+2 1-2-3-4-5-6-7-8-9	A74

5.1.2 Description of respondents and interview

The target respondents of this questionnaire should be good at **quality engineering** and simultaneously understand **Thai telecommunication industry** well. For this reason, the target group comprises five experts (whose brief information can be seen in Appendix 5). Two of them are academicians of the university whereas the other three come from the industrial sector.

The researcher interviewed the experts after the Delphi process. And, the questionnaires were established in Thai language (see English version in Appendix 1) for Thai experts. In the first round, the individual experts received the questionnaire separately. After they had already answered the questionnaires, the researcher collected them back, and then calculated the inconsistency ratios and summarise the results and comments. These feedbacks were then returned to the experts in the second round in order to improve the inconsistency ratios (until no more than 0.1 according to AHP) and recomment their own widely-diverse results. If they still insisted on their comments, they were obliged to give reasons.

As a result, for questions based on the assessment model of ISO 9000, three of five experts mostly had general agreements. On the other hand, most of the other two experts' comments were widely different from the group. Therefore, the former three

were chosen (;in other words, their comments would be utilised in the next analysis,) while the latter two were unchosen.

For questions based on the assessment model of the Baldrige Award, only three of five experts (not the same as the first three mentioned above) had most consensus. Again, three experts were chosen but two experts were unchosen.

5.2 Relative weights of criteria and subcriteria

5.2.1 Assessment model of ISO 9000

5.2.1.1 Relative importance of criteria under the achievement of successful quality management system

For unchosen experts, (as seen in Table 5.1) their comments are rather different from those of chosen experts. For example, the relative importance of "handling and delivery" criterion they give is relatively high as the relative importance of "design and development" criterion is the lowest. This is because they both believe Thai telecommunication companies do not often design the products and/or services on their own, and handling and delivery of telecommunication product cannot be easily controlled.

For the chosen experts, solely two of them have a consensus. However, all of them give "quality management," "vendor assurance," "production" and "problem identification and correction" criteria at the very first orders. In overall results (as seen in Table 5.2), quality management is ranked the highest. Production is ranked the second highest. Problem identification and correction is ranked the third, vendor assurance the fourth, design and development the fifth, quality documentation the sixth, and product definition the seventh Finally, handling and delivery is ranked the lowest.

Table 5.1 Relative importance of criteria under achievement of successful quality management system

criteria	chosen experts			unchosen experts	
	1	2	3	4	5
quality management (A1)	.345	.316	.333	.455	.328
production definition (A2)	.053	.049	.054	.061	.069
design and development (A3)	.069	.070	.093	.051	.058
quality documentation (A4)	.045	.034	.093	.068	.062
vendor assurance (A5)	.090	.126	.101	.075	.165
handling and delivery (A6)	.032	.028	.046	.095	.082
production (A7)	.213	.243	.101	.090	.174
problem identification and correction (A8)	.153	.135	.179	.105	.061
consistency ratio	.028	.098	.023	.059	.023
rank no. 1	A1	A1	A1	A1	A1
rank no. 2	A7	A7	A8	A8	A7
rank no. 3	A8	A8	A5,A7	A6	A5
rank no. 4	A5	A5	-	A7	A6
rank no. 5	A3	A3	A3,A4	A5	A2
rank no. 6	A2	A2	-	A4	A4
rank no. 7	A4	A4	A2	A2	A8
rank no. 8	A6	A6	A6	A3	A3

Table 5.2 Average relative importance of criteria under achievement of successful quality management system

criteria	average of three chosen experts
quality management (A1)	.331
product definition (A2)	.052
design and development (A3)	.077
quality documentation (A4)	.057
vendor assurance (A5)	.106
handling and delivery (A6)	.035
production (A7)	.186
problem identification and correction (A8)	.156
rank no. 1	A1
rank no. 2	A7
rank no. 3	A8
rank no. 4	A5
rank no. 5	A3
rank no. 6	A4
rank no. 7	A2
rank no. 8	A6

5.2.1.2 Relative importance of subcriteria under "quality management" criterion

In comparison between subcriteria under "quality management" criterion, expert no. 4's results are the most widely diverse from those of the others (as seen in Table 5.3). Only he gives the lowest relative importance to "quality system" subcriterion. It is meant in his viewpoint quality system is less important than management responsibility, internal audit and training.

Considering chosen experts' comments, there is a general agreement. As a result , "management responsibility" subcriterion is ranked the highest. "Quality system" subcriterion is ranked the second highest, "training" subcriterion the third and "internal quality audit" the lowest.

Table 5.3 Relative importance of subcriteria under "quality management" criterion

subcriteria	chosen experts			unchosen experts	
	1	2	3	4	5
management responsibility (A11)	.644	.598	.549	.629	.586
quality system (A12)	.199	.203	.284	.063	.205
internal quality audit (A13)	.065	.076	.079	.106	.107
training (A14)	.091	.123	.079	.202	.102
consistency ratio	.095	.025	.003	.007	.002
rank no. 1	A11	A11	A11	A11	A11
rank no. 2	A12	A12	A12	A14	A12
rank no. 3	A14	A14	A14	A13	A13
rank no. 4	A13	A13	A13	A12	A14

Table 5.4 Average relative importance of subcriteria under "quality management" criterion

criteria	average of three chosen experts
management responsibility (A11)	.597
quality system (A12)	.229
internal quality audit (A13)	.073
training (A14)	.101
rank no. 1	A11
rank no. 2	A12
rank no. 3	A14
rank no. 4	A13

5.2.1.3 Relative importance of subcriteria under "product definition" criterion

In comparison between subcriteria under "product definition" criterion (as seen in Table 5.5), two out of three chosen experts have a consensus. According to their results, "contract review" subcriterion is ranked higher than "design input" subcriterion. On the other hand, the other expert gives the same importance to these two subcriteria. Nevertheless, in overall looking (as seen in Table 5.6), contract review is more important than design input.

Table 5.5 Relative importance of subcriteria under "product definition" criterion

subcriteria	chosen experts			unchosen experts	
	1	2	3	4	5
contract review (A21)	.857	.500	.667	.333	.750
design input (A22)	.143	.500	.333	.667	.250
consistency ratio	-	-	-	-	-
rank no. 1	A21	A21 , A22	A21	A22	A21
rank no. 2	A22	-	A22	A21	A22

Table 5.6 Average relative importance of subcriteria under "product definition" criterion

subcriteria	average of three chosen experts
contract review (A21)	.675
design input (A22)	.325
rank no. 1	A21
rank no. 2	A22

5.2.1.4 Relative importance of subcriteria under "design and development" criterion

In comparison between subcriteria under "design and development" criterion (as seen in Table 5.7), expert no. 4 provides very widely diverse comments from the others. For example, he gives "design changes" subcriterion at the highest order ;whereas, the others at relatively low order. He believes that design changes can lead to so high costs and time-consuming tasks. Conversely, the others' belief is that design control, and design and development planning outweigh design changes.

For the chosen experts' comments, there is no general agreement. However, all three experts give "design control" and "design and development planning" subcriteria at the highest and second highest rank, respectively. In overall looking (as seen in Table 5.8), "design control" subcriterion is ranked the highest. "Design and development planning" subcriterion is ranked the second highest, "design verification" subcriterion the third highest and "design changes" subcriterion the fourth highest. Finally, "design output" is ranked the lowest.

Table 5.7 Relative importance of subcriteria under "design and development" criterion

subcriteria	chosen experts			unchosen experts	
	1	2	3	4	5
design control (A31)	.557	.386	.503	.334	.463
design and development planning (A32)	.164	.202	.203	.046	.217
design output (A33)	.126	.104	.062	.085	.126
design verification (A34)	.099	.154	.116	.071	.100
design changes (A35)	.054	.154	.116	.464	.095
consistency ratio	.058	.081	.004	.097	.025
rank no. 1	A31	A31	A31	A35	A31
rank no. 2	A32	A32	A32	A31	A32
rank no. 3	A33	A34 , A35	A34 , A35	A33	A33
rank no. 4	A34	-	-	A34	A34
rank no. 5	A35	A33	A33	A32	A35

Table 5.8 Average relative importance of subcriteria under "design and development" criterion

subcriteria	average of three chosen experts
design control (A31)	.483
design and development planning (A32)	.189
design output (A33)	.097
design verification (A34)	.123
design changes (A35)	.108
rank no. 1	A31
rank no. 2	A32
rank no. 3	A34
rank no. 4	A35
rank no. 5	A33

5.2.1.5 Relative importance of subcriteria under "quality documentation" criterion

In comparison between subcriteria under "quality documentation" criterion, two out of three chosen experts have a consensus (as seen in Table 5.9). According to them, "document control" subcriterion is more important than "quality records" one. In contrast, the other gives the same importance to those two subcriteria. However, average comment (as seen in Table 5.10) shows that "document control" subcriterion is much higher in rank than "quality records" one.

Table 5.9 Relative importance of subcriteria under "quality documentation" criterion

subcriteria	chosen experts			unchosen experts	
	1	2	3	4	5
document control (A41)	.857	.500	.667	.833	.750
quality records (A42)	.143	.500	.333	.167	.250
consistency ratio	-	-	-	-	-
rank no. 1	A41	A41 , A42	A41	A41	A41
rank no. 2	A42	-	A42	A42	A42

Table 5.10 Average relative importance of subcriteria under "quality documentation" criterion

subcriteria	average of three chosen experts
document control (A41)	.675
quality records (A42)	.325
rank no. 1	A41
rank no. 2	A42

5.2.1.6 Relative importance of subcriteria under "vendor assurance" criterion

In comparison between subcriteria under "vendor assurance" criterion, two out of three chosen experts have a consensus (as seen in Table 5.11). According to them, "purchasing" subcriterion is ranked the highest, "receiving inspection and testing" subcriterion the second highest, and "customer-supplied products" subcriterion the lowest. The other gives "purchasing" subcriterion at the highest rank, too, but the other two subcriteria have similar importance. In overall looking (as seen in Table 5.12), the two former experts' comments dominate the other's.

Table 5.11 Relative importance of subcriteria under "vendor assurance" criterion

subcriteria	chosen experts			unchosen experts	
	1	2	3	4	5
purchasing (A51)	.767	.623	.600	.615	.539
customer - supplied products (A52)	.090	.137	.200	.308	.164
receiving inspection and testing (A53)	.143	.239	.200	.077	.297
consistency ratio	.048	.016	.000	.000	.008
rank no. 1	A51	A51	A51	A51	A51
rank no. 2	A53	A53	A52 , A53	A52	A53
rank no. 3	A52	A52	-	A53	A52

Table 5.12 Average relative importance of subcriteria under " vendor assurance " criterion

subcriteria	average of three chosen experts
purchasing (A51)	.663
customer - supplied products (A52)	.142
receiving inspection and testing (A53)	.195
rank no. 1	A51
rank no. 2	A53
rank no. 3	A52

5.2.1.7 Relative importance of subcriteria under "handling and delivery" criterion

In comparison between subcriteria under "handling and delivery" criterion, (as seen in Table 5.13) two out of five experts differ in comments from the others. Expert

no. 4 gives the highest importance to "product identification and traceability" subcriterion and expert no. 5 gives the highest importance to "handling, storage, packaging and delivery" subcriterion. On the other hand, the others consider in the same way that "inspection and test status" subcriterion is of most critical importance. This is because in Thai telecommunication industry the customers are usually interested in inspection and test status rather than whether products can be traceable or how well products can be handled and stored.

There is a consensus among three chosen experts. They all believe that "inspection and test status" subcriterion should be ranked the highest, "handling, storage, packaging and delivery" the second highest and "product identification and traceability" the lowest.

Table 5.13 Relative importance of subcriteria under "handling and delivery" criterion

subcriteria	chosen experts			unchosen experts	
	1	2	3	4	5
product identification and traceability (A61)	.198	.159	.170	.775	.243
inspection and test status (A62)	.490	.589	.443	.105	.088
handling , storage , packaging and delivery (A63)	.312	.252	.387	.118	.669
consistency ratio	.046	.046	.016	.009	.006
rank no. 1	A62	A62	A62	A61	A63
rank no. 2	A63	A63	A63	A63	A61
rank no. 3	A61	A61	A61	A62	A62

Table 5.14 Average relative importance of subcriteria under "handling and delivery" criterion

subcriteria	average of three chosen experts
product identification and traceability (A61)	.176
inspection and test status (A62)	.507
handling , storage , packaging and delivery (A63)	.317
rank no. 1	A62
rank no. 2	A63
rank no. 3	A61

5.2.1.8 Relative importance of subcriteria under "production" criterion

In comparison between subcriteria under "production" criterion, expert no.5's comments are slightly different from the others' comments (as seen in Table 5.15). He determines "inspection and test" is of most critical importance; whereas, most of them comment "process control" is the most crucial. Most experts believe that if the process is controlled well, the output will be good; consequently, inspection and test may be not necessary.

Two out of three chosen experts have a consensus. For their comments, "process control" subcriterion is ranked the highest. "Inspection, measuring and test equipment" subcriterion is ranked the second highest, "inspection and test" subcriterion the third highest and "statistical techniques" subcriterion the lowest. One out of three chosen experts comments "process control" and "inspection, measuring and test equipment" subcriterion simultaneously are ranked the highest. "Inspection and test" is ranked the

second highest and "statistical techniques" is ranked the lowest. But, average comments are similar to those of the two former experts (as seen in Table 5.16).

Table 5.15 Relative importance of subcriteria under "production" criterion

subcriteria	chosen experts			unchosen experts	
	1	2	3	4	5
process control (A71)	.563	.412	.405	.672	.222
inspection and test (A72)	.103	.141	.130	.165	.592
inspection , measuring and test equipment (A73)	.261	.314	.405	.096	.131
statistical techniques (A74)	.073	.133	.060	.067	.055
consistency ratio	.024	.017	.001	.063	.012
rank no. 1	A71	A71	A71 , A73	A71	A72
rank no. 2	A73	A73	-	A72	A71
rank no. 3	A72	A72	A72	A73	A73
rank no. 4	A74	A74	A74	A74	A74

Table 5.16 Average relative importance of subcriteria under "production" criterion

subcriteria	average of three chosen experts
process control (A71)	.460
inspection and test (A72)	.125
inspection , measuring and test equipment (A73)	.327
statistical techniques (A74)	.088
rank no. 1	A71
rank no. 2	A73
rank no. 3	A72
rank no. 4	A74

5.2.1.9 Relative importance of subcriteria under "problem identification and correction" criterion

In comparison between subcriteria under "problem identification and correction" criterion, (as seen in Table 5.17) two out of five experts comment "control of nonconforming product" subcriterion should be ranked the highest. In contrast, three out of five comment "corrective action" subcriterion should be ranked the highest. This may be because most experts believe we should solve any problem before accepting nonconformity.

Considering three chosen experts' comments, clearly there is no general agreement. However, they all give the highest importance to "corrective action" subcriterion. In overall looking, "corrective action" is much higher in rank than "servicing" and "servicing" is slightly higher in rank than "control of nonconforming product" (as seen in Table 5.18).

Table 5.17 Relative importance of subcriteria under "problem identification and correction"

subcriteria	chosen experts			unchosen experts	
	1	2	3	4	5
control of nonconforming product (A81)	.164	.143	.358	.692	.549
corrective action (A82)	.539	.429	.587	.077	.211
servicing (A83)	.297	.429	.055	.231	.241
consistency ratio	.008	.000	.032	.000	.016
rank no. 1	A82	A82 , A83	A82	A81	A81
rank no. 2	A83	-	A81	A83	A83
rank no. 3	A81	A81	A83	A82	A82

Table 5.18 Average relative importance of subcriteria under "problem identification and correction" criterion

subcriteria	average of three chosen experts
control of nonconforming product (A81)	.222
corrective action (A82)	.518
servicing (A83)	.260
rank no. 1	A82
rank no. 2	A83
rank no. 3	A81

5.2.2 Assessment model of the Baldrige Award

5.2.2.1 Relative importance of criteria under the achievement of successful quality management system

In comparison between criteria under the achievement of successful quality management system, two out of five experts differ in comments from the other three (as seen in Table 5.19). For instance, the two experts give "customer focus and satisfaction" criterion at a very high rank. On the other hand, the others give it at a very low rank.

In Thai telecommunication industry, product market is still semi-open under a government control. Thus, customers have too few choices. In Thailand, customer satisfaction is sometimes not the focus. That is why most experts here comment "customer focus and satisfaction" criterion is not so important as the same-level criteria.

Two out of three chosen experts have a consensus. Only one chosen expert slightly differs in comments from them. Therefore, average comments are that "senior executive leadership" criterion is ranked the highest, "management of process" criterion

the second highest and "quality and operational results" criterion the third. "Information and analysis" and "strategic quality planning" criteria both are ranked the fourth highest. Finally, "customer focus and satisfaction" criterion is ranked the second lowest; whereas, "human resource development and management" criterion is ranked the lowest.

Table 5.19 Relative importance of criteria under achievement of successful quality management system

criteria	chosen experts			unchosen experts	
	A	B	C	D	E
senior executive leadership (B1)	.372	.428	.328	.070	.238
information and analysis (B2)	.097	.069	.097	.091	.027
strategic quality planning (B3)	.064	.082	.117	.128	.056
human resource development and management (B4)	.051	.037	.091	.209	.122
management of process quality (B5)	.184	.216	.137	.138	.082
quality and operational results (A6)	.176	.111	.135	.176	.238
customer focus and satisfaction (B7)	.054	.056	.096	.188	.238
consistency ratio	.010	.064	.070	.097	.004
rank no. 1	B1	B1	B1	B4	B1 , B6 , B7
rank no. 2	B5	B5	B5	B7	-
rank no. 3	B6	B6	B6	B6	-
rank no. 4	B2	B3	B3	B5	B4
rank no. 5	B3	B2	B2	B3	B5
rank no. 6	B7	B7	B7	B2	B3
rank no. 7	B4	B4	B4	B1	B2

Table 5.20 Average relative importance of criteria under achievement of successful quality management system

criteria	average of three chosen experts
senior executive leadership (B1)	.376
information and analysis (B2)	.088
strategic quality planning (B3)	.088
human resource development and management (B4)	.059
management of process quality (B5)	.179
quality and operational results (A6)	.141
customer focus and satisfaction (B7)	.069
rank no. 1	B1
rank no. 2	B5
rank no. 3	B6
rank no. 4	B2 , B3
rank no. 5	-
rank no. 6	B7
rank no. 7	B4

5.2.2.2 Relative importance of subcriteria under "senior executive leadership" criterion

In comparison between subcriteria under "senior executive leadership" criterion, all experts have a consensus (as seen in Table 5.21). According to their comments, "senior executive leadership" subcriterion is ranked the highest, "management for quality" subcriterion the second highest and "public responsibility" the lowest.

Table 5.21 Relative importance of subcriteria under "senior executive leadership" criterion

subcriteria	chosen experts			unchosen experts	
	A	B	C	D	E
senior executive leadership (B11)	.753	.754	.623	.589	.600
management for quality (B12)	.172	.054	.239	.252	.300
public responsibility (B13)	.075	.092	.137	.159	.100
consistency ratio	.065	.029	.016	.046	.000
rank no. 1	B11	B11	B11	B11	B11
rank no. 2	B12	B12	B12	B12	B12
rank no. 3	B13	B13	B13	B13	B13

Table 5.22 Average relative importance of subcriteria under "senior executive leadership" criterion

subcriteria	average of three chosen experts
senior executive leadership (B11)	.710
management for quality (B12)	.188
public responsibility (B13)	.101
rank no. 1	B11
rank no. 2	B12
rank no. 3	B13

5.2.2.3 Relative importance of subcriteria under "information and analysis" criterion

In comparison between subcriteria under "information and analysis" criterion, expert D's comments are the most widely diverse from the group (as seen in Table 5.23). He gives "competitive comparisons and benchmarks" subcriterion the most weight; whereas, the others give "scope and management of quality and performance data and information" subcriterion the most weight. His belief is that we should first consider the external factors (such as competitors' data) and then improve ourselves (such as management of our data and information) later.

Considering three chosen experts' comments, there is a general agreement. "Scope and management of quality and performance data and information" is ranked the highest, "analysis and uses of company-level data" subcriterion the second highest and "competitive comparisons and and benchmarks" subcriterion the lowest.

Table 5.23 Relative importance of subcriteria under "information and analysis" criterion

subcriteria	chosen experts			unchosen experts	
	A	B	C	D	E
scope and management of quality and performance data and information (B21)	.633	.722	.539	.200	.400
competitive comparisons and benchmarks (B22)	.175	.103	.164	.400	.200
analysis and uses of company-level data (B23)	.192	.174	.297	.400	.400
consistency ratio	.008	.026	.008	.000	.000
rank no. 1	B21	B21	B21	B22 , B23	B21 , B23
rank no. 2	B23	B23	B23	-	-
rank no. 3	B22	B22	B22	B21	B22

Table 5.24 Average relative importance of subcriteria under "information and analysis" criterion

subcriteria	average of three chosen experts
scope and management of quality and performance data and information (B21)	.631
competitive comparisons and benchmarks (B22)	.147
analysis and uses of company - level data (B33)	.222
rank no. 1	B21
rank no. 2	B23
rank no. 3	B22

5.2.2.4 Relative importance of subcriteria under "strategic quality planning" criterion

In comparison between subcriteria under "strategic quality planning" criterion, all chosen experts comment "strategic quality and company performance planning process" subcriterion should be much higher in rank than "quality and performance plans" subcriterion (as seen in Table 5.25 and 5.26).

Table 5.25 Relative importance of subcriteria under "strategic quality planning" criterion

subcriteria	chosen experts			unchosen experts	
	A	B	C	D	E
strategic quality and company performance planning process (B31)	.800	.875	.667	.750	.500
quality and performance plans (B32)	.200	.125	.333	.250	.500
consistency ratio	-	-	-	-	-
rank no. 1	B31	B31	B31	B31	B31 , B32
rank no. 2	B32	B32	B32	B32	-

Table 5.26 Average relative importance of subcriteria under "strategic quality planning" criterion

subcriteria	average of three chosen experts
strategic quality and company performance planning process (B31)	.781
quality and performance plans (B32)	.219
rank no. 1	B31
rank no. 2	B32

5.2.2.5 Relative importance of subcriterion under "human resource development and management" criterion

In comparison between subcriteria under "human resource development and management" criterion, solely three out of five experts are mostly agreeable (as seen in Table 5.27). They commonly comment "human resource management," "employee education and training" and "employee performance and recognition" subcriterion hold the highest, second highest and third highest rank, respectively. In an overall summary (as seen in Table 5.28), the first three ranks are the same as explained before. And, "employee well-being and morale" and "employee involvement" subcriterion are ranked the fourth highest and lowest, respectively.

Table 5.27 Relative importance of subcriteria under "human resource development and management" criterion

subcriteria	chosen experts			unchosen experts	
	A	B	C	D	E
human resource management (B41)	.560	.500	.343	.430	.292
employee involvement (B42)	.062	.062	.104	.113	.225
employee education and training (B43)	.168	.215	.230	.155	.146
employee performance and education (B44)	.105	.132	.182	.081	.168
employee well - being and morale(B45)	.105	.090	.141	.221	.168
consistency ratio	.013	.019	.022	.022	.017
rank no. 1	B41	B41	B41	B41	B41
rank no. 2	B43	B43	B43	B45	B42
rank no. 3	B44,B45	B44	B44	B43	B43 , B45
rank no. 4	-	B45	B45	B42	-
rank no. 5	B42	B42	B42	B44	B44

Table 5.28 Average relative importance of subcriteria under "human resource development and management" criterion

subcriteria	average of three chosen experts
human resource management (B41)	.468
employee involvement (B42)	.076
employee education and training (B43)	.204
employee performance and recognition (B44)	.140
employee well - being and morale (B45)	.112
rank no. 1	B41
rank no. 2	B43
rank no. 3	B44
rank no. 4	B45
rank no. 5	B42

5.2.2.6 Relative importance of subcriteria under "management of process quality" criterion

In comparison between subcriteria under "management of process quality" criterion, two out of five experts differ in comments from the group (as seen in Table 5.29). For example, expert D is the only person giving little importance to "business process and support services" subcriterion, since he determines business process and support services to be just support processes, not product realisation processes (such as design and production process).

However, three chosen experts' comments are slightly different. Expert A comments "design and introduction of quality products and services" subcriterion should be ranked the highest. Expert B comments "process management or process quality

control" subcriterion should be ranked the highest, for instance. However, average comments represent "process management or process quality control," "design and introduction of quality products and services," "business process and support services," "supplier quality" and "quality assessment" are ranked the highest, the second, the third, the fourth and the lowest, respectively (as seen in Table 5.30).

Table 5.29 Relative importance of subcriteria under "management of process quality" criterion

subcriteria	chosen experts			unchosen experts	
	A	B	C	D	E
design and introduction of quality products and services (B51)	.532	.230	.294	.416	.298
process management or process quality control (B52)	.194	.586	.294	.264	.158
business process and support services (B53)	.140	.080	.123	.067	.158
supplier quality (B54)	.071	.060	.180	.136	.089
quality assessment (B55)	.063	.044	.109	.117	.298
consistency ratio	.059	.041	.037	.033	.003
rank no. 1	B51	B52	B51 , B52	B51	B51 , B55
rank no. 2	B52	B51	-	B52	-
rank no. 3	B53	B53	B54	B54	B52 , B53
rank no. 4	B54	B54	B53	B55	-
rank no. 5	B55	B55	B55	B53	B54

Table 5.30 Average relative importance of subcriteria under "management of process quality" criterion

subcriteria	average of three chosen experts
design and introduction of quality products and services (B51)	.352
process management or process quality control (B52)	.358
business process and support services (B53)	.114
supplier quality (B54)	.104
quality assessment (B55)	.072
rank no. 1	B52
rank no. 2	B51
rank no. 3	B53
rank no. 4	B54
rank no. 5	B55

5.2.2.7 Relative importance of subcriteria under "quality and operational results" criterion

In comparison between subcriteria under "quality and operational results" criterion, expert E differs greatly in comments from the others (as seen in Table 5.31). For him, "product and service quality results" subcriterion is ranked quite low; whereas, for the others, it is ranked the highest. This is because he believes that if process quality is achieved, quality of products and services will be achieved, too.

Clearly, three chosen experts have a consensus. "product and service quality results," "company operational results," "supplier quality results" and "business process and support service results" subcriteria are ranked the highest, the second, the third and the lowest, respectively.

Table 5.31 Relative importance of subcriteria under "quality and operational results" criterion

subcriteria	chosen experts			unchosen experts	
	A	B	C	D	E
product and service quality results (B61)	.593	.540	.466	.406	.200
company operational results (B62)	.228	.278	.161	.240	.329
business process and support service results (B63)	.072	.062	.096	.177	.329
supplier quality results (B64)	.107	.120	.277	.177	.142
consistency ratio	.098	.038	.011	.057	.023
rank no. 1	B61	B61	B61	B61	B62 , B63
rank no. 2	B62	B62	B62	B62	-
rank no. 3	B64	B64	B64	B63 , B64	B61
rank no. 4	B63	B63	B63	-	B64

Table 5.32 Average relative importance of subcriteria under "quality and operational results" criterion

subcriteria	average of three chosen experts
product and service quality results (B61)	.533
company operational results (B62)	.222
business process and support service results (B63)	.077
supplier quality results (B64)	.168
rank no. 1	B61
rank no. 2	B62
rank no. 3	B64
rank no. 4	B63

5.2.2.8 Relative importance of subcriteria under "customer focus and satisfaction" criterion

In comparison between subcriteria under "customer focus and satisfaction" criterion, expert D's comments are widely diverse (as seen in Table 5.33). For example, he comments "future requirements and expectations of customers" subcriterion to be ranked quite high; whereas, the other experts's comments are opposite to his. In his sense, the more future customer requirements are recognised, the longer customer loyalty is kept.

Only two out of three chosen have a consensus but the other's comments are slightly different. However, in overall looking (as seen in Table 5.34), "customer relationship management," "customer satisfaction determination," "customer satisfaction results," "customer satisfaction comparison" and "future requirements and expectations of customers" subcriterion are ranked the highest, the second, the third, the fourth and the lowest.

Table 5.33 Relative importance of subcriteria under "customer focus and satisfaction" criterion

subcriteria	chosen experts			unchosen experts	
	A	B	C	D	E
customer relationship management (B71)	.606	.430	.172	.306	.135
customer satisfaction determination (B72)	.146	.290	.602	.192	.489
customer satisfaction results (B73)	.109	.131	.111	.155	.190
customer satisfaction comparison (B74)	.080	.086	.058	.155	.093
future requirements and expectations of customers (B75)	.060	.062	.057	.192	.093
consistency ratio	.042	.021	.023	.044	.034
rank no. 1	B71	B71	B72	B71	B72
rank no. 2	B72	B72	B71	B72 , B75	B71
rank no. 3	B73	B73	B73	-	B73
rank no. 4	B74	B74	B74	B73 , B74	B74 , B75
rank no. 5	B75	B75	B75	-	-

Table 5.34 Average relative importance of subcriteria under "customer focus and satisfaction" criterion

subcriteria	average of three chosen experts
customer relationship management (B71)	.403
customer satisfaction determinatior (B72)	.346
customer satisfaction results (B73)	.117
customer satisfaction comparisons (B74)	.075
future requirements and expecta - tions of customers (B75)	.059
rank no. 1	B71
rank no. 2	B72
rank no. 3	B73
rank no. 4	B74
rank no. 5	B75

5.3 Data collection of the 2nd questionnaire

5.3.1 Questionnaire development

Again, this set of questionnaire (as seen in Appendix 2) is developed depending upon the assessment model of ISO 9000 and the Baldrige Award. It is composed of three main parts: introduction, instruction and question part. The first part mainly deals with the objectives of this study and the questionnaire. The second part identifies how to answer all questions in the questionnaire. And, a series of the closed questions are contained in the final part.

The respondents have to answer yes-no statement and circle around a number as below:

1 represents the worst level

3 represents the medium level

5 represents the best level

2 represents the level between level 1 and 3

4 represents the level between level 3 and 5

These levels mean the achievement levels of each subcriterion for the selected company.

5.3.2 Sample

As identified in the first paragraph of this chapter, this set of questionnaire is aimed to self-assessing the score of individual subcriteria for the surveyed company. Thus, population of the questionnaire should be at least middle management or even senior supervisors since they have known well which level of each subcriterion's requirements their day-to-day operations can achieve.

The number of senior supervisors, managers and executive management at ABC Electronic Ltd. are estimated to be 200 in total. But, 40 out of 200 persons were randomly selected to answer the questionnaires. However, the number of respondents are just 21 (or about 10% of total population) because of the limitation of timescale and financial constraint. Table 5.35 shows the sample classified by individual departments of the company.

Table 5.35 The sample classification by department of ABC Electronic Ltd.

Department	Number of sample
Finance and Administration Office	5
Human Resource Office	1
Marketing Communication Office	5
Corporate Development Office	1
Network Implementation Division	2
Business Networks Division	1
Logistic Department	1
Defense System Division	1
Manufacturing Division	1
System Services Division	1
Telecom Systems Division	1
Mobile Phones Division	1
Total	21

Next, since the respondents were obliged to answer the questions only applicable or relevant to their operations, it is meant all 21 respondents (whose brief information is contained in Appendix 6) did not answer all questions available. Table 5.36 and Table 5.37 demonstrate various number of respondents answering different questions.

Table 5.36 Various number of respondents answering different questions for assessment model of ISO 9000

Questions for		Number of respondents
Criterion	Subcriterion	
A1	A11	21
	A12	21
	A13	19
	A14	21
A2	A21	17
	A22	18
A3	A31	18
	A32	17
	A33	18
	A34	18
	A35	18
A4	A41	21
	A42	20
A5	A51	21
	A52	18
	A53	7
A6	A61	13
	A62	12
	A63	12
A7	A71	13
	A72	13
	A73	15
	A74	16
A8	A81	20
	A82	18
	A83	20

Table 5.37 Various number of respondents answering different questions for assessment model of the Baldrige Award

Questions for		Number of respondents
Criterion	Subcriterion	
B1	B11	19
	B12	20
	B13	21
B2	B21	21
	B22	21
	B23	20
B3	B31	21
	B32	21
B4	B41	20
	B42	21
	B43	21
	B44	21
	B45	21
B5	B51	18
	B52	15
	B53	17
	B54	17
	B55	17
B6	B61	19
	B62	19
	B63	17
	B64	17
B7	B71	20
	B72	20
	B73	20
	B74	20
	B75	19

5.4 Score of individual subcriteria for ABC Electronic Ltd. and synthesised results

Score of individual subcriteria were calculated by averaging all individual scores given by the corresponding respondents under those subcriteria. Then, with the use of the formula explained in section 3.5.1 (the simple weight ranking method), the weight of each criterion and subcriterion, and score of each subcriterion were synthesised together to become the value of each criterion and achievement value of each criterion, respectively.

5.4.1 Assessment model of ISO 9000

From Table 5.38, it can be seen that **quality management** A1 has the highest value (= 1.25) relative to the other criteria. Subcriteria under this criterion which gain high values include **management responsibility** A11 (= .597 × 3.733 = 2.229) and **training** A14 (= .101 × 4.133 = .417). The ABC Electronic managers are responsible for leading the way and motivating their employees to achieve significant breakthroughs and continuous improvements. ABC Electronic Ltd. utilises competence development as a beginning part of the strategic planning procedure. As well as providing an in-house training, it develops its employees' competence by actively cooperating with the leading research institutions and educational institutions. Besides, it puts much effort on implementing TQM (total quality management) of which aim is to achieve total customer satisfaction through continuous improvement.

Production A7, and **problem identification and correction** A8 gain relatively high values (=.755 and .571, respectively). For production, **process control** A71, and **inspection, measuring and testing equipment** A73 subcriteria have received high values (= .663 × 3.375 = 2.238 and = .460 × 3.997 = 1.839, respectively). ABC Electronic Ltd. usually plans, controls and monitors its processes with the use of balance of the following three management approaches:

1. Management by policy: top-down approach.
2. Process management: for large cross-functional processes.
3. Day-to-day improvements: at all levels of organisational structure.

ABC Electronic Ltd. makes the process improvements with the use of so-called PDCA (plan-do-check-act) principle as seen in Figure 5.2. It does not often use inspection and test equipment unless they are actually economical. However, it simultaneously improves the efficiency and effectiveness of the inspection process as well. This can be seen from a large number of projects concerning lead time reduction of inspection and testing procedures for telecommunication systems and services at ABC Electronic Ltd..

For problem identification and correction, **corrective action** A82 (= .518 × 3.777 = 1.956) subcriterion gains high value (= .518 × 3.777 = 1.956). ABC Electronic Ltd. usually takes not only corrective action, but also preventive action since its belief is that to prevent the problem is better than to correct the problem.

Vendor assurance A5 has not so high value (= .373). **Purchasing** A51 subcriterion under this criterion has got the highest value (= .663 × 3.375 = 2.238). ABC Electronic Ltd. has quite stringent procedures for ensuring whether incoming products conform to the specified requirements. Such procedures involve assessing vendors, monitoring vendors and verification of receiving products. However, the receiving department is sometimes necessary to release the purchased products though they are not inspected because of time limitations. This could result in some nonconformities later in the process.

Design and development A3, and **quality documentation** A4 criterion gain relatively low values (= .297 and .220, respectively). ABC Electronic Ltd. usually receives most of product designs from the mother company. Moreover, it has utilised the following two strategies concerning on design and development:

1. Adapting know-how developed in ABC Electronic Ltd.'s international labs to local conditions.

2. Extensive transfer of technologies.

Nonetheless, it has already overcome at some stages of product design and development problems. Some products such as some network systems and services have been designed by itself.

For quality documentation, just a few divisions in the company such as finance and administration office, and network engineering division possess the experienced document writers and sufficient supporting documents.

Product definition A2, and **handling and delivery** A6 criteria have the lowest values compared to the others. Again, the existing products mostly are not designed by ABC Electronic Ltd.. In these cases, to define the products may be not needed.

ABC Electronic Ltd. has already had procedures for handling, storage, packaging, preservation and delivery to ensure the conformity of incoming materials, work-in-progress and finished products. However, in practice, as the products are to be delivered to customers, it is the most forgotten issue. For example, procedures for handling of the products during transportation or when loading out of trucks could be ignored.

Figure 5.2 The PDCA principle (adapted from quality manual of the selected company)

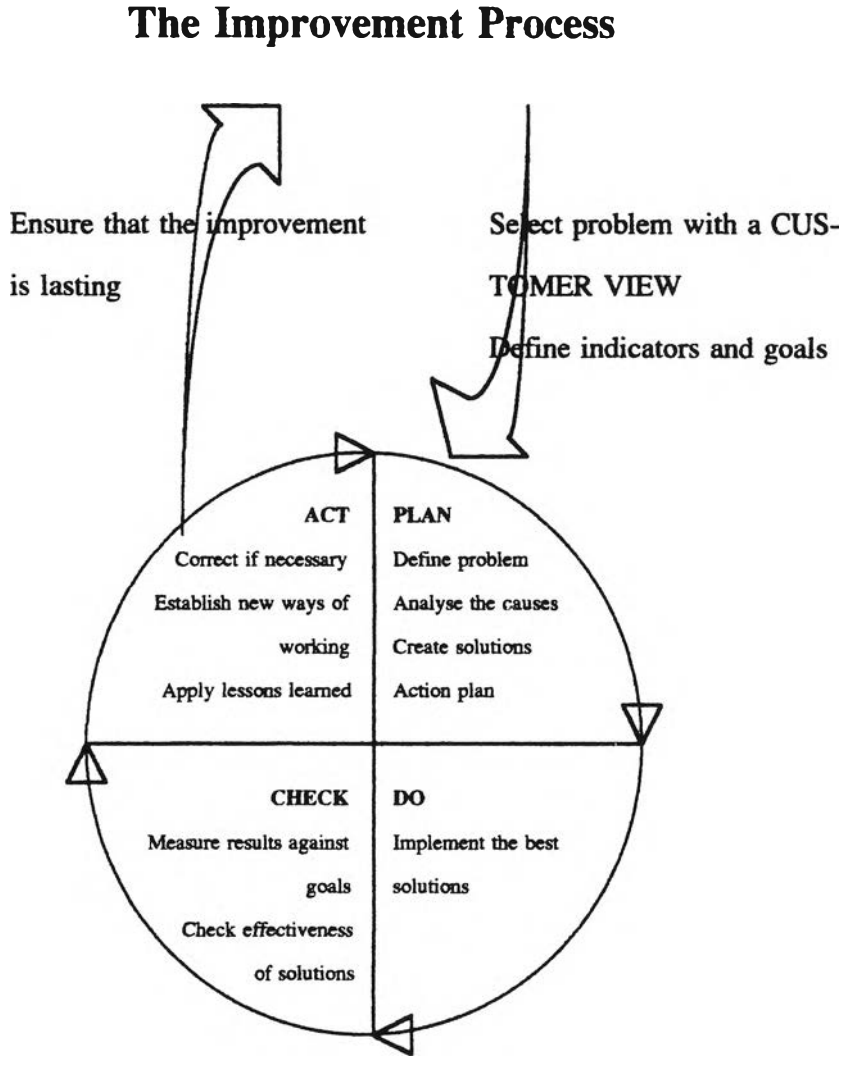

Table 5.38 Score of individual subcriteria and synthesised results

criteria (weight)	subcriteria (weight)	score of each subcriterion	value of each criterion	achievement value of each criterion (rank)
A1 (.331)	A11 (.597)	3.733	3.792	1.255 (1)
	A12 (.229)	3.789		
	A13 (.073)	3.816		
	A14 (.101)	4.133		
A2 (.052)	A21 (.675)	3.835	4.051	.135 (7)
	A22 (.325)	4.500		
A3 (.077)	A31 (.483)	3.830	3.856	.297 (5)
	A32 (.189)	4.000		
	A33 (.097)	4.000		
	A34 (.123)	3.500		
	A35 (.108)	4.000		
A4 (.057)	A41 (.675)	3.887	3.865	.220 (6)
	A42 (.325)	3.820		

Table 5.38 (Next)

criteria (weight)	subcriteria (weight)	score of each subcriterion	value of each criterion	achievement value of each criterion (rank)
A5 (.106)	A51 (.663)	3.375	3.519	.373 (4)
	A52 (.142)	4.167		
	A53 (.195)	3.532		
A6 (.035)	A61 (.176)	3.423	3.478	.122 (8)
	A62 (.507)	3.458		
	A63 (.317)	3.542		
A7 (.186)	A71 (.460)	3.997	4.062	.755 (2)
	A72 (.125)	4.030		
	A73 (.327)	4.204		
	A74 (.088)	-		
A8 (.156)	A81 (.222)	3.567	3.661	.571 (3)
	A82 (.518)	3.777		
	A83 (.260)	3.509		

Note "-" in parentheses does not mean "0" level. So, be careful in calculation (total weight of subcriteria under corresponding criterion not equal to 1). For example, "-" here means **statistical techniques** subcriterion is not applicable to ABC Electronic Ltd.. Total weight of the same-level subcriteria is .912 (.460 + .125 + .327) (excluding the weight of statistical techniques).

5.4.2 Assessment model of the Baldrige Award

From Table 5.39 **senior executive leadership** B1 criterion has the highest value (= 1.379) compared to the other criteria. Under this criterion, **senior executive leadership** subcriterion has the highest value (= .710 × 3.684 = 2.616) compared to the same-level subcriteria. ABC Electronic Ltd.'s executive management regularly reviews, at least once a year, its quality system to ensure that the system is suitable and effective. The reviews principally focus on negative deviations related to results, such as customer complaints, customer satisfaction measurements, competitor analysis and so on. Excluding the reviews, senior executives could play a "sponsor" role at the toll-gate decision phase for any project.

Management of process quality B5, and **quality and operational results** B6 criteria gain relatively high values (= .654 and .495 , respectively). As explained in section 5.4.1, ABC Electronic Ltd. is quite good at process management. For quality and operational results, it defines the performance indicators from a number of measurements of operational performance. Such indicators deal with not only internal efficiency, but also external one such as customer satisfaction data.

Information and analysis B2, and **strategic quality planning** B3 criteria have relatively low values (= .308 and . 309). Both information and analysis, and strategic quality planning have become more and more important for a company to gain more competitive advantages in this highly changing world. Many world-class companies established information and technology (IT) department in their organisational structures. For ABC Electronic Ltd., on the other hand, IT is only part of the finance and administration department's jobs. This department comprises just 79 employees which have to be responsible for four critical tasks: finance, accounting, information technology/information system (IT/IS) and office administration. Some issues about information and analysis may be neglected.

At company level, ABC Electronic Ltd. attempts to maintain a strategic plan for developing business to meet the demands of the market-place. An improvement plan is usually developed annually based on the strategic plan and on evaluations of the needs of the operation and the market. However, in many divisions, some of their sections have no plan.

Human resource management and development B4, and **customer focus and satisfaction** B7 criteria have the lowest values compared to the other criteria. ABC Electronic Ltd. generally gives much weight to human resource aspects. It adheres to the principle of equal employment opportunities, with respect for the individual and without any form of discrimination with regard to race, sex, colour, religion, political opinion, nationality, union membership or social background. Nevertheless, in terms of employee workload, problems have still not actually been solved especially in the divisions or departments comprising too few persons (such as corporate marketing office, corporate development office and telecom systems division). Their workload has become terribly peak as ABC Electronic Ltd. has been studied by the researcher due to ISO 9001 and reorganisation implementation. Some people have to write much more documents, for instance. Conversely, other people may have to change their offices.

Under customer focus and satisfaction, **customer satisfaction comparison** B74 gains quite low value (= .117 × 3.475 = .407). ABC Electronic Ltd. not only waits for customer complaints, but also collects the customer satisfaction and dissatisfaction data directly from its major customers. However, customer satisfaction comparison with its competitors is sometimes ignored.

Table 5.39 Score of each subcriterion and synthesised results

criteria (weight)	subcriteria (weight)	score of each subcriterion	value of each criterion	achievement value of each criterion (rank)
B1 (.376)	B11 (.710)	3.684	3.668	1.379 (1)
	B12 (.188)	3.693		
	B13 (.101)	3.547		
B2 (.088)	B21 (.631)	3.562	3.497	.308 (5)
	B22 (.147)	3.417		
	B23 (.222)	3.366		
B3 (.088)	B31 (.781)	3.628	3.630	.319 (4)
	B32 (.219)	3.635		
B4 (.059)	B41 (.468)	3.657	3.483	.205 (7)
	B42 (.076)	3.439		
	B43 (.204)	3.249		
	B44 (.140)	3.326		
	B45 (.112)	3.405		

Table 5.39 (Next)

criteria (weight)	subcriteria (weight)	score of each subcriterion	value of each criterion	achievement value of each criterion (rank)
B5 (.179)	B51 (.352)	3.681	3.654	.654 (2)
	B52 (.358)	3.700		
	B53 (.114)	3.701		
	B54 (.104)	3.441		
	B55 (.072)	3.529		
B6 (.141)	B61 (.533)	3.605	3.514	.495 (3)
	B62 (.222)	3.492		
	B63 (.077)	3.294		
	B64 (.168)	3.353		
B7 (.069)	B71 (.403)	3.809	3.637	.251 (6)
	B72 (.346)	3.633		
	B73 (.117)	3.475		
	B74 (.075)	2.975		
	B75 (.059)	3.651		

5.4.3 ISO 9000 versus the Baldrige Award

For the assessment model of ISO 9000, the sum of achievement values of individual criteria is equal to 3.728. On the other hand, for the assessment model of the Baldrige Award, the sum of them is equal to 3.611. It could be said that, in overall looking, ABC Electronic Ltd. can achieve quality requirements in ISO 9000 more than in the Baldrige Award.

The Baldrige Award is quite difficult to receive, since it recognises total quality excellence. Its emphasis is placed on customer satisfaction; whereas, that of ISO 9000 is documentation and implementation of quality procedures and quality records [Steeples, 1994]. ISO 9000 does not address the quality of a company's products or continuous improvement, it simply requires the company to have a basic quality system in place and the products to be made according to documented procedures [Henkoff, 1993]. However, the ISO 9000 registrars tend to change this. Auditors have committed to surveillance audit twice a year to ensure the consistency of quality system of the certified company.

However, the assessment model of ISO 9000 and the Baldrige Award can work well together. For ABC Electronic Ltd., ISO 9000 becomes a good first step in helping standardise quality management systems and practices (in various divisions or offices) which streamline processes and minimise loss. If it want to achieve the quality improvement target, the Baldrige Award might be helpful.

5.5 Sensitivity analysis

It cannot be denied that to do the sensitivity analysis on 15 criteria and 53 subcriteria is very time-consuming and tedious task. Considering the assessment model of ISO 9000, "quality management," "production" and "problem identification and correction" criteria are the major ones which cover about 67% of the overall weight of importance for the model. It could be said that to test the deviation on the weight of these three criteria is enough to show some degree of stability for the decision making.

Likewise, considering the assessment model of the Baldrige Award, testing the deviation on the weight of "senior executive leadership" and "management of process quality" criteria was done. This is because these two criteria cover about 56% of the total weight of importance for the model. However, sensitivity analysis on "customer focus and satisfaction" criterion was also done since it has become more and more interesting in this highly competitive and changing world.

In addition, the researcher tested the deviation on the weight and score of individual subcriteria under the corresponding criteria for two models.

5.5.1 "Quality management" criterion

From Table 5.40, it can be seen that the fourth, fifth and eighth rank (**vendor assurance** A5, **product definition** A3, and **handling and delivery** A6, respectively) are very stable and would not be changed though the weight of quality management is deviated up to 50%. The first, second, third, sixth and seventh rank are not so stable and would exchange the position if the weight of **quality management** was changed to certain percentage.

Table 5.40 Deviation on weight of "quality management" criterion

quality management(A1)		rank							
deviation	weight	A1	A2	A3	A4	A5	A6	A7	A8
-50 %	.165	3	7	5	6	4	8	1	2
-40 %	.198	2	7	5	6	4	8	1	3
-30 %	.231	1	7	5	6	4	8	2	3
-20 %	.264	1	7	5	6	4	8	2	3
-10 %	.298	1	7	5	6	4	8	2	3
0 %	.331	1	7	5	6	4	8	2	3
+10 %	.364	1	6	5	7	4	8	3	2
+20 %	.398	1	7	5	6	4	8	2	3
+30 %	.432	1	7	5	6	4	8	2	3
+40 %	.463	1	7	5	6	4	8	2	3
+50 %	.497	1	7	5	6	4	8	2	3

5.5.2 Subcriteria under quality management

Only testing the deviation on the weight and score of "management responsibility" and "quality system" subcriteria was done. This is because **management responsibility** and **quality system** cover 83% of the total weight of importance for "quality management" criterion.

It is evident that (as seen in Table 5.41 and 5.43) there is no change to the overall ranking though the weight of **management responsibility** and **quality system** are deviated from the base case up to 50%.

Again, although the score of **management responsibility** and **quality system** are deviated from -50% to +30%, there is not any change to the overall ranking (as seen in Table 5.42 and 5.44).

Table 5.41 Deviation on weight of "management responsibility" subcriterion

management respons. (A11)		rank							
deviation	weight	A1	A2	A3	A4	A5	A6	A7	A8
-50 %	.299	1	7	5	6	4	8	2	3
-40 %	.358	1	7	5	6	4	8	2	3
-30 %	.418	1	7	5	6	4	8	2	3
-20 %	.478	1	7	5	6	4	8	2	3
-10 %	.537	1	7	5	6	4	8	2	3
0 %	.597	1	7	5	6	4	8	2	3
+10 %	.657	1	7	5	6	4	8	2	3
+20 %	.716	1	7	5	6	4	8	2	3
+30 %	.776	1	7	5	6	4	8	2	3
+40 %	.836	1	7	5	6	4	8	2	3
+50 %	.895	1	7	5	6	4	8	2	3

Table 5.42 Deviation on score of "management responsibility" subcriterion

management respons. (A11)		rank							
deviation	score	A1	A2	A3	A4	A5	A6	A7	A8
-50 %	1.867	1	7	5	6	4	8	2	3
-40 %	2.240	1	7	5	6	4	8	2	3
-30 %	2.613	1	7	5	6	4	8	2	3
-20%	2.986	1	7	5	6	4	8	2	3
-10 %	3.360	1	7	5	6	4	8	2	3
0 %	3.733	1	7	5	6	4	8	2	3
+10 %	4.106	1	7	5	6	4	8	2	3
+20 %	4.480	1	7	5	6	4	8	2	3
+30 %	4.853	1	7	5	6	4	8	2	3

Table 5.43 Deviation on weight of "quality system" subcriterion

quality system (A12)		rank							
deviation	weight	A1	A2	A3	A4	A5	A6	A7	A8
-50 %	.115	1	7	5	6	4	8	2	3
-40 %	.137	1	7	5	6	4	8	2	3
-30 %	.160	1	7	5	6	4	8	2	3
-20 %	.183	1	7	5	6	4	8	2	3
-10 %	.206	1	7	5	6	4	8	2	3
0 %	.229	1	7	5	6	4	8	2	3
+10 %	.252	1	7	5	6	4	8	2	3
+20 %	.275	1	7	5	6	4	8	2	3
+30 %	.298	1	7	5	6	4	8	2	3
+40 %	.321	1	7	5	6	4	8	2	3
+50 %	.343	1	7	5	6	4	8	2	3

Table 5.44 Deviation on score of "quality system" subcriterion

quality system (A12)		rank							
deviation	score	A1	A2	A3	A4	A5	A6	A7	A8
-50 %	1.895	1	7	5	6	4	8	2	3
-40 %	2.273	1	7	5	6	4	8	2	3
-30 %	2.652	1	7	5	6	4	8	2	3
-20 %	3.031	1	7	5	6	4	8	2	3
-10 %	3.410	1	7	5	6	4	8	2	3
0 %	3.789	1	7	5	6	4	8	2	3
+10 %	4.168	1	7	5	6	4	8	2	3
+20 %	4.547	1	7	5	6	4	8	2	3
+30 %	4.926	1	7	5	6	4	8	2	3

5.5.3 "Production" criterion

The stability of the first rank (**quality management** A1) is quite constant (as seen in Table 5.45). It would not be changed even though the weight of **production** is deviated from -50% to +40%. Further, the second, third and fourth rank are not so stable and would exchange the position if the weight of production is deviated to certain percentage.

Table 5.45 Deviation on weight of "production" criterion

production (A7)		rank							
deviation	weight	A1	A2	A3	A4	A5	A6	A7	A8
-50 %	.093	1	7	5	6	3	8	4	2
-40 %	.112	1	7	5	6	4	8	3	2
-30 %	.130	1	7	5	6	4	8	3	2
-20 %	.149	1	6	5	7	4	8	2	3
-10 %	.167	1	7	5	6	4	8	2	3
0 %	.186	1	7	5	6	4	8	2	3
+10 %	.205	1	7	4	6	5	8	2	3
+20 %	.223	1	7	6	5	4	8	2	3
+30 %	.242	1	7	5	6	4	8	2	3
+40 %	.260	1	7	5	6	4	8	2	3
+50 %	.279	2	6	5	7	4	8	1	3

5.5.4 Subcriteria under production

Sensitivity analysis on "process control" and "inspection, measuring and testing equipment" subcriteria were done since they cover more than 78% of the total weight of importance for the "process control" criterion.

From Table 5.46 and 5.48, there is no change to the overall rankings though the deviation on weight of **process control,** and **inspection, measuring and testing equipment** are up to 50%. As seen in Table 5.47 and 5.49, again there is not any change to the overall rankings despite the deviation on score of **process control**, and **inspection , measuring and testing equipment** being from -50 % to +20 % and from -50% to +10%, respectively.

Table 5.46 Deviation on weight of "process control" subcriterion

process control (A71)		rank							
deviation	weight	A1	A2	A3	A4	A5	A6	A7	A8
-50 %	.230	1	7	5	6	4	8	2	3
-40 %	.276	1	7	5	6	4	8	2	3
-30 %	.322	1	7	5	6	4	8	2	3
-20 %	.368	1	7	5	6	4	8	2	3
-10 %	.414	1	7	5	6	4	8	2	3
0 %	.460	1	7	5	6	4	8	2	3
+10 %	.506	1	7	5	6	4	8	2	3
+20 %	.552	1	7	5	6	4	8	2	3
+30 %	.598	1	7	5	6	4	8	2	3
+40 %	.644	1	7	5	6	4	8	2	3
+50 %	.690	1	7	5	6	4	8	2	3

Table 5.47 Deviation on score of "process control" subcriterion

process control (A71)		rank							
deviation	score	A1	A2	A3	A4	A5	A6	A7	A8
-50 %	1.999	1	7	5	6	4	8	3	2
-40 %	2.398	1	7	5	6	4	8	2	3
-30 %	2.798	1	7	5	6	4	8	2	3
-20 %	3.198	1	7	5	6	4	8	2	3
-10 %	3.597	1	7	5	6	4	8	2	3
0 %	3.997	1	7	5	6	4	8	2	3
+10 %	4.397	1	7	5	6	4	8	2	3
+20 %	4.796	1	7	5	6	4	8	2	3

Table 5.48 Deviation on weight of "inspection, measuring and testing equipment" subcriterion

inspection...equipment(A73)		rank							
deviation	weight	A1	A2	A3	A4	A5	A6	A7	A8
-50 %	.163	1	7	5	6	4	8	2	3
-40 %	.196	1	7	5	6	4	8	2	3
-30 %	.229	1	7	5	6	4	8	2	3
-20 %	.262	1	7	5	6	4	8	2	3
-10 %	.294	1	7	5	6	4	8	2	3
0 %	.327	1	7	5	6	4	8	2	3
+10 %	.359	1	7	5	6	4	8	2	3
+20 %	.392	1	7	5	6	4	8	2	3
+30 %	.425	1	7	5	6	4	8	2	3
+40 %	.458	1	7	5	6	4	8	2	3
+50 %	.491	1	7	5	6	4	8	2	3

Table 5.49 Deviation on score of "inspection, measuring and testing equipment" subcriterion

inspection...equipment (A73)		rank							
deviation	score	A1	A2	A3	A4	A5	A6	A7	A8
-50 %	2.102	1	7	5	6	4	8	2	3
-40 %	2.522	1	7	5	6	4	8	2	3
-30 %	2.943	1	7	5	6	4	8	2	3
-20 %	3.363	1	7	5	6	4	8	2	3
-10 %	3.784	1	7	5	6	4	8	2	3
0 %	4.204	1	7	5	6	4	8	2	3
+10 %	4.624	1	7	5	6	4	8	2	3

5.5.5 "Problem identification and correction" criterion

As seen in Table 5.50, the stability of the first rank, **quality management**, is very constant. It would not be changed even the weight of **problem identification and correction** is deviated up to 50%. The second, third, fourth and fifth ranks are not very stable and would exchange to the position if the weight of "problem identification and correction" criterion is deviated to certain percentage. There are minor changes to the sixth and seventh rank.

Again, although the weights and scores of subcriteria under this criterion are deviated up to 50%, the overall rankings are not changed. Therefore, the results of sensitivity analysis on those subcriteria are not presented.

Table 5.50 Deviation on weight of "problem identification and correction" criterion

problem iden...correction(A8)		rank							
deviation	weight	A1	A2	A3	A4	A5	A6	A7	A8
-50 %	.078	1	7	4	6	3	8	2	5
-40 %	.094	1	7	5	6	3	8	2	4
-30 %	.109	1	7	5	6	4	8	2	3
-20 %	.125	1	7	5	6	4	8	2	3
-10 %	.140	1	7	5	6	4	8	2	3
0 %	.156	1	7	5	6	4	8	2	3
+10 %	.172	1	6	5	7	4	8	2	3
+20 %	.187	1	7	5	6	4	8	2	3
+30 %	.203	1	7	5	6	4	8	3	2
+40 %	.218	1	7	5	6	4	8	3	2
+50 %	.234	1	7	5	6	4	8	3	2

5.5.6 "Senior executive leadership" criterion

In overall looking, (as seen in Table 5.51) the stability of all ranks are very constant though the weight of **senior executive leadership** is changed up to 50%. However, there are minor changes to the first and second ranks.

Table 5.51 Deviation on weight of "senior executive leadership" criterion

senior executive leader. (B1)		rank						
deviation	weight	B1	B2	B3	B4	B5	B6	B7
-50 %	.188	2	5	4	7	1	3	6
-40 %	.226	1	5	4	7	2	3	6
-30 %	.263	1	5	4	7	2	3	6
-20 %	.301	1	5	4	7	2	3	6
-10 %	.338	1	5	4	7	2	3	6
0 %	.376	1	5	4	7	2	3	6
+10 %	.414	1	5	4	7	2	3	6
+20 %	.451	1	5	4	7	2	3	6
+30 %	.489	1	5	4	7	2	3	6
+40 %	.526	1	5	4	7	2	3	6
+50 %	.564	1	5	4	7	2	3	6

5.5.7 Subcriteria under senior executive leadership

Sensitivity analysis on "senior executive leadership" subcriterion was done because it cover 71% of the total weight of importance for "senior executive leadership" criterion.

It is evident that (as seen in Table 5.52 and 5.53) there is no change to the overall rankings if the weight and score of **senior executive leadership** subcriterion are deviated up to the predefined percentage.

Table 5.52 Deviation on weight of "senior executive leadership" subcriterion

senior executive leader.(B11)		rank						
deviation	weight	B1	B2	B3	B4	B5	B6	B7
-50 %	.355	1	5	4	7	2	3	6
-40 %	.426	1	5	4	7	2	3	6
-30 %	.497	1	5	4	7	2	3	6
-20 %	.568	1	5	4	7	2	3	6
-10 %	.639	1	5	4	7	2	3	6
0 %	.710	1	5	4	7	2	3	6
+10 %	.781	1	5	4	7	2	3	6
+20 %	.852	1	5	4	7	2	3	6
+30 %	.923	1	5	4	7	2	3	6
+40 %	.994	1	5	4	7	2	3	6

Table 5.53 Deviation on score of "senior executive leadership" subcriterion

senior executive leader.(B11)		rank						
deviation	score	B1	B2	B3	B4	B5	B6	B7
-50 %	1.842	1	5	4	7	2	3	6
-40 %	2.210	1	5	4	7	2	3	6
-30 %	2.579	1	5	4	7	2	3	6
-20 %	2.947	1	5	4	7	2	3	6
-10 %	3.316	1	5	4	7	2	3	6
0 %	3.684	1	5	4	7	2	3	6
+10 %	4.052	1	5	4	7	2	3	6
+20 %	4.421	1	5	4	7	2	3	6
+30 %	4.789	1	5	4	7	2	3	6

5.5.8 "Management of process quality" criterion

It can be seen from Table 5.54 that the first (**senior executive leadership** B1), sixth (**customer focus and satisfaction** B7) and seventh ranks (**human resource development and management** B4) are very stable and would not be changed even though the weight of **management of process quality** is deviated up to 50%. The second, third, fourth and fifth ranks are not so stable when the weight of "management of process quality" criterion is changed to certain percentage.

Table 5.54 Deviation on weight of "management of process quality" criterion

management of proc. (B5)		rank						
deviation	weight	B1	B2	B3	B4	B5	B6	B7
-50 %	.089	1	4	3	7	5	2	6
-40 %	.107	1	5	4	7	3	2	6
-30 %	.125	1	5	4	7	3	2	6
-20 %	.143	1	5	4	7	2	3	6
-10 %	.161	1	5	4	7	2	3	6
0 %	.179	1	5	4	7	2	3	6
+10 %	.197	1	5	4	7	2	3	6
+20 %	.215	1	5	4	7	2	3	6
+30 %	.233	1	5	4	7	2	3	6
+40 %	.251	1	5	4	7	2	3	6
+50 %	.269	1	5	4	7	2	3	6

5.5.9 Subcriteria under management of process quality

Sensitivity analysis on "design and introduction of quality products and services" subcriterion was done. "Design and introduction of quality products and services" and "process management or process quality control" subcriteria cover more than 70% of the total weight of importance for "management of process quality" criterion. Nevertheless, their weights and scores are almost the same. The result of sensitivity analysis for these two subcriteria, thus, would be indifferent from each other.

There is no change to the overall rankings even though the weight of **design and introduction of quality products and services** is deviated from the base case up to 50% (as seen in Table 5.55).

As well, (as seen in Table 5.56) the overall ranking is not changed though the score of design and introduction of quality products and services is deviated from -50% to +30%.

Table 5.55 Deviation on weight of "design and introduction of quality products and services" subcriterion

design and intro. (B51)		rank						
deviation	weight	B1	B2	B3	B4	B5	B6	B7
-50 %	.176	1	5	4	7	2	3	6
-40 %	.211	1	5	4	7	2	3	6
-30 %	.246	1	5	4	7	2	3	6
-20 %	.282	1	5	4	7	2	3	6
-10 %	.317	1	5	4	7	2	3	6
0 %	.352	1	5	4	7	2	3	6
+10 %	.387	1	5	4	7	2	3	6
+20 %	.422	1	5	4	7	2	3	6
+30 %	.458	1	5	4	7	2	3	6
+40 %	.493	1	5	4	7	2	3	6
+50 %	.528	1	5	4	7	2	3	6

Table 5.56 Deviation on score of "design and introduction of quality products and services" subcriterion

design and intro. (B51)			rank					
deviation	score	B1	B2	B3	B4	B5	B6	B7
-50 %	1.841	1	5	4	7	2	3	6
-40 %	2.209	1	5	4	7	2	3	6
-30 %	2.577	1	5	4	7	2	3	6
-20 %	2.945	1	5	4	7	2	3	6
-10 %	3.313	1	5	4	7	2	3	6
0 %	3.681	1	5	4	7	2	3	6
+10 %	4.049	1	5	4	7	2	3	6
+20 %	4.417	1	5	4	7	2	3	6
+30 %	4.785	1	5	4	7	2	3	6

5.5.10 "Customer focus and satisfaction" criterion

As seen in Table 5.57, the first (**senior executive leadership** B1), second (**management of process quality** B5) and third ranks (**quality and operational results** B3) are very stable and would not exchange the position even though the weight of **customer focus and satisfaction** is deviated up to 50%. There are minor changes to the sixth and seventh ranks.

It could be said that the weight and score of the subcriteria under **customer focus and satisfaction** have too little impact on degree of stability for decision-making. Therefore, sensitivity analysis on them was not done.

Table 5.57 Deviation on weight of "customer focus and satisfaction" criterion

customer focus and sat.(B7)		rank						
deviation	weight	B1	B2	B3	B4	B5	B6	B7
-50 %	.035	1	5	4	6	2	3	7
-40 %	.041	1	5	4	6	2	3	7
-30 %	.048	1	5	4	6	2	3	7
-20 %	.055	1	5	4	6	2	3	7
-10 %	.062	1	5	4	7	2	3	6
0 %	.069	1	5	4	7	2	3	6
+10 %	.076	1	5	4	7	2	3	6
+20 %	.083	1	5	4	7	2	3	6
+30 %	.089	1	6	5	7	2	3	4
+40 %	.097	1	6	5	7	2	3	4
+50 %	.103	1	6	5	7	2	3	4

In summary, it is evident that the achievement value of **quality management** and **senior executive leadership** are very stable though the weight of several criteria, and the weight and score of corresponding subcriteria are deviated up to 50%. In other words, both **quality management** and **senior executive leadership** frequently gain the highest values for the assessment models of ISO9000 and the Baldrige Award, respectively. It can, therefore, be claimed that ABC Electronic Ltd. is strong at quality management and senior executive leadership.

In addition, there is no change to the overall ranking though the weight and score of many subcriteria are deviated up to 50%. For this reason, the weight and score of those subcriteria have little impact on degree of the stability for decision-making on which issues ABC Electronic Ltd. is strong at and bad in.