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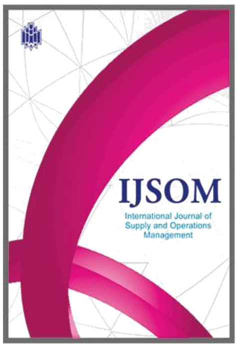

Selecting Total Quality Management (TQM) Best Practices in the Hotel Industry Environment: A Hybrid Model based on DEMATEL and ANP

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Abstract

Recently, developing strategies for sustainable development (SD) in the hotel industry has been seen globally as a crucial issue. Numerous management systems can assist the hotel industry in creating sustainable performance, such as Total Quality Management (TQM) which is well-reputed in the industry. As such, selecting TQM under an evolving hotel industry environment is seen as an important decision from a strategic perspective given it constitutes contradictory practices, thereby making it a multi-criteria decision-making (MCDM) issue. In achieving this aim, a Decision-Making Trial and Evaluation Laboratory (DEMATEL) approach was adopted in determining the inter-relationships between the primary practices and sub-practices in addition to applying the Analytic Network Process (ANP) for examining the weights of primary practices and sub-practices. In other words, this study aims to provide innovative insight to researchers and practitioners to examine the TQM optimal practices to be implemented incrementally in phases within the hotel industry environment.

Keywords: total quality management; sustainable development; multi-criteria decision making; decision-making trial and evaluation laboratory; analytic network process; hotel.

1. Introduction

The fast-paced and revolutionary change within the hotel industry has resulted in many new challenges for management toward sustainable development (SD) (The Sustainable Development Goals Report-United Nations, 2018). This is especially relevant given the hotel industry ill-prepared to adopt sustainability measures given the global economy and competition within the global markets, in addition to new technologies and information systems that are added challenges (Cohen et al., 2015b). As a result, these external factors have brought about internal changes and the evolution of new management strategies, philosophical changes, and practices within the hotel industry.

To remain competitive, operational hotel enterprises should review their strategies regularly to manage and implement different approaches, such as Total Quality Management (TQM) (Sin & Jusoh, 2019; Bouranta, Psomas, & Pantouvakis, 2017). TQM is recognized as sharing corresponding purposes and standard implementation practices regarding the organization's sustainable management system (Nguyen, Phan, & Matsui, 2018). Moreover, TQM enables hotels to differentiate their practices and operations regarding wastage, cost savings, brand recognition, customer loyalty and satisfaction, and competitors (Junior, Lucato, Vanalle, & Jagoda,

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2014). Therefore, it is essential to understand the concept of TQM concerning sustainable performance within this sector.

However, choosing a suitable TQM system for sustainable performance of the hotel industry is complicated given considerations relating to practices, features, requirements, and wide-ranging practices (Bouranta et al., 2017). In addition, those making decisions must choose the most suitable TQM practices, particularly for four and five-star hotels, in addition to deciding on other elements such as the design of services, products, customer relationship management (CRM), process management, management of employees, and leadership. Many of these elements are difficult to express financially, thus making them difficult to quantify (Chen, 2016). As such, choosing a TQM system is a complex multiple-criteria decision-making (MCDM) issue. The decision-making process as portrayed in Figure 1 fits well with TQM best practices selection since the intelligence, design, and choice phases can be vividly determined.

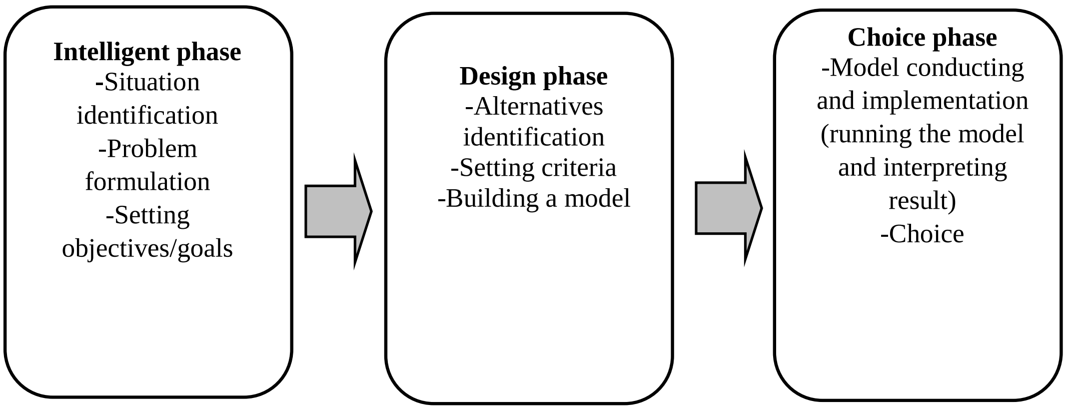

Figure 1. Decision-Making Process
Source: Adapted from Pedersen *et al*. (2016), pg. 27.

In such a complex system, the majority of practices are interrelated, and is challenging for those making decisions to distinguish between both (Hsu, Tsai, & Tzeng, 2018). The preferred approach is to distinguish between these practices into a cause-and-effect category to acknowledge the inter-relationships referred to as interdependency relationships (Gomes, Fernandes, & Soares de Mello, 2014). Accordingly, the present study adopts the MCDM measurement approach to evaluate the benefits of choosing a TQM system to assist management by offering a way to distinguish best practices and to develop and acknowledge interdependencies in multi-attribute decision analysis.

The MCDM approach is applied in numerous fields such as education, finance, economics, environmental protection, medicine, and engineering (Garg, 2019; Gong, Simpson, Koh, & Tan, 2018). Given the many uses and applications, the method has become quite common in operational research and management science (Sin, Jusoh, & Mardani, 2020). Moreover, the MCDM approach is more efficient to assist decision-makers in choosing a discrete set of options and decisions, compared to other conventional measurement tools or numerical approaches (Hsu et al., 2018). Among the different techniques to rank specific alternatives and options, MCDM appears to be the most acceptable, since it can save computing time without forgoing measurement quality (Zamani-Sabzi, King, Gard, & Abudu, 2016).

Accordingly, this study aims to investigate the effectiveness of the MCDM approach regarding the assessment and to choose suitable TQM best practices within the hotel industry in Malaysia by applying DEMATEL (Decision-Making Trial and Evaluation Laboratory) and the ANP (Analytic Network Process). The DEMATEL approach is applied to adapt the assessment item's significance and to gauge the influence of its causal relationship and causes (Altuntas & Dereli, 2015). Whereas, the ANP model was adopted to gauge the significance of the assessment criteria in addition to prioritising the categories involved in the scheduling of problems and project selection (Yang & Tzeng, 2011). The combination of DEMATEL and ANP is expected to offer more standard and proportional weight values, in comparison to conventional approaches that neglect the existence of interrelations between TQM practices (Chen, 2016).

Through this integrated approach, the inter-relationships between the practices, which are not only supported via the literature review but also confirmed by the opinion of experts are analysed. ANP was used to determine the significance of TQM and used to identify how TQM is weighted and prioritised by management representatives and/or hotel management. As a result, TQM best practices appropriate for the Malaysian hotel industry's sustainable performance are determined, which is parallel to the aim of this study. In summary, establishing the ANP and DEMATEL integration model is anticipated to expand the application of this approach and quality management evaluation by addressing and resolving the complex and challenging causal relationships and ranking issues. This integrated model will provide the opportunity to inspect and strengthen quality management by weighing and ranking, and consequently improve and enhance sustainable performance in the hotel industry, reducing costs and utilisation of resources.

2. Literature Review

2.1. Review of TQM Practices

Given the global economy, the sustainability and survival of organizations have become exceedingly difficult unless supported and maintained through excellent business operations and quality measures. TQM as a tool is used in manufacturing and service entities to improve business performance. Moreover, it is viewed as a modern management philanthropy and management discipline faced by global service and manufacturing organizations that focus on competitive and technical challenges (Nguyen et al., 2018). As a business management programm, TQM helps to value-add, improve competitiveness, organizational management, and quality while creating a competitive advantage for the business (Sin, Jusoh, & Mardani, 2021).

A comprehensive literature was conducted to identify the practices for TQM and it can be found the problem under investigation includes 10 main practices namely, Leadership (C1), Strategic Planning (C2), Supplier's Quality Management (C3), Process Management (C4), Product and Service Design (C5), Employee Management (C6), Customer Relationship Management (C7), Information and Analysis (C8), Hard TQM (C9) and Tools and Technique (C10). In addition, the sub-practices were: Top Management Commitment (S11), Top Management Support (S12), Top Management Involvement (S13), Quality System (S21), Quality Culture (S22), Supplier Involvement (S31), Supplier Focus (S32), Supplier Quality (S33), Continuous Improvement Process (S41), Resource Management (S42), Product/Service Design (S51), Product/Process Design (S52), Training and Education (S61), Teamwork (S62), Communication (S63), Reward and Recognition (S64), Employee Empowerment (S65), Employee involvement (S66), Employee Commitment (S67), Organizational Trust (S68), Customer Focus (S71), Customer Involvement (S72), Customer Satisfaction (S73), Customer Feedback (S74), Information Management (S81), Performance Measurement System (S82), Quality Data and Reporting (S83), Quality Control (S91), Quality Improvement (S92), Quality Assurance (S93), Advanced Quality Planning (S94), Quality Function Deployment (S101), Just in Time (S102) and Benchmarking (S103).

These TQM practices and sub-practices have been chosen in the current research based on the following rationale. First, these practices have been discussed in previous studies as core (Mosadeghrad, 2014) and address primary areas of quality management as revealed by Maistry, Kumar, and Ramessur (2017). Second, these practices incorporate the different views of quality 'masters', like Deming and Juran (Sin et al., 2020). Third, these practices combine the leading quality award standards that are conceded by TQM scholars and have been accepted in both local and international circles (Arunachalam & Palanichamy, 2017).

Table 1 shows that numerous articles established from 2010 to 2023 extracted from renowned online databases, such as Science Direct, Springer, Emerald, Wiley, ProQuest, and Taylor & Francis, had been reviewed in this study to discover the research gap.

Various endeavors have been formulated to investigate the effect of TQM and researchers have identified that TQM influences organisational success in different ways in diverse sectors (Ojha, 2023; Flamini, Pareschi and Martinez, 2023; Ali & Johl, 2021) while scarcely within the hospitality and hotel domain. Table 1 displays several gaps in the assessment and evaluation of TQM literature, which represent issues for further investigations. Based on Table 1, first, there is a shortage of studies about assessment and evaluation of TQM especially in the hotel industry using the MCDM method. Second, among the studies that had assessed and evaluated TQM specifically in the hotel industry, there is an absence in studies that assessed this interrelationship using DEMATEL & ANP techniques. In conclusion, the results of searching the above databases exhibited the existence of research gaps.

Table 1. Overview of TQM and related studies from 2010-2022

Author(s)	Year	Focused TQM aspects	Focused hotel industry aspects	Focused MCDM aspects	Focused DEMATEL & ANP aspects
Juan et al	2010	*	*		
Chen et al	2011		*	*	
Liu et al	2012			*	
Wu et al	2012	*	*		
Tajeddini et al	2012		*		
José Tarí et al	2013	*	*		
Wang et al	2014		*		
Carlos, et al	2014	*	*		
Carlos et al	2014	*	*		
Wu et al	2015		*		
Zeng et al	2015	*			
Rahimi et al	2016		*		
Yu et al	2018		*	*	
Nilashi et al	2019			*	
Ahani et al	2019		*		
Kheybari et al	2020		*	*	
Nguyen	2021		*	*	
Abbasi et al	2022			*	
Current Research	2023	*	*	*	*

Source: Compiled by the Authors

2.2. MCDM Methodologies

MCDM methods are applicable in real business practices and their unique features subscribe to their applicability in deciphering complex problems (Ahmad, Hasan, & Barbhuiya, 2021). The goal of MCDM is to aid decision-makers to ascertain the problem, indicating their discernment about the importance of criteria and priority of alternatives, antagonize other participants' discrimination, comprehending the values of the final alternatives, and applying them in real-world problem-solving activities. Furthermore, MCDM methods do not tend to substitute instinctive discrimination or judgment and it does not monopolise creative thinking. MCDM methods' commitment and compliance are to complement instinct, acknowledge ideas, and sustain problem-solving (Lo, Shiue, Liou, & Tzeng, 2020). These methods can manage mixed sets of quantitative or qualitative data, including expert opinions, and dedicate a process that results in reasonable, sensible, and interpretable decisions (Sin & Sin, 2019). Ultimately, in MCDM, distinct methods can be distinguished and their ease in solving a problem be evaluated. In addition, the most convenient and practical MCDM methods are theoretically simple, tangible, and computer-supported.

Table 2 provides a comprehensive list of MCDM methodologies, prepared based on a review of relevant literature. The listing was done in no specific order, while fuzzy models and their variants were exceptional in this research. This table is an expansion of a prior work by Georgiadis, Mazzuchi, and Sarkani (2012). Besides that, Setiawan *et al*. (2016) heavily contributed to Table 2 with quality examples for each model. This new list consists of 59 models, while in Georgiadis *et al.* (2012) only 33 models were listed. The brief introduction of MCDM methodologies in this section would have assisted in understanding the context of the research topic.

Table 2. MCDM Methodologies Summary

List of MCDM Methodologies
Simple Additive Weighing (SAW) or Weighted Sum Method (WSM)
Weighted Product Model (WPM)
Analytic Hierarchy Process (AHP)
Revised Analytic Hierarchy Process (AHP)
Analytic Network Process (ANP)
Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)
Multi-Attribute Utility Theory (MAUT)
Multiple Attribute Group Decision Making (MAGDM)
Elimination and Choice Translation Reality (ELECTRE)
Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE)
Geometrical Analysis for Interactive Aid (GAIA)
Superiority and Inferiority Ranking method (SIR method)
Potentially All Pairwise Rankings of all possible Alternatives (PAPRIKA)
Decision Making Trial and Evaluation Laboratory (DEMATEL)
Data Envelopment Analysis (DEA)
Complex Proportional Assessment of Alternatives (COPRAS)
Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA)
Dominance Based Rough Set Approach (DRSA)
The Evidential Reasoning Approach (ER)
Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH)
Goal programming (GP)
Grey Relational Analysis (GRA)
Step Method (STEM)
Concordance and Discordance Analysis by Similarity to Ideal Designs (CODASID)
New Approach to Appraisal (NATA)
Value Analysis (VA), Value engineering (VE)
VIseKriterijumslca Optimizacija I Kompromisno Resenje (VIKOR)
Group Decision Support System (GDSS)
Interpretive Structural Modeling (ISM)
Games Theory Methods
Policy Goal Percentaging Analysis (P/G%)
UTA (Utilities Additives) Method
Simple Multi Attribute rating Technique (SMART)
ORESTE
QUALIFLEX

Table 2. MCDM Methodologies Summary (Continued)

Treatment of the Alternatives According To the Importance of Criteria (TACTIC)
Preference Ranking Global Frequencies in Multi-criterion Analysis (PRAGMA)
Multi-criterion Analysis of Preference by means of Pairwise Actions and Criterion comparisons (MAPPAC)
nTOMIC
Generalized Regression with Intensities of Preference (GRIP)
Stochastic Multi-criteria Acceptability Analysis (SMAA)
Preference Programming
Alternative Ranking Interactive Aid based on Dominance structural information Elicitation (ARIADNE)
Optimality Conditions
Holistic Orthogonal Parameter Incomplete Estimation (HOPIE)
Preference Assessment by Imprecise ratio statements (PAIRS)
Preference Programming AHP-style Pair wise Comparisons
Linear Constraints
Preference Ratios in Multi-attribute Evaluation (PRIME)
Dominance and Potential Optimality
Rank Inclusion in Criteria Hierarchies (RICH)
Interval SMART/SWING Valued Ratio Statements
Even Swaps (Smart Swaps)
Robust Portfolio Modeling (RPM)
Multiple Criteria Robust Interactive Decision (MCRID)
Bayesian Analysis (BA)

Source: Adapted from Georgiadis, Mazzuchi & Sarkani (2012) and Setiawan et al. (2016)

3. Research Methodology

To uncover the relationship, interdependencies, and feedback among the main and sub-practices, as well as to examine the ranking among them, integrated MCDM was applied using DEMATEL and ANP. In the first phase of this research, DEMATEL was adopted to access correspondence of cause and effect and to explicate reciprocity within the decision model. Then, ANP is applied to perceive the corresponding weight of each dimension within the decision model.

A final sample of 10 respondents such as the quality management director, quality control administrative, and operations management executive were purposively selected as they had the largest possibility of engaging in similar TQM practices and being familiar with and taking responsibility for the hotel's TQM implementation to advocate the reliability and validity of the data acquired (Lim *et al*. 2013). Furthermore, they were knowledgeable regarding the quality management initiatives being implemented in their respective companies. All the potential participants were required to fill up the DEMATEL and ANP (DANP) questionnaire to examine the corresponding importance of these factors. Figure 2 depicts the flowchart of the research methodology as shown below.

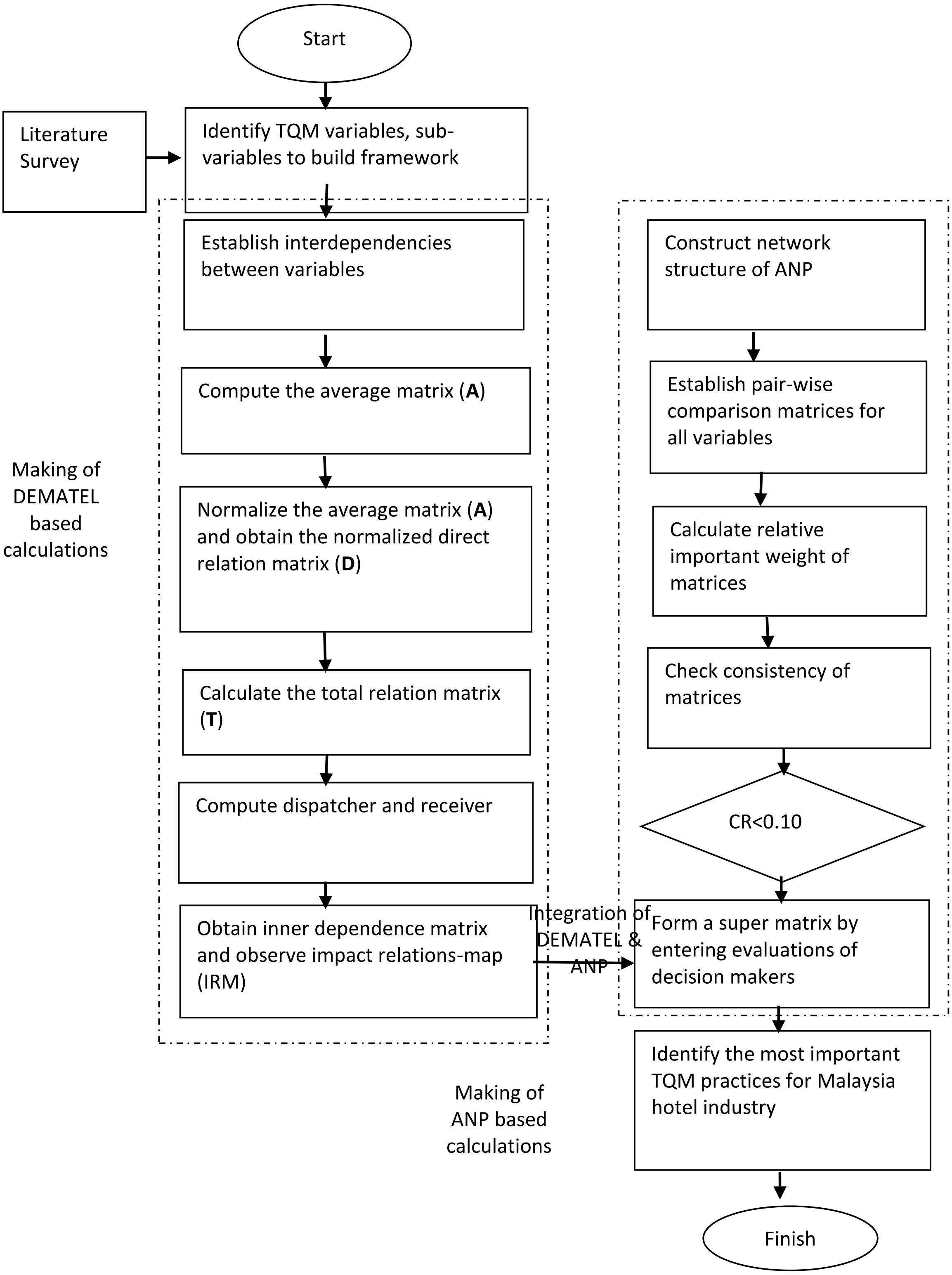

Figure 2. Research Methodology Flowchart Combining MCDM (By authors)

4. Data Analysis

As discussed in Section 2, a comprehensive literature was conducted to identify the TQM practices. From this table, it can be found the problem under investigation includes 10 main practices and 35 sub-practices.

4.1. DEMATEL

The procedure of the DEMATEL technique is presented as follows.

Step 1: After identifying the factors of the model, the data is collected using a designed DEMATEL questionnaire from the experts. In this research, 10 experts in the field of quality management are selected to complete the questionnaire survey. The experts provide the answers based on the 5 effect scales as presented in Table 3. They are No effect (0), Low effect (1), Medium effect (2), High effect (3), and Very high effect (4). The completed questionnaires are presented in Appendix A. In the first step of DEMATEL, the average matrix from all responses is computed.

Table 3. Effect scale

Value	Meaning
0	No effect
1	Low effect
2	Medium effect
3	High effect
4	Very high effect

The answer matrix for the DEMATEL questionnaires is defined as $X^k = [\, x_{ij}^k \,]$ which $1 \le k \le H$, indicates H as the number of experts. All elements of the matrices are non-negative. In addition, when $i = j$, the diagonal elements of the matrices are set to zero. To obtain the average matrix A, the researchers used Equation (1). In Table 4, the average matrix from all ten experts' responses is presented.

$$A = [a_{ij}] = \frac{1}{H}\sum_{k=1}^{H} x_{ij}^{k}. \qquad (1)$$

Table 4. Average matrix from all ten experts' responses

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	0	3.4	2.2	3.3	3.6	3.9	3.6	1.9	1.2	1
C2	0	0	0.3	1.8	1.7	1.9	1.9	0.6	0.3	0.5
C3	0.1	0.3	0	0.5	0.9	0.8	0	0	0.6	0
C4	0.7	1.6	0.9	0	2	2	2.2	1	0.7	0.6
C5	0.1	0.8	0.4	0.5	0	1	1.8	0.6	0.2	0.1
C6	2.4	3.1	2.1	2.9	3.4	0	4	2.2	1.1	0.3
C7	1.4	1.3	0	0.1	1.7	3.7	0	0.8	0.5	0
C8	0	0.9	0	0.5	0.4	0.7	1	0	0.1	0.8
C9	0.3	0.8	0.3	0.5	1.4	0.9	0.7	0.1	0	0.1
C10	0.2	0	0.6	0	1	0.7	0.2	0.1	0.1	0

Step 2: The normalized initial direct-relation matrix is calculated. Normalize initial direct-relation matrix D is obtained by the use of Equation (2). Accordingly, each element of matrix D falls between 1 and 0. In Table 5, the matrix D is presented.

$$D = A \times S, \quad S = \frac{1}{\max\limits_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}} \qquad (2)$$

Table 5. Average matrix from all ten experts' responses

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	0.000	0.141	0.091	0.137	0.149	0.162	0.149	0.079	0.050	0.041
C2	0.000	0.000	0.012	0.075	0.071	0.079	0.079	0.025	0.012	0.021
C3	0.004	0.012	0.000	0.021	0.037	0.033	0.000	0.000	0.025	0.000
C4	0.029	0.066	0.037	0.000	0.083	0.083	0.091	0.041	0.029	0.025
C5	0.004	0.033	0.017	0.021	0.000	0.041	0.075	0.025	0.008	0.004
C6	0.100	0.129	0.087	0.120	0.141	0.000	0.166	0.091	0.046	0.012
C7	0.058	0.054	0.000	0.004	0.071	0.154	0.000	0.033	0.021	0.000
C8	0.000	0.037	0.000	0.021	0.017	0.029	0.041	0.000	0.004	0.033
C9	0.012	0.033	0.012	0.021	0.058	0.037	0.029	0.004	0.000	0.004
C10	0.008	0.000	0.025	0.000	0.041	0.029	0.008	0.004	0.004	0.000

Step 3: The total relation matrix is calculated by the use of Equation (3). In this equation, *I* is the identity matrix. The result of this step is shown in Table 6.

$$T = D(I - D)^{-1} \tag{3}$$

Table 6. Total relation matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	0.052	0.230	0.137	0.208	0.263	0.271	0.268	0.138	0.086	0.063
C2	0.024	0.040	0.033	0.101	0.116	0.123	0.127	0.051	0.027	0.029
C3	0.012	0.027	0.008	0.032	0.054	0.047	0.020	0.009	0.030	0.003
C4	0.055	0.112	0.061	0.040	0.140	0.140	0.150	0.072	0.047	0.035
C5	0.019	0.057	0.028	0.039	0.031	0.072	0.102	0.040	0.018	0.010
C6	0.134	0.206	0.125	0.181	0.239	0.116	0.264	0.140	0.077	0.034
C7	0.085	0.108	0.032	0.054	0.134	0.202	0.074	0.069	0.041	0.013
C8	0.010	0.053	0.009	0.034	0.039	0.051	0.063	0.011	0.011	0.037
C9	0.024	0.054	0.024	0.039	0.084	0.063	0.058	0.019	0.008	0.009
C10	0.015	0.012	0.031	0.010	0.055	0.041	0.024	0.012	0.009	0.002

In this step, to determine the Network Relationship Map (NRM), a threshold value must be considered. In this way, partial relations can be discarded and the network is drawn based on important relationships. Only relationships whose values in the matrix T are greater than the threshold value will be displayed in NRM. The threshold value of the criteria in this study is 0.071. The model of the meaningful relationships of the criteria is given in Table 7. The important relationships are indicated by "1".

Table 7. NRM of relationships

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	0	1	1	1	1	1	1	1	1	0
C2	0	0	0	1	1	1	1	0	0	0
C3	0	0	0	0	0	0	0	0	0	0
C4	0	1	0	0	1	1	1	1	0	0
C5	0	0	0	0	0	1	1	0	0	0
C6	1	1	1	1	1	1	1	1	1	0
C7	1	1	0	0	1	1	1	0	0	0
C8	0	0	0	0	0	0	0	0	0	0
C9	0	0	0	0	1	0	0	0	0	0
C10	0	0	0	0	0	0	0	0	0	0

Step 4. In this step, two vectors $r(n \times 1)$ and $c(1 \times n)$ are defined to represent respectively the sum of rows and the sum of columns of the calculated total relation matrix, T. The results are presented in Table 8. According to the results, Leadership (C1) has the highest impact, and Tools and Technique (C10) has the least impact on the system. In addition, Product and Service Design (C5) is more influenced by the other factors, and Tools and Technique (C10) receive the least impact from the other factors. The results also indicate that Strategic Planning, Supplier Quality Management, Product and Service Design, Customer Relationship Management, Information and Analysis, and Tools and Technique are net receivers based on (r-c) values. In addition, Leadership, Process Management, Employee Management, and Hard TQM are net causes in the system. Furthermore, from the results, we can say that Employee Management is the most important factor based on (r + c) values. Accordingly, from these results, we can provide the digraph of causal relations among ten factors. The digraph of causal relations is presented in Figure 3. Note that the average of the elements in matrix T is considered as a threshold value (0.071) to construct the digraph of ten factors.

Table 8. Influences given and received among the ten dimensions

	r	**c**	**r+c**	**r-c**
C1	1.715	0.429	2.144	1.286
C2	0.670	0.900	1.570	-0.230
C3	0.241	0.488	0.729	-0.246
C4	0.853	0.738	1.591	0.114
C5	0.415	1.155	1.570	-0.740
C6	1.516	1.126	2.642	0.390
C7	0.814	1.150	1.964	-0.336
C8	0.319	0.562	0.881	-0.243
C9	0.382	0.353	0.736	0.029
C10	0.211	0.235	0.446	-0.023

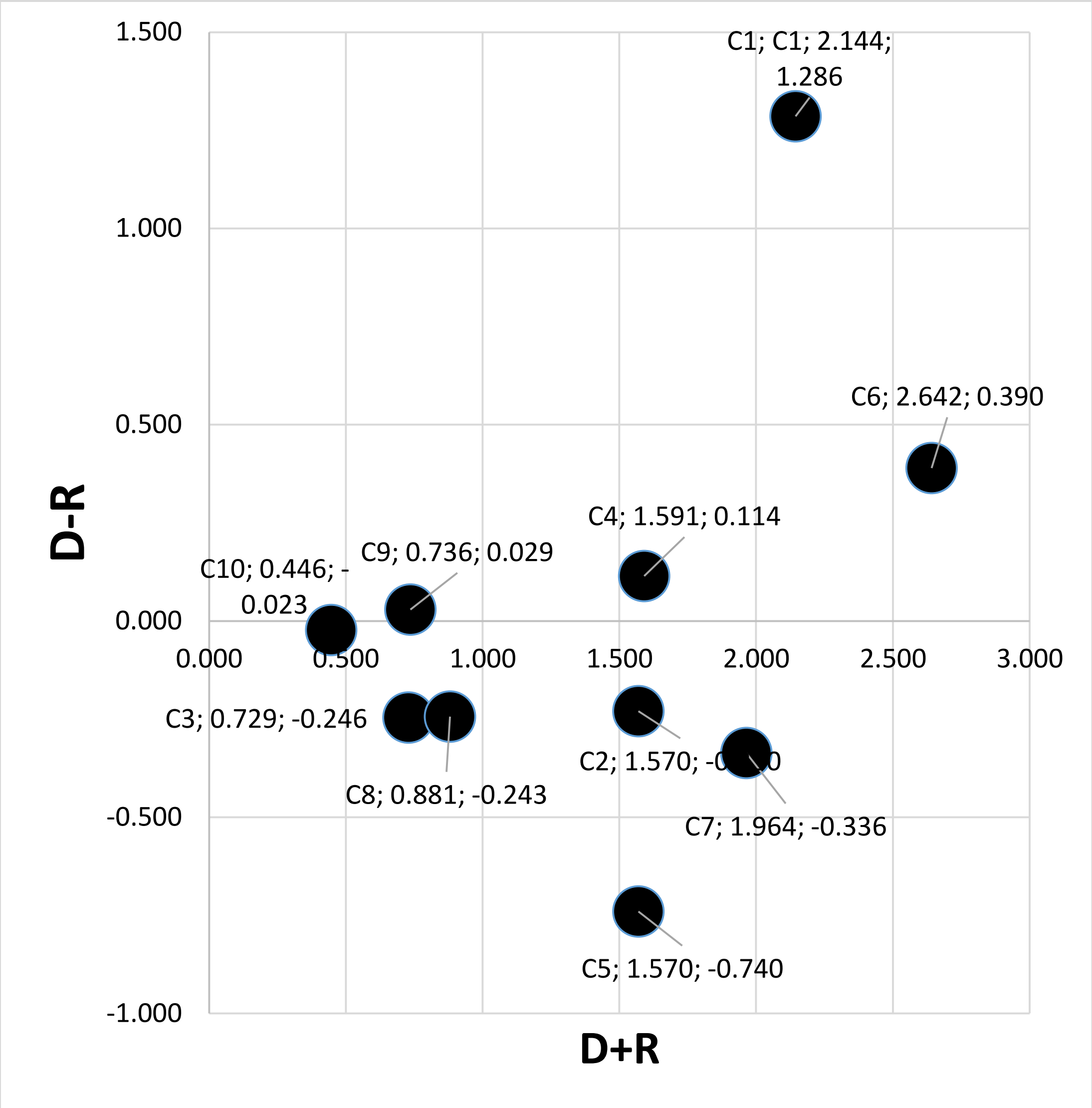

Figure 3. The digraph of causal relations

4.2. ANP

The results of CR values of all matrices are presented in the results of the comparison matrices which were accessed by Super Decisions software (Lin, Tsai, Shiang, Kuo, & Tsai, 2009). It can be found that for all comparison matrices, the CR values are acceptable (CR<0.1).

This research has ten main practices for which the average paired comparisons are presented in Table 9. The results of this pairwise comparison show that, without considering the internal relationships, the Employee Management (C6) practice with a weight of 0.265 is the most important practice of the model. The Customer Relationship Management (C7) with a weight of 0.230 and the Leadership (C1) with a weight of 0.227 are respectively in the second and third ranks. The CR value of this matrix is 0.058<0.1.

Table 9. The pairwise comparison matrix of main practices concerning the goal

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Weight
C1	1.000	5.848	7.739	7.368	4.656	0.693	1.130	7.509	8.091	8.198	0.227
C2	0.171	1.000	5.237	1.839	0.794	0.136	0.164	3.490	6.371	6.336	0.072
C3	0.129	0.191	1.000	0.390	0.215	0.124	0.137	0.810	2.364	2.879	0.026
C4	0.136	0.544	2.564	1.000	0.466	0.121	0.146	2.145	4.013	4.125	0.044
C5	0.215	1.259	4.651	2.146	1.000	0.166	0.216	3.651	5.172	4.982	0.074
C6	1.443	7.353	8.065	8.264	6.024	1.000	1.000	7.496	7.855	8.526	0.265
C7	0.885	6.098	7.299	6.849	4.630	1.000	1.000	7.972	8.183	8.415	0.230
C8	0.133	0.287	1.235	0.466	0.274	0.133	0.125	1.000	2.395	3.659	0.029
C9	0.124	0.157	0.423	0.249	0.193	0.127	0.122	0.418	1.000	1.714	0.018
C10	0.122	0.158	0.347	0.242	0.201	0.117	0.119	0.273	0.583	1.000	0.015
CR=0.058											

Leadership includes three sub-practices and the pairwise comparisons of its elements are presented in Table 10. From this table, it can be found that the CR value of this matrix is 0.001<0.1.

Table 10. The pairwise comparison matrix of sub-practices of Leadership

	S11	S12	S13	Weight
S11	1.000	4.379	2.145	0.587 (Most important)
S12	0.228	1.000	0.443	0.130
S13	0.466	2.257	1.000	0.283
CR=0.001				

Strategic Planning includes two sub-practices and the pairwise comparisons of its elements are presented in Table 11. From this table, it can be found that the CR value of this matrix is 0.0000<0.1.

Table 11. The pairwise comparison matrix of sub-practices of Strategic Planning

	S21	S22	Weight
S21	1	0.321	0.243
S22	3.115	1	0.757 (Most important)
CR=0.0000			

Supplier's Quality Management includes four sub- practices and the pairwise comparisons of its elements are presented in Table 12. From this table, it can be found that the CR value of this matrix is 0.049<0.1.

Table 12. The pairwise comparison matrix of sub-practices of Supplier's Quality Management

	S31	S32	S33	S34	Weight
S31	1.000	0.206	0.191	0.143	0.052
S32	4.854	1.000	0.408	0.443	0.185
S33	5.236	2.451	1.000	0.425	0.294
S34	6.993	2.257	2.353	1.000	0.469 (Most important)
CR=0.049					

Process Management includes two sub-practices and the pairwise comparisons of its elements are presented in Table 13. From this table, it can be found that the CR value of this matrix is 0.0000<0.1.

Table 13. The pairwise comparison matrix of sub-practices of Process Management

	S41	S42	Weight
S41	1	1.951	0.661(Most important)
S42	0.513	1	0.339
CR=0.0000			

Product and Service Design includes two sub-practices which the pairwise comparisons of its elements are presented in Table 14. From this table, it can be found that the CR value of this matrix is 0.0000<0.1.

Table 14. The pairwise comparison matrix of sub-practices of Product and Service Design

	S51	S52	Weight
S51	1	8.586	0.896 (Most important)
S52	0.116	1	0.104
CR=0.0000			

Employee Management includes eight sub-practices and the pairwise comparisons of its elements are presented in Table 15. From this table, it can be found that the CR value of this matrix is 0.035<0.1.

Table 15. The pairwise comparison matrix of sub-practices of Employee Management

	S61	S62	S63	S64	S65	S66	S67	S68	Weight
S61	1.000	0.262	0.871	3.149	0.413	0.530	0.530	0.456	0.072
S62	3.817	1.000	1.072	4.595	1.149	1.149	1.149	1.282	0.171
S63	1.148	0.933	1.000	3.926	0.871	1.149	0.707	1.072	0.124
S64	0.318	0.218	0.255	1.000	0.148	0.283	0.257	0.231	0.030
S65	2.421	0.870	1.148	6.757	1.000	6.302	1.414	1.374	0.224(Most important)
S66	1.887	0.870	0.870	3.534	0.159	1.000	0.509	0.443	0.091
S67	1.887	0.870	1.414	3.891	0.707	1.965	1.000	1.072	0.145
S68	2.193	0.780	0.933	4.329	0.728	2.257	0.933	1.000	0.142
CR=0.0000									

Customer Relationship Management includes four sub-practices and the pairwise comparisons of its elements are presented in Table 16. From this table, it can be found that the CR value of this matrix is 0.004<0.1.

Table 16. The pairwise comparison matrix of sub-practices of Customer Relationship Management

	S71	S72	S73	S74	Weight
S71	1.000	2.814	0.435	0.492	0.176
S72	0.355	1.000	0.158	0.166	0.062
S73	2.299	6.329	1.000	1.000	0.389 (Most important)
S74	2.033	6.024	1.000	1.000	0.373
CR=0.004					

Information and Analysis includes three sub-practices and the pairwise comparisons of its elements are presented in Table 17. From this table, it can be found that the CR value of this matrix is 0.017<0.1.

Table 17. The pairwise comparison matrix of sub-practices of Information and Analysis

	S81	S82	S83	Weight
S81	1.000	0.319	0.470	0.155
S82	3.135	1.000	2.203	0.556 (Most important)
S83	2.128	0.454	1.000	0.289
CR=0.017				

Hard TQM includes four sub-practices and the pairwise comparisons of its elements are presented in Table 18. From this table, it can be found that the CR value of this matrix is 0.002<0.1.

Table 18. The pairwise comparison matrix of sub-practices of Hard TQM

	S91	S92	S93	S94	Weight
S91	1.000	0.860	0.608	1.149	0.216
S92	1.163	1.000	0.871	1.422	0.269
S93	1.645	1.148	1.000	1.516	0.320 (Most important)
S94	0.870	0.703	0.660	1.000	0.196
CR=0.002					

The Tools and Technique includes three sub- practices which the pairwise comparisons of its elements are presented in Table 19. From this table, it can be found that the CR value of this matrix is 0.001<0.1.

Table 19. The pairwise comparison matrix of sub-practices of Tools and Technique

	S101	S102	S103	Weight
S101	1.000	1.182	0.300	0.205
S102	0.846	1.000	0.381	0.199
S103	3.333	2.625	1.000	0.597 (Most important)
CR=0.001				

The results of these comparisons and interdependencies among the practices are presented in Table 20.

Table 20. The weights of main factors according to their interdependencies

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	0	0	0	0	0	0.236	0.231	0	0	0
C2	0.158	0	0	0.068	0	0.065	0.039	0	0	0
C3	0.031	0	0	0	0	0.022	0	0	0	0
C4	0.086	0.050	0	0	0	0.040	0	0	0	0
C5	0.111	0.094	0	0.083	0	0.073	0.047	0	1	0
C6	0.288	0.538	0	0.462	0.712	0.268	0.374	0	0	0
C7	0.263	0.319	0	0.350	0.288	0.251	0.310	0	0	0
C8	0.039	0	0	0.037	0	0.028	0	0	0	0
C9	0.023	0	0	0	0	0.017	0	0	0	0
C10	0	0	0	0	0	0	0	0	0	0

According to the pairwise comparisons and the relative weights of the factors, the initial supermatrix (un-weighted supermatrix) can be formed. Dimensions of this supermatrix include all system factors and their relative weights. The primary supermatrix is given in Table 1 of Appendix B. After the initial supermatrix is formed, each element of this supermatrix in each column is divided on the sum of the corresponding column to form the weighted supermatrix. The sum of the columns of this supermatrix is equal to 1. The weighted supermatrix is presented in

Table 2 of Appendix B. The weighted supermatrix is then transformed into the limit supermatrix. To calculate the limit matrix, the weighted supermatrix is multiplied by itself until all the columns of the matrix are identical. The priorities of the elements of the decision model can be obtained from the limit supermatrix by normalizing the relative weights for each factor. The limit supermatrix is presented in Table 3 of Appendix B. The final weights of the practices of the model are presented in Table 19. The weights of the sub-criteria of the model are presented in Tables 4-12 in Appendix B.

According to Table 21, Employee Management with a weight of 0.347 was ranked first, Customer Relationship Management with a weight of 0.266 was the second important factor, Leadership with a weight of 0.143 was in the third rank, Product and Service Design with weight of 0.089 was in fourth rank, Strategic Planning with Weight 0.058 was in fifth rank, Process Management with a weight of 0.041 was in sixth rank, Hard TQM with a weight of 0.026 was in Seventh rank, Information and Analysis with a weight of 0.017 was in eighth rank, Supplier's Quality Management with a weight of 0.012 was in ninth rank. The weight of the Tool and Technique is zero because it has no connection (as reported by the DEMATEL technique) with the other factors and is only influenced by the other factors), which indicates its very low significance compared to the other factors.

Table 21. The final weights of practices and their ranks concerning the goal

Practices	Normalized By Cluster	Rank
(C1) Leadership	0.143	3
(C2) Strategic Planning	0.058	5
(C3) Supplier's Quality Management	0.012	9
(C4) Process Management	0.041	6
(C5) Product and Service Design	0.089	4
(C6) Employee Management	0.347	1
(C7) Customer Relationship Management	0.266	2
(C8) Information and Analysis	0.017	8
(C9) Hard TQM	0.026	7
(C10) Tools and Technique	0.000	10

5. Discussions

In this study, the integrated DEMATEL-ANP findings demonstrated that EM weights 0.347 and was ranked the highest, followed by CRM (0.266) and leadership (0.143). This was followed by P&SD (0.089), strategic planning (0.058), PM (0.041), Hard TQM (0.026), information and analysis (0.017), supplier's quality management (0.012), and tools and technique with a weight of 0.000 ranked the last place. This result suggests that the participants tended to agree that EM and CRM are significant elements that should be considered within the hotel industry in Malaysia.

Given that the hotel industry is constantly in contact with people, superior communication skills, are vital, particularly amongst workers. Importantly, the qualities of employees regarding ideas, skills, and knowledge contribute to the survivability of hotels and SD. Besides, hotel workers such as porters, vendors, laundry room staff, and front counter employees who report to management, perform particular tasks and roles in the ongoing operation of the business. Moreover, the failure of any function within the business will disrupt operations, causing a 'rippling effect' that restricts the hotel's ability to effectively utilise resources, thereby impacting customers if services are disrupted. This issue is supported by literature in this field, suggesting that the effective management of employees is important in the hotel business and is seen as an indispensable management tool or mechanism. In effectively managing and meeting customer needs, many benefits prevail such as providing a conducive working environment, enhancing work experience, aiding the business to remain competitive, reducing unnecessary waste, reducing harm to the environment, being responsive to customer needs, and inspiring enthusiasm in undertaking work activities between employees and management (Bouranta et al., 2017; Mohammed et al., 2014a).

Furthermore, to ensure the business plan for hotels within this industry caters to long-term survivability and sustainability the finding presented above is also supported by previous CRM literature given the importance of effective strategies and practices for hotel growth, development, and performance (Wu & Lu, 2012). Along the same lines, in achieving CS and maintaining profitability, hoteliers need to comply with a CRM strategy that endeavors to locate, collect, and maintain proper data, disseminate information right through the hotel, and utilize the data across all levels of the organization to improve the uniqueness and personalisation customer experience (Den Hoed & Russo, 2017; Ammari, 2014). In addition, CRM is predominantly founded on the notion that creating a sustainable relationship with customers forms the backbone of the business towards gaining customer loyalty thereby being more profitable compared to non-loyal customers (Ammari & Nusair, 2015). In other words, the hotel industry, similar to other industry sectors, must remain highly competitive to remain sustainable. Moreover, hotels must create and inspire patterns of behaviour for the re-purchase intention of customers and retain existing customers (Mohammed et al., 2014a).

Lastly, while leadership was rated third, lagging behind EM and CRM, this result may reflect the concern of staff who were functioning as a team, given the reliance on team effort instead of individual effort. Notwithstanding, given hotels, constitute a community in fulfilling the function of the organization, the team needs to perform to an acceptable level, since they are accountable for their performance (Rababah, 2012). In comparison to leadership, teams can function by coordinating their tasks and other interdependent delivery, communicating about obstructions and work, and as a group, solving issues and making decisions in support of achieving organizational goals.

6. Conclusion

The findings of this study have shown that the combined MCDM approach utilizing the DEMATEL and ANP methods is considered to be extremely worthwhile and acceptable in addressing the problems related to the assessment manner of choosing TQM best practices within the hotel industry. These days, the hotel sector is constrained by the availability of resources and could benefit from adopting a systematic approach to assessing management systems that are available to them in addressing challenges attributed to sustainability. Accordingly, this paper has integrated the DEMATEL and ANP methods in establishing a novel hybrid MCDM model to address and resolve issues effectively. The characteristics and nature of this model integrate both the DEMATEL and ANP methods in considering the interdependencies amongst TQM practices and sub-practices and prioritise these practices with the resource constraints in this particular industry. From the analysis and results of this study, EM and CRM were chosen and ranked as the two topmost practices, whereas employee empowerment and CS were chosen as the best sub-practices. As such, this demonstrates that the proposed integrated model can make good decisions about choosing quality management practices.

There are also significant managerial and practical implications in this research. There is no doubt that this research will raise the level of awareness of TQM practices implementation throughout the Malaysian and global hotel industry. Thereby, the empirical results of this study provide some guidance for hotel managers to assess their company's TQM adoption. The results demonstrated here have implications not only for practitioners in the hospitality industry but also for researchers in the hospitality or tourism management sector. Likewise, quality management solution providers can also benefit from the results of this study by enhancing their approaches to mitigate the TQM adoption issues described in this study, for example emphasizing the credibility of several TQM practices like leadership, strategic planning, supplier’s quality management, process management, product and service design, employee management, customer relationship management, and information and analysis, as well as the overall reliability of the TQM system.

In conclusion, the process outlined in this study signifies an appropriate model for managing the operational requirements of hotel organizations and managing resource constraints in selecting suitable practices. A further advantage of this approach is that it may be translated into addressing various forms of decision-making. In this regard, the organization could completely comprehend and appreciate their requirements and assess differences between the data models. Nevertheless, in the course of conducting this study, various constraint that may affect the extension of the results was identified. Underpinning the distinct background of this study, research results might not be extended to other work environments due to differences in the working settings and job features. In other words, the results of this study do not represent other sectors. Hence, future studies may consider conducting thorough research, enrolling samples from different industries, and verifying existing research models across industries and/or geographical regions to confirm the significance of the model investigated in this study. In addition, further studies are recommended to adopt fuzzy theory to achieve precise data on these as certain selection criteria are qualitative.

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Appendix A. The completed DEMATEL questioners by ten experts

Expert 1	TQM Main Variables									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1		3	2	3	4	3	3	2	2	1
C2	0		0	2	2	2	2	1	1	0
C3	1	1		1	1	0	0	0	1	0
C4	0	2	1		2	2	2	1	1	0
C5	0	1	1	2		2	3	2	1	0
C6	3	3	1	3	3		4	3	2	1
C7	3	3	0	0	2	4		1	0	0
C8	0	1	0	1	0	1	1		0	1
C9	1	1	0	1	2	1	1	0		0
C10	0	0	1	0	1	0	0	1	1	
Expert 2	TQM Main Variables									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1		3	1	3	3	4	4	1	0	1
C2	0		0	2	1	2	2	0	0	1
C3	0	0		0	1	1	0	0	0	0
C4	1	1	1		3	2	2	1	1	1
C5	1	1	1	1		3	3	1	0	1
C6	3	3	2	2	3		4	2	1	0
C7	3	2	0	0	2	3		0	1	0
C8	0	1	0	0	1	2	2		0	1
C9	1	1	1	1	2	1	1	0		0
C10	1	0	1	0	1	1	0	0	0	
Expert 3	TQM Main Variables									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1		3	1	3	3	4	3	1	2	1
C2	0		1	2	2	2	3	1	0	0
C3	0	0		1	1	1	0	0	1	0

C4	1	2	1		3	2	2	1	1	0
C5	0	1	1	0		2	3	1	0	0
C6	3	3	1	3	3		4	3	1	0
C7	3	1	0	0	1	3		1	1	0
C8	0	1	0	1	0	1	1		0	1
C9	1	1	0	1	2	0	0	1		1
C10	0	0	0	0	1	1	1	0	0	
Expert 4	TQM Main Variables									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1		3	1	3	4	4	4	1	2	1
C2	0		1	2	2	2	2	0	0	1
C3	0	0		0	1	1	0	0	1	0
C4	1	2	1		2	2	2	1	1	1
C5	0	1	0	0		1	2	1	0	0
C6	3	3	2	4	3		4	2	1	0
C7	0	1	0	0	2	4		0	1	0
C8	0	1	0	0	0	1	0		0	1
C9	0	1	1	1	1	2	1	0		0
C10	0	0	0	0	1	1	0	0	0	

Expert 5	TQM Main Variables									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1		3	2	3	4	4	3	2	2	1
C2	0		0	2	1	2	2	0	0	1
C3	0	0		1	1	1	0	0	1	0
C4	1	2	1		2	3	3	1	0	1
C5	0	0	1	1		1	1	0	1	0
C6	2	3	3	2	3		4	2	1	0
C7	3	1	0	0	1	3		1	1	0
C8	0	1	0	0	0	1	0		1	0
C9	0	1	1	1	1	0	0	0		0
C10	1	0	1	0	1	1	0	0	0	
Expert 6	TQM Main Variables									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1		4	3	3	4	4	4	2	2	1
C2	0		0	2	2	2	1	1	0	0
C3	0	0		0	1	1	0	0	1	0
C4	0	1	1		1	1	1	1	0	1
C5	0	1	0	1		0	0	0	0	0
C6	2	3	2	2	4		4	1	1	0
C7	1	1	0	0	1	4		1	0	0
C8	0	0	0	0	0	0	0		0	0
C9	0	1	0	0	1	1	0	0		0
C10	0	0	0	0	1	1	1	0	0	
Expert 7	TQM Main Variables									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1		4	4	4	3	4	4	2	1	1
C2	0		1	2	2	2	2	1	0	0
C3	0	0		0	1	1	0	0	1	0
C4	1	2	1		2	2	2	1	1	1
C5	0	1	0	0		0	0	0	0	0
C6	3	3	2	3	4		4	2	1	1
C7	0	1	0	0	2	4		2	0	0
C8	0	1	0	1	1	0	2		0	1
C9	0	1	0	0	2	1	1	0		0
C10	0	0	0	0	1	0	0	0	0	
Expert 8	TQM Main Variables									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10

C1		4	2	3	4	4	3	3	1	1
C2	0		0	1	2	2	2	1	1	1
C3	0	1		1	0	0	0	0	0	0
C4	0	1	0		1	2	3	1	1	0
C5	0	1	0	0		0	2	0	0	0
C6	2	3	2	4	4		4	3	1	1
C7	0	1	0	1	3	4		1	0	0
C8	0	1	0	1	0	0	1		0	1
C9	0	0	0	0	1	1	1	0		0
C10	0	0	1	0	1	0	0	0	0	

Expert 9	TQM Main Variables									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1		3	2	4	3	4	4	2	0	1
C2	0		0	2	1	1	1	0	0	1
C3	0	1		0	1	1	0	0	0	0
C4	1	1	1		2	2	3	1	1	1
C5	0	0	0	0		0	3	0	0	0
C6	1	4	3	4	3		4	2	1	0
C7	0	1	0	0	2	4		0	1	0
C8	0	1	0	0	1	1	1		0	1
C9	0	1	0	0	1	1	1	0		0
C10	0	0	1	0	1	1	0	0	0	
Expert 10	TQM Main Variables									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1		4	4	4	4	4	4	3	0	1
C2	0		0	1	2	2	2	1	1	0
C3	0	0		1	1	1	0	0	0	0
C4	1	2	1		2	2	2	1	0	0
C5	0	1	0	0		1	1	1	0	0
C6	2	3	3	2	4		4	2	1	0
C7	1	1	0	0	1	4		1	0	0
C8	0	1	0	1	1	0	2		0	1
C9	0	0	0	0	1	1	1	0		0
C10	0	0	1	0	1	1	0	0	0	

Appendix B

Table 1. Un-weighted supermatrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Goal
C1	0.000	0.000	0.000	0.000	0.000	0.236	0.231	0.000	0.000	0.000	0.227
C2	0.158	0.000	0.000	0.068	0.000	0.065	0.039	0.000	0.000	0.000	0.072
C3	0.031	0.000	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.000	0.026
C4	0.086	0.050	1.000	0.000	0.000	0.040	0.000	0.000	0.000	0.000	0.044
C5	0.111	0.094	0.000	0.083	0.000	0.073	0.047	0.000	1.000	0.000	0.074
C6	0.288	0.538	0.000	0.462	0.712	0.268	0.374	0.000	0.000	0.000	0.265
C7	0.263	0.319	0.000	0.351	0.288	0.251	0.310	0.000	0.000	0.000	0.230
C8	0.039	0.000	0.000	0.037	0.000	0.028	0.000	0.000	0.000	0.000	0.029
C9	0.023	0.000	0.000	0.000	0.000	0.017	0.000	1.000	0.000	0.000	0.018
C10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015
Goal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S11	0.587	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S12	0.130	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S13	0.283	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S21	0.000	0.243	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S22	0.000	0.757	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S31	0.000	0.000	0.052	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S32	0.000	0.000	0.185	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S33	0.000	0.000	0.294	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

S34	0.000	0.000	0.469	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S41	0.000	0.000	0.000	0.661	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S42	0.000	0.000	0.000	0.339	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S51	0.000	0.000	0.000	0.000	0.896	0.000	0.000	0.000	0.000	0.000	0.000
S52	0.000	0.000	0.000	0.000	0.104	0.000	0.000	0.000	0.000	0.000	0.000
S61	0.000	0.000	0.000	0.000	0.000	0.072	0.000	0.000	0.000	0.000	0.000
S62	0.000	0.000	0.000	0.000	0.000	0.171	0.000	0.000	0.000	0.000	0.000
S63	0.000	0.000	0.000	0.000	0.000	0.124	0.000	0.000	0.000	0.000	0.000
S64	0.000	0.000	0.000	0.000	0.000	0.030	0.000	0.000	0.000	0.000	0.000
S65	0.000	0.000	0.000	0.000	0.000	0.224	0.000	0.000	0.000	0.000	0.000
S66	0.000	0.000	0.000	0.000	0.000	0.091	0.000	0.000	0.000	0.000	0.000
S67	0.000	0.000	0.000	0.000	0.000	0.145	0.000	0.000	0.000	0.000	0.000
S68	0.000	0.000	0.000	0.000	0.000	0.142	0.000	0.000	0.000	0.000	0.000
S71	0.000	0.000	0.000	0.000	0.000	0.000	0.176	0.000	0.000	0.000	0.000
S72	0.000	0.000	0.000	0.000	0.000	0.000	0.062	0.000	0.000	0.000	0.000
S73	0.000	0.000	0.000	0.000	0.000	0.000	0.389	0.000	0.000	0.000	0.000
S74	0.000	0.000	0.000	0.000	0.000	0.000	0.373	0.000	0.000	0.000	0.000
S81	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.155	0.000	0.000	0.000
S82	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.556	0.000	0.000	0.000
S83	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.289	0.000	0.000	0.000
S91	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.216	0.000	0.000
S92	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.269	0.000	0.000
S93	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.320	0.000	0.000
S94	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.196	0.000	0.000
S101	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.205	0.000
S102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.199	0.000
S103	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.597	0.000

Table 2. Weighted supermatrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Goal
C1	0.000	0.000	0.000	0.000	0.000	0.118	0.115	0.000	0.000	0.000	0.227
C2	0.079	0.000	0.000	0.034	0.000	0.032	0.019	0.000	0.000	0.000	0.072
C3	0.016	0.000	0.000	0.000	0.000	0.011	0.000	0.000	0.000	0.000	0.026
C4	0.043	0.025	0.500	0.000	0.000	0.020	0.000	0.000	0.000	0.000	0.044
C5	0.055	0.047	0.000	0.041	0.000	0.036	0.023	0.000	0.500	0.000	0.074
C6	0.144	0.269	0.000	0.231	0.356	0.134	0.187	0.000	0.000	0.000	0.265
C7	0.132	0.159	0.000	0.175	0.144	0.125	0.155	0.000	0.000	0.000	0.230
C8	0.020	0.000	0.000	0.019	0.000	0.014	0.000	0.000	0.000	0.000	0.029
C9	0.012	0.000	0.000	0.000	0.000	0.009	0.000	0.500	0.000	0.000	0.018
C10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015
Goal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S11	0.294	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S12	0.065	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S13	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S21	0.000	0.122	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S22	0.000	0.379	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S31	0.000	0.000	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S32	0.000	0.000	0.092	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S33	0.000	0.000	0.147	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S34	0.000	0.000	0.235	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S41	0.000	0.000	0.000	0.331	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S42	0.000	0.000	0.000	0.169	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S51	0.000	0.000	0.000	0.000	0.448	0.000	0.000	0.000	0.000	0.000	0.000
S52	0.000	0.000	0.000	0.000	0.052	0.000	0.000	0.000	0.000	0.000	0.000
S61	0.000	0.000	0.000	0.000	0.000	0.036	0.000	0.000	0.000	0.000	0.000
S62	0.000	0.000	0.000	0.000	0.000	0.086	0.000	0.000	0.000	0.000	0.000

S63	0.000	0.000	0.000	0.000	0.000	0.062	0.000	0.000	0.000	0.000	0.000
S64	0.000	0.000	0.000	0.000	0.000	0.015	0.000	0.000	0.000	0.000	0.000
S65	0.000	0.000	0.000	0.000	0.000	0.112	0.000	0.000	0.000	0.000	0.000
S66	0.000	0.000	0.000	0.000	0.000	0.046	0.000	0.000	0.000	0.000	0.000
S67	0.000	0.000	0.000	0.000	0.000	0.073	0.000	0.000	0.000	0.000	0.000
S68	0.000	0.000	0.000	0.000	0.000	0.071	0.000	0.000	0.000	0.000	0.000
S71	0.000	0.000	0.000	0.000	0.000	0.000	0.088	0.000	0.000	0.000	0.000
S72	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.000	0.000	0.000	0.000
S73	0.000	0.000	0.000	0.000	0.000	0.000	0.195	0.000	0.000	0.000	0.000
S74	0.000	0.000	0.000	0.000	0.000	0.000	0.187	0.000	0.000	0.000	0.000
S81	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.078	0.000	0.000	0.000
S82	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.278	0.000	0.000	0.000
S83	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.144	0.000	0.000	0.000
S91	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.108	0.000	0.000
S92	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.134	0.000	0.000
S93	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.160	0.000	0.000
S94	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.098	0.000	0.000
S101	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.205	0.000
S102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.199	0.000
S103	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.597	0.000

Table 3. Limit supermatrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Goal
C1	0.0717	0.0717	0.0717	0.0717	0.0717	0.0717	0.0717	0.0717	0.0717	0.0000	0.0717
C2	0.0291	0.0291	0.0291	0.0291	0.0291	0.0291	0.0291	0.0291	0.0291	0.0000	0.0291
C3	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0061	0.0000	0.0061
C4	0.0207	0.0207	0.0207	0.0207	0.0207	0.0207	0.0207	0.0207	0.0207	0.0000	0.0207
C5	0.0444	0.0444	0.0444	0.0444	0.0444	0.0444	0.0444	0.0444	0.0444	0.0000	0.0444
C6	0.1736	0.1736	0.1736	0.1736	0.1736	0.1736	0.1736	0.1736	0.1736	0.0000	0.1736
C7	0.1329	0.1329	0.1329	0.1329	0.1329	0.1329	0.1329	0.1329	0.1329	0.0000	0.1329
C8	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0000	0.0085
C9	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131	0.0000	0.0131
C10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Goal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
S11	0.0421	0.0421	0.0421	0.0421	0.0421	0.0421	0.0421	0.0421	0.0421	0.0000	0.0421
S12	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	0.0000	0.0093
S13	0.0203	0.0203	0.0203	0.0203	0.0203	0.0203	0.0203	0.0203	0.0203	0.0000	0.0203
S21	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0000	0.0071
S22	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0000	0.0221
S31	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0000	0.0003
S32	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0000	0.0011
S33	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0000	0.0018
S34	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0000	0.0029
S41	0.0137	0.0137	0.0137	0.0137	0.0137	0.0137	0.0137	0.0137	0.0137	0.0000	0.0137
S42	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0000	0.0070
S51	0.0397	0.0397	0.0397	0.0397	0.0397	0.0397	0.0397	0.0397	0.0397	0.0000	0.0397
S52	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0000	0.0046
S61	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0000	0.0125
S62	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0000	0.0297
S63	0.0216	0.0216	0.0216	0.0216	0.0216	0.0216	0.0216	0.0216	0.0216	0.0000	0.0216
S64	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0000	0.0052
S65	0.0389	0.0389	0.0389	0.0389	0.0389	0.0389	0.0389	0.0389	0.0389	0.0000	0.0389
S66	0.0159	0.0159	0.0159	0.0159	0.0159	0.0159	0.0159	0.0159	0.0159	0.0000	0.0159
S67	0.0252	0.0252	0.0252	0.0252	0.0252	0.0252	0.0252	0.0252	0.0252	0.0000	0.0252
S68	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0000	0.0246
S71	0.0233	0.0233	0.0233	0.0233	0.0233	0.0233	0.0233	0.0233	0.0233	0.0000	0.0233

S72	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0000	0.0082
S73	0.0517	0.0517	0.0517	0.0517	0.0517	0.0517	0.0517	0.0517	0.0517	0.0000	0.0517
S74	0.0496	0.0496	0.0496	0.0496	0.0496	0.0496	0.0496	0.0496	0.0496	0.0000	0.0496
S81	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0000	0.0013
S82	0.0047	0.0047	0.0047	0.0047	0.0047	0.0047	0.0047	0.0047	0.0047	0.0000	0.0047
S83	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0000	0.0024
S91	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0000	0.0028
S92	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0000	0.0035
S93	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0000	0.0042
S94	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0000	0.0026
S101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
S102	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
S103	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 4. The final weights of sub-practices of Leadership and their ranks

Sub-practices	Normalized By Cluster	Rank
S11	0.587	1
S12	0.130	3
S13	0.283	2

Table 5. The final weights of sub-practices of Strategic Planning and their ranks

Name	Normalized By Cluster	Rank
S21	0.243	2
S22	0.757	1

Table 6. The final weights of sub-practices of Supplier's Quality Management and their ranks

Name	Normalized By Cluster	Rank
S31	0.051	4
S32	0.185	3
S33	0.294	2
S34	0.469	1

Table 7. The final weights of sub-practices of Process Management and their ranks

Name	Normalized By Cluster	Rank
S41	0.661	1
S42	0.339	2

Table 8. The final weights of sub-practices of Product and Service Design and their ranks

Name	Normalized By Cluster	Rank
S51	0.896	1
S52	0.104	2

Table 9. The final weights of sub-practices of Employee Management and their ranks

Name	Normalized By Cluster	Rank
S61	0.072	7
S62	0.171	2
S63	0.124	5
S64	0.030	8
S65	0.224	1

S66	0.091	6
S67	0.145	3
S68	0.142	4

Table 10. The final weights of sub-practices of Customer Relationship Management and their ranks

Name	Normalized By Cluster	Rank
S71	0.176	3
S72	0.062	4
S73	0.389	1
S74	0.373	2

Table 11. The final weights of sub-practices of Information and Analysis and their ranks

Name	Normalized By Cluster	Rank
S81	0.155	3
S82	0.556	1
S83	0.289	2

Table 12. The final weights of sub-practices of Hard TQM and their ranks

Name	Normalized By Cluster	Rank
S91	0.216	3
S92	0.269	2
S93	0.319	1
S94	0.196	4