Food supplier selection in the catering industry using the analytic hierarchy process

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Abstract

Choosing the right supplier is vital as it helps to achieve high-quality products at relatively lower costs on the one hand and increases profitability by increasing customer satisfaction on the other. Cost alone is not enough in the supplier selection process. Managers should also consider other criteria such as quality, reliability, crisis management, green product simultaneously. Supplier selection is a multi-criteria decision-making (MCDM) problem involving both qualitative and quantitative criteria. This study uses the Analytic Hierarchy Process (AHP), which is one of the MCDM methods. The aims of this study are to determine the most essential supplier selection criteria in the catering industry and to choose the most suitable supplier. A semi-structured questionnaire was used to identify the supplier selection criteria and conducted with 30 experts. Based on the identified criteria by the experts, six experienced supply chain managers from six different catering firms were invited to complete the pair-wise comparison survey. Finally, the supplier with the highest overall score, using the seven highest-ranked criteria, have been selected from the three alternatives. This study concludes that the most critical criterion is crisis management. Cost is relatively less critical criterion in the catering industry.

Keywords: supplier selection; catering industry; analytic hierarchy process; selection criteria.

Practical Application: This study provides an analytical tool to determine the criteria and to formulate supplier selection in catering industry using the AHP.

1 Introduction

Today's increasing competition conditions, advancement in technology, and increasing customer expectations have required businesses to manage their supply chains to effectively respond to competition, maintain and increase their market shares, and reach profit and customer satisfaction goals. The success of businesses also depends on the performance and efficient operation of the supply chain.

The most critical element in this chain is the suppliers. Supplier selection decisions play a key role in reducing overall purchasing costs, maintaining quality standards and improving performance. Firms must choose their suppliers correctly and establish long-term strategic partnerships with their suppliers to gain a long-term competitive advantage and improve their performance (Ulutaş, 2015).

A strategic partnership between suppliers and service providers can achieve competitive advantages related to supply chain management. The success of a supply chain is directly associated with the selection of the most appropriate suppliers. Merely looking for suppliers offering the lowest prices is no longer sufficient for "efficient sourcing". Numerous criteria should be considered in supplier selection (Ng, 2008). Supplier selection is a process by which suppliers are reviewed, evaluated, and chosen to become a part of the organization's supply chain (Chung, 2015). The evaluation process primarily involves assessing several complex factors for selecting a supplier that will best meet the catering firm's requirements.

Supplier selection has a key role in the catering industry (Fu, 2019; Amorim et al., 2016). The economic, social and cultural changes brought about by urban life has gradually increased the number of businesses serving in the catering sector. The catering sector continuously expands and evolves and is the centre of the food and drink industry. It provides services to many other sectors in Turkey as in the rest of the entire world. Catering firms face many problems at almost every stage, from the production to the marketing. Food safety violations are amongst the major problems in Turkey (Tomar & Akarca, 2019). Besides, they have to be very competitive. There are far too many firms serving in the catering sector, and these firms are constantly cutting the prices. When there is the slightest complaint in the firm that the catering firm serves, the firm receiving the service uses this complaint to excuse to change the catering firm (Kahraman et al., 2004).

As the catering firms are continually cutting the prices due to severe competition, global food prices increase. The adverse effects of climate change on agricultural production increase agricultural input prices. Rising labour cost, machinery and equipment prices, and fixed input prices such as electricity water and natural gas are also putting pressure on costs. The widely accepted belief that 'you earn when you buy, not when you sell' is also a highly accepted belief in the catering sector. Therefore, a fully functional supply chain is particularly important for catering firms.

The purchasing department should practice the correct way of supplier selection to help the firm to procure goods or services at the right price, right quantity, right quality, right time and from the right source to minimize wastage but maximize profitability.

This study examines the perceived importance of supplier selection criteria (quality, cost, reliability, green production, etc.) and identifies the relative weights of the attributes in the actual selection of suppliers for catering firms. Moreover, using the selected criteria, the aim is to choose the most suitable supplier to reduce the purchasing costs of firms, increase their competitiveness and ensure the sustainability of the business with AHP.

This study will help to formulate supplier selection in catering firms. Supplier selection is a key issue for risk management and sustainability of firms in competitive global markets.

2 Literature review

2.1 Supplier selection criteria

In recent years, supply chain management and the supplier selection process have received considerable attention in the business management literature. The supplier selection problem has been considered in many studies for a number of years, and a variety of criteria and solution methods have been generated to solve this problem efficiently.

Identification of decision-making criteria together with the right supplier selection methods are the driving factors determining a firm's growth and competitiveness. Thus, the criteria are truly important in supplier selection (Taherdoost & Brard, 2019).

Previously, supplier selection process has been based solely on price criterion, which resulted in firms engaging many short term agreements with suppliers with the lowest price quotation. As time progresses, however, more emphasis has been put on several additional criteria other than the price due to changes in production systems and customer expectations. The evaluation and selection of suppliers in the modern context needs to incorporate more criteria.

Dickson (1966) made a comprehensive study by setting 23 criteria for supplier evaluation. He determined the importance levels by scoring the criteria in the range of 0-4. Quality, delivery time and performance history were the most important factors for supplier selection. Dixon's work still remains significant and provides an important resource for developing a more advanced approach for specific industries.

Weber et al. (1991) identified ten criteria to determine the best suppliers, which are net price, delivery, quality, production capability, geographic location, technical capability, management and organization, reputation and position in the industry, financial position, and performance history.

There are many related research studies and reviews about different supplier selection and evaluation criteria, in addition to these studies. Increased competition and globalization of markets have brought new criteria into the supplier selection process and changed the ranking of existing criteria. Supplier selection criteria will continue to change over time.

2.2 The Analytic Hierarchy Process (AHP) in supplier selection

There are several supplier selection methods available based on multi-criteria decision-making approaches such as the Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Elimination and Choice Expressing Reality (ELECTRE) and Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) (Taherdoost & Brard, 2019).

The traditional cost-based solution methodologies are not as efficient as multi-criteria decision-making approaches. They do not consider qualitative supplier selection criteria such as flexibility, reliability of the supplier, cultural effects, crisis management, capability of the chosen firm, environmental factors, service capability, etc.

The analytic hierarchy process (AHP) developed by Saaty (1987) AHP allows to convert the ranked information or pairwise comparison data and allow complex problems to become much more understandable (De Felice et al., 2015). This method makes it possible to formulate the problem as a hierarchy and a mixture of quantitative and qualitative criteria. One of the other certain advantages of the AHP is that it can demonstrate the compatibility or incompatibility of the decision (Alehashem et al., 2013; Taherdoost, 2017; Darko et al., 2018; Güleş et al., 2014).

The AHP methodology can be employed as a discriminative technique and a valid method to analyze supplier selection (Baba et al., 2017). This methodology has been widely used in many fields, such as political, economic, social, and management science (Liu & Hai, 2005). Consequently, there are numerous studies in the literature in which AHP is used in supplier selection (UmaDevi et al., 2012; Anyaeche & Abegunde, 2013; Erdil & Erbıyık, 2015; Emrouznejad & Marra, 2017; Ergul et al., 2019; Kahraman et al., 2004; Alehashem et al., 2013; Zhang, 2018).

Problem statement

The problem of choosing the appropriate supplier includes many criteria. Therefore, it is insufficient for managers to find a solution based only on intuition or past experiences. It gives more accurate results that businesses use a number of systematic and scientific methods to solve such problems. This research aims to determine the criteria that firms serving in the catering sector prioritize in selecting suppliers and proposes a scientific approach to the supplier selection problem.

3 Materials and methods

3.1 Research Scope

This study has used the data collected in 2019 from catering firms that operate in Bursa, Turkey. Bursa is the fourth largest city in terms of population, and according to industry statistics, the city is the largest industrial city and automotive manufacturing centre in Turkey. This high population and developed industry

also increase the demand for catering firms. According to the Ministry of Food, Agriculture and Animal Husbandry data, the number of registered catering firms operating in Turkey as of 2018 is over 5000. According to Bursa Chamber of Commerce and Industry figures in 2019, 478 catering firms served in Bursa.

3.2 Methodology

In the supplier selection process using the AHP, *the first stage* is identifying criteria that will be considered in the selection of suppliers. *The second stage* is the pair-wise comparison surveys. *The last stage* is the selection of suppliers based on the assessment results.

Identification of supplier selection criteria

Firstly, a comprehensive literature review was conducted, and all criteria that may be the subject of supplier selection were determined. A pool of questions was then prepared, and a semi-structured questionnaire was prepared to enable insightful data exploration within the pre-set boundaries.

Thirty experts working in various positions from catering firms operating in Bursa province and having at least five years and more experience participated in the interview. The participants were initially briefed about the interview content.

The result of these in-depth interviews determined the main criteria that are considered the most important in supplier selection, and the same experts were asked to evaluate these criteria by using the 5-point Likert scale. The criteria that scored an average of 3 and above mean score were determined as essential supplier selection criteria to be evaluated at the next stage.

The pair-wise comparison survey

Pairwise comparison is a process of comparing alternatives in pairs to judge which criterion is preferred over others or has a greater quantitative property. Pairwise comparison is one of the ways to determine how to access alternatives by providing an easy way to rate and rank decision-making. Pairwise comparison provides to the respondent the scaling of two criteria in order to decide their relative preference and importance.

Purchasing managers from six catering firms were asked to participate in the pair-wise comparison survey, which included key supplier criteria set in the previous round of interviews and achieved a three and above mean score. For making clear any ambiguity in terms of understanding the concept of the questions, face-to-face interviews were provided. Purchasing managers completed the pair-wise comparison surveys based on Saaty's scale (Table 1). Using this scale, each catering firm's purchasing manager participating in the research was asked to compare the essential and relative criteria with each other. They rated the comparison as 1 being equally preferred, 3 moderately preferred, 5 strongly preferred, 7 very preferred and 9 extremely preferred.

The judgment was collected by using a purposely designed questionnaire format as shown in Table 2. If the criterion 1 is strongly preferred than the criterion 2, criterion 1 will contain

Table 1. AHP pair-wise scale (Saaty, 1977).

Importance Scale	Definition of Importance Scale
1	Equally Preferred
3	Moderately Preferred
5	Strongly Preferred
7	Very Preferred
9	Extremely Preferred
2-4-6-8	Intermediate values between two neighboring judgments

Table 2. Example of the questionnaire for pair-wise comparisons for the criteria.

How important is Criterion 1 When it is compared with Criterion 2?																
Criterion 1									Criterion 2							
9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9

Table 3. Example of the questionnaire for pair-wise comparisons for the alternatives.

With respect to the Criterion 1																
How important is Alternative A When it is compared with Alternative B?																
Alternative A									Alternative B							
9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9

the value 5. And also, pair-wise comparison of all the alternatives with respect to each criterion is needed (Table 3). The three most preferred suppliers by six catering firms were selected as alternatives.

The geometric mean is the only method for deriving weights from multiplicative pair-wise comparisons which satisfies fundamental consistency requirements.

Application of Analytic Hierarchy Process

The AHP decomposes a decision-making problem into several levels to form a hierarchy with unidirectional hierarchical relationships between levels. The top level of the hierarchy is the primary goal of the decision problem. The lower levels are the tangible and/or intangible criteria and sub-criteria that contribute to the goal. The alternatives for evaluating the criteria form the bottom level.

The steps of the AHP are described in the literature by Saaty (2008), Franek & Kresta (2014), De Felice et al. (2015), Abdul Moktadir et al. (2017), Erdil & Erbıyık (2015), Okifanto et al. (2018), Sivaprakasam et al. (2015), Ahmad & Pirzada (2014), Russo & Camanho (2015) and Mu & Pereyra-Rojas (2017).

Step 1. Definition of the goal

The goal for the multi criteria decision should be set.

Step 2. Establishment of the hierarchical structure

The problem is decomposed into a hierarchy of goal, criteria, sub-criteria (if any) and alternatives. Structuring the decision
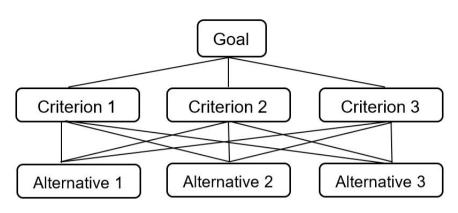
Figure 1. The model of hierarchical structure.

problem as a hierarchy is fundamental to the process of the AHP (Figure 1). Structuring the problem makes it possible to understand the decision to be taken, the criteria to be used and the alternatives to be evaluated. This step is crucial and it is possible to request the participation of experts to ensure that all criteria and possible alternatives have been considered.

Step 3. Construction of a pair-wise comparison matrix

This step determines the relative importance of the criteria and alternatives and also to compare how well the options perform on the different criteria. The pair-wise comparison judgment is obtained from experts or specialists in the relevant area (UmaDevi et al., 2012). A nine-point scale is used for pair-wise comparisons between criteria and alternatives (Sivaprakasam et al., 2015). The meaning of each scale measurement is explained in Table 1.

The pair-wise comparison matrix determines the relative priorities (weights) of the elements within each level. The exceptional or absolute importance of one element over the other is assessed at 9, and if both elements are equal in importance, then number 1 is used to denote this equality.

Total of n×(n−1)/2 comparisons are required to develop the set of matrices for the pair-wise comparisons as mentioned in above.

After all elements have been compared with the priority scale pair by pair, a paired comparison or judgment matrix (1) is formed. This matrix is composed of n rows and n columns (nxn matrix). When a_{ij} denotes the intensity of importance of the ith and jth criteria, the pairwise comparison matrix (A) is:

$$A = \left[a_{ij}\right] = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \tag{1}$$

Each element (a_{ij}) in a pair-wise comparison matrix shows the degree of preference of the *ith* criterion over the *jth* criterion. A score of 1 represents equal importance for the two components and 9 represents the extreme importance of component *i* over component *j*.

The fundamental properties of pair-wise comparison matrix are: reciprocal comparison: if $a_{ij} = x$ then $a_{ji} = 1/x$; homogeneity: if the element i and j are judged, they have an equal relative importance, thus, $a_{ij} = a_{ji} = 1$; and all the elements of its main diagonal take a value of 1.

Step 4. Calculating the eigenvector and maximum eigenvalue

After all matrices are structured and all pair-wise comparisons are obtained, the eigenvector (relative weights) and the maximum eigenvalue (λ_{max}) for each matrix are calculated.

To calculate the eigenvector, firstly, A matrix is normalized by dividing the elements of each column of the matrix by the sum of that column, using the Formula 2:

$$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \tag{2}$$

The normalized matrix A is shown as B matrix (3):

$$B = \left[b_{ij}\right] = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{bmatrix} \tag{3}$$

From this normalized B matrix, the eigenvector (or relative weights) is calculated by adding the elements in each resulting row and dividing this sum by the number of elements in the row, using the Formula 4:

$$W_i = \frac{\sum_{j=1}^{n} b_{ij}}{n} \tag{4}$$

The eigenvector of the matrix A is computed as W_i (nx1 matrix) (5) (Sivaprakasam et al., 2015).

$$W_i = \begin{bmatrix} \frac{b_{11} + b_{12} + \cdots + b_{1n}}{n} \\ \frac{b_{21} + b_{22} + \cdots + b_{2n}}{n} \\ \vdots \\ \frac{b_{n1} + b_{n2} + \cdots + b_{nn}}{n} \end{bmatrix} = \begin{bmatrix} W_1 \\ W_2 \\ \vdots \\ W_n \end{bmatrix} \tag{5}$$

The λ_{max} value is an important validating parameter in AHP. It is used as a reference index to screen information by calculating the consistency ratio of the estimated vector to validate whether the pair-wise comparison matrix provides a completely consistent evaluation.

To calculate the maximum eigenvalue, the D column vector should be obtained by using Equations 6 and 7:

$$D = [A]_{nxn} \; x \; [W_i]_{nx1} = [d_i]_{nx1} \tag{6}$$

$$D = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} x \begin{bmatrix} W_1 \\ W_2 \\ \vdots \\ W_n \end{bmatrix} = \begin{bmatrix} d_1 \\ d_2 \\ \vdots \\ d_n \end{bmatrix} \tag{7}$$

The maximum eigenvalue, λ_{max}, also known as principal eigenvalue, can be calculated by using the Formula 8:

$$\lambda_{max} = \frac{\sum_{i=1}^{n} \frac{d_i}{W_i}}{n} \tag{8}$$

The maximum eigenvalue and the corresponding normalized eigenvector of the comparing matrix give the relative importance of the various criteria being compared. The elements of the normalized eigenvector are termed weights with respect to the criteria and ratings with respect to the alternatives.

Step 5. Test of consistency

Since the numeric values are derived from individuals' subjective preferences, it is impossible to avoid some inconsistencies in the final matrix of judgments. Some inconsistency is expected and allowed in AHP analysis. The consistency ratio (CR) provides a very good estimation of the respondent's consistency in answering the questions. The consistency index (CI) is computed for each matrix of order n by the Formula 9:

$$CI = \frac{(\lambda_{max} - n)}{n-1} \tag{9}$$

The consistency ratio (CR) is then calculated using the Formula 10:

$$CR = \frac{CI}{RI} \tag{10}$$

where RI is a known random consistency index obtained from a large number of simulation runs and which varies depending upon the order of the matrix (Baba et al., 2017). Table 4 shows the value of the Random Consistency Index (RI).

Table 4. Random index (RI) values based on matrix size (Saaty, 1982).

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

The acceptable upper limit for the CR is 0.10. (Saaty, 1987). If CR ≤ 0.10, it implies that the evaluation within the matrix is acceptable or indicates a good level of consistency in the comparative judgments represented in that matrix. On the contrary, if CR > 0.10, the inconsistency of judgments within that matrix has occurred and the evaluation process should be reviewed, reconsidered and improved. An acceptable consistency ratio helps to ensure decision-maker reliability in determining the priorities of a set of criteria.

Step 6. Selecting the best alternative

The final step starts from the summation of global weights for each set of alternatives on all hierarchy level. These values are combined together to establish the overall priority weights of each alternative.

After finding all relative weights of the alternatives (V_i) and the criteria (W_i) by using the pair-wise comparisons in same method, the global weights of the alternatives (Z_i) are determined by multiplying the relative weights of the criteria (W_i) and the relative weights of the alternatives (V_i). Sum of the global weights of the alternatives gives the overall priority weights. The best alternative is the one having the highest overall priority weights.

The overall priority weight of alternative (Sj) can be calculated using the Formula 11:

$$Z_{ij} = W_i V_{ij} \; \text{ and } \; S_j = \sum_{i=1}^{n} Z_{ij} \tag{11}$$

where, Z_{ij}= global weights of alternative j, Wi= relative weights of the criteria, Vij= relative weight of the alternative j and Sj = Overall priority weight of alternative j.

This methodology implemented using commonly used software MS Excel.

4 Empirical results and discussion

4.1 Definition of the criteria

The definition of the criteria and the calculation of their weights are central in the AHP method to evaluate the alternatives. The research's focus was to determine the criteria to be used in selecting the catering suppliers and measuring their performance.

As described in detail in the methodology section, in-depth interviews were done with 30 catering experts to identify the supplier selection criteria.

This first round of expert survey revealed 15 desired criteria in the supplier selection. These criteria are shown in Table 5. These 15 criteria were asked to be evaluated by the same experts on a 5 point Likert scale, and 7 criteria with 3 or more mean score were determined as the leading supplier selection criteria in the catering sector. These 7 criteria are defined as follows:

- **Crisis management:** The supply chain has a workflow affected by multiple factors. Therefore, it is inevitable that problems may occur in delivery or afterward. If suppliers determine critical control points well, they can prevent

Table 5. Supplier selection criteria.

Criteria	Mean Rating	References
Crisis management	3.80	Tam & Tummala (2001), Görener (2009), Chung (2015)
Quality	3.46	Dickson (1966), Alehashem et al. (2013), Li et al. (1997), Yahya & Kingsman (1999), Tam &Tummala (2001), Yu & Jing (2004), Liu & Hai (2005), Weber et al. (1991), Zhang et al. (2003), Zhang (2018), Ghodsypour & O'Brien (1998), Ng (2008), Ha & Krishnan (2008), Chan & Kumar (2007), Verma & Pullman (1998)
Payment term	3.43	Haq & Kanan (2006)
Reliability	3.36	Yu & Jing (2004), Ramlan et al. (2016)
Cost	3.26	Alehashem et al. (2013), Tam & Tummala (2001), Yu & Jing (2004), Weber et al. (1991), Zhang et al. (2003), Zhang (2018), Ghodsypour & O'Brien (1998), Dickson (1966), Ramlan et al. (2016), Verma & Pullman (1998), Amid et al. (2006)
Experience	3.16	Dickson (1966), Lehmann & O'Shaughnessy (1974), Haq & Kanan (2006)
Green production	3.13	Min & Galle (1999), Lee et al. (2009)
References	2.86	Lehmann & O'Shaughnessy (1974)
Product variety	2.03	Görener (2009)
Market share	2.80	Ahmad & Pirzada (2014)
Communication	2.33	Dickson (1966), Chan et al. (2008), Haq & Kanan (2006)
Brand name	2.16	Jain et al. (2018)
Minimum order quantity	1.90	Perreault & Russ (1976)
Production facilities and capacity	1.70	Dickson (1966), Weber et al. (1991)
Geographical location	1.30	Dickson (1966), Weber et al. (1991), Chan et al. (2008)

problems or respond quickly to problems and minimize losses and damages. Crisis management is the supplier's ability to take action against problems;

- **Quality:** This is the quality of the goods and services offered by the supplier. As in every sector, the quality of the material to be used in production is of high importance. The waste ratio in the raw material is one of the most influential factors in product quality in the food industry. The supplier's quality systems and food safety measures are the characteristics that maintain and improve quality. Food safety measures is essential to reduce foodborne risks (Tomar & Akarca, 2019);

- **Payment term:** The payment term is the payment period that the supplier gives to the buyer after the delivery of the goods. The suppliers agree with the buyers they sell to about advance or term payment. In each product class, there are generally applied terms to be determined by the suppliers. Unless there is a special bilateral agreement between the buyer and the supplier, the standard maturity period is applied by the suppliers to the buyers;

- **Reliability:** This is the trust of the supplier in the decision maker in line with the financial situation and the references in the sector. Financial strength can be a good indicator of the supplier's long-term stability;

- **Cost:** Cost criteria recognize important elements of cost associated with the purchase. The suppliers can apply a direct discount to the product price due to bilateral agreements with the buyer or provide promotional product support according to the quantity of products ordered. The cost of the product is the unit price obtained after applying for a discount or promotional support;

- **Experience:** Experience is the level of experience that the firm has in direct proportion to the service it provides in the sector. The supplier's experience can determine procurement success and keep operations smooth. The experienced suppliers can be more capable of solving problems and issues;

- **Green production:** Firms with environmental management systems must develop their businesses in a way that ensures that the wastes they generate during their production are kept to a minimum in their environmental damage. The production method of firms (suppliers) that effectively apply environmental management systems is described as green production.

The hierarchical structure of the supplier selection model of this study with the seven criteria is depicted in Figure 2. The hierarchy of criteria and alternatives is composed of three levels. The goal of the problem is placed at the first level of the hierarchical structure. At the second level, the criteria are listed. The last level of the hierarchical structure of the decision problem belongs to the alternatives (suppliers). The problem is to select one of three candidate suppliers.

4.2 Pair-wise comparison of criteria and alternatives

Once the hierarchy has been structured, the prioritization procedure commences by determining the relative weights of the criteria within each level. Six experienced purchasing managers from six different catering firms were asked to make a pair-wise comparison based on Saaty's scale. They had more than five years of field experience and had a minimum of bachelor's degree. While the capacity of the aforementioned 6 different catering firms varies between 14000 and 130000, the average capacity has been determined as 52500 person/day.

The hierarchical structure of the decision model shows that 8 pair-wise comparison matrices must be developed, which are pair-wise comparison for the criteria, and pair-wise comparison for alternatives based on crisis management, quality, payment
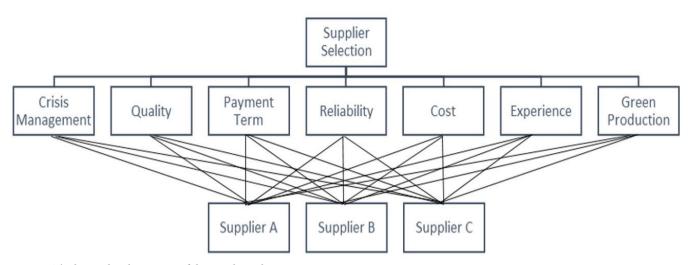
Figure 2. The hierarchical structure of the supplier selection.

term, reliability, cost, experience, and green production. The completed pair-wise comparison for the criteria is shown in Table 6 below. The completed judgment matrix has the following properties: $a_{ij} > 0$ and $a_{ji} = \dfrac{1}{a_{ij}}$.

Analysis of the results shows that the supplier's crisis management capability (30%) is at the top of the criteria that catering firms care most about when choosing a supplier. Product quality (23%) ranked the second most sought after criteria in supplier selection. Supplier reliability (16%) and payment terms (15%) were among the other pre-requisite criteria of almost equal importance. The cost (9%) of the supplied product has been attributed only to the fifth place by catering purchasing managers.

After calculating the eigenvector and maximum eigenvalue, the next step is pair-wise comparison matrix consistency verification, to explain that the pair-wise comparison matrix is logically reasonable. As a result of the calculations, it was observed that the CR value of each matrix was below 0.10 (Table 7). The consistency of the pair-wise judgments in all matrices is acceptable. Then, the overall results for each matrix were obtained by computing the geometric means of the scores given by the experts. After all the evaluation matrices were found to be consistent, the weights were calculated.

There were seven pair-wise comparison matrices that needed to be calculated for deriving relative weights of the alternatives with respect to each criterion and tested for consistency. The three most preferred suppliers by six catering firms were selected as alternatives and named suppliers A, B and C. For each criterion, the pair-wise comparison matrices were calculated.

The three alternatives pair-wise comparison matrix based on crisis management is shown in Table 8. Consistency ratio (CR) for the seven matrices of alternatives was tested as acceptable. According to Table 8, supplier B is the most important supplier based on crisis management criteria (58%).

All achieved vectors and values were formed, as shown in Table 9 for calculating the final decision. The matrix multiplication gives the rate for the three suppliers from which alternative should be chosen.

Table 6. Pair-wise comparison matrix of criteria.

Criteria	Crisis Management	Quality	Payment Term	Reliability	Cost	Experience	Green Production	Relative Weights (W_i)
Crisis Management	1	3	3	1	4	5	5	0.30
Quality	1/3	1	2	2	3	5	7	0.23
Payment Term	1/3	1/2	1	1	3	3	5	0.15
Reliability	1	1/2	1	1	2	3	5	0.16
Cost	1/4	1/3	1/3	1/2	1	3	5	0.09
Experience	1/5	1/5	1/3	1/3	1/3	1	3	0.05
Green Production	1/5	1/7	1/5	1/5	1/5	1/3	1	0.03

Table 7. Consistency ratio for the criteria.

Maximum eigenvalue (λ_{max})	7.480
Consistency Indwex (CI)	0.08
Consistency Ratio (CR)	0.061
Conclusion	Since CR < 0.10, accept the pair-wise comparison matrix

Table 8. Three alternatives pair-wise comparison matrix based on "*Crisis Management*".

Alternatives	Supplier A	Supplier B	Supplier C	Relative weights (V_i)
Supplier A	1	1/2	3	0.31
Supplier B	2	1	5	0.58
Supplier C	1/3	1/5	1	0.11
		λ_{max} = 3.004	CR = 0.003< 0.10	

Table 9. Overall rating of three suppliers using AHP.

Criteria	Relative weights of criteria (W_i)	Relative weights of suppliers (V_i)			Global weights of suppliers (Z_i)		
		A	B	C	A	B	C
Crisis Management	0.30	0.31	**0.58**	0.11	0.0930	0.1740	0.0033
Quality	0.23	**0.54**	0.30	0.16	0.1240	0.0690	0.0368
Payment Term	0.15	0.33	0.33	0.33	0.0495	0.0495	0.0495
Reliability	0.16	**0.56**	0.32	0.12	0.0896	0.0512	0.0192
Cost	0.09	**0.54**	0.35	0.11	0.0486	0.0315	0.0099
Experience	0.05	**0.57**	0.33	0.10	0.0285	0.0165	0.0050
Green Production	0.03	**0.57**	0.29	0.14	0.0171	0.0087	0.0042
Overall Priority Weights =					0.4505	0.4004	0.1576
Ranking=					1	2	3

Supplier A meets all the criteria that catering managers want to have in a supplier, except for crisis management (Table 9). As seen in Table 9, supplier B only satisfies crisis management (58%) criteria. The analysis also reveals that supplier C does not possess any desirable criteria. Table 9 proposed that supplier A is the best choice, achieving the highest overall score (overall priority) in supplier selection. Accordingly, supplier B is the second option, while supplier C is the last option.

Although supplier B was the supplier with the highest crisis management capability which was the most desired criteria of catering experts, the preferred supplier was supplier A.

From the results, it can be seen that the ranking of criteria that catering managers wish to have in a supplier will change with the relative importance of the other desired criteria. These desired criteria can change in every situation.

4.3 Discussion

Selecting the most appropriate supplier is an important strategic management decision that impacts all areas of an organization. Supply chain management will fail if the cheapest supplier is selected without considering additional costs such as the costs related to unreliable delivery, limited quality of goods supplied, and poor communication. Supplier selection is defined as the process of finding the suppliers that are most able to provide the buyer with the right quality products, at the right price, at the right quantities and at the right time.

Supplier selection criteria are determined by the personal opinions and experiences of the experts under the influence of the economic climate of the country and the world. The financial situation of the world, the country or even the sector and the existence of crisis affect every firm in different ways. Supplier selection criteria change depending on developing technology and consumer preferences also general economic conditions are decisive factors.

This study concluded that the important criteria for supplier selection in catering industry were crisis management, quality, reliability, payment term, cost and green production, respectively.

Catering firms serve to both large corporate firms such as offices, factories, schools, hotels, and smaller and individual invitations and organizations such as weddings and birthdays. Uncertainties or disruptions in the country's economy are first reflected in large firms as cut down on catering services, while for smaller organizations catering services may be postponed or cancelled altogether. Since being a service sector, the catering sector is one of the sectors most directly and quickly affected by economic developments.

On the top of the current problems the world is experiencing, the Covid-19 outbreak that emerged in early 2020 and spread rapidly around the world, also shook the world economy and caused radical changes in many sectors. The Covid-19 outbreak caused a high fluctuation in financial markets as well as supply and demand shocks. There are no sectors left unaffected by the outbreak on a local, national and global scale. Some sectors have come to a complete standstill, while others have received high demands (Gürbüz & Özkan, 2020). Catering firms have been affected by the crisis both directly and indirectly. Due to the social distance rules adopted to reduce the spread of the virus, some industrial workplaces suspended their production, while some reduced the number of employees. Office workers were allowed to work from home, while schools switched to distance learning. Depending on the pandemic's progress, hotels, restaurants and cafes were either closed or could only serve takeaways. All kinds of crowd-demanding events such as weddings, engagements, funerals, business meetings, parties were banned. Due to the pandemic, on the one hand, the demand for mass meals has disappeared, on the other hand, the demand for the food sector has increased, and people have been consuming more food at home. This made it necessary for catering firms to adapt to the current situation and develop new strategies. Besides, this revealed the necessity of crisis management for catering firms, that is, to work with suppliers who have the ability to adapt to unexpected situations.

Firms in the supply chain have been desired to have high crisis management skills related to the catering sectors' unique characteristic. Catering industry works with the just-in-time production (JIT) model. Agricultural production constitutes the primary input of the catering sector. The agricultural sector is also the most open sector to extreme weather events such as drought, extreme rainfall, hail and seasonal effects. For this reason, the ability of suppliers to quickly develop solutions in a possible shortage of product supply is essential.

Although this study was conducted before the Covid-19 pandemic, it determined that crisis management was the most

important supplier selection criterion in the catering industry. It is clear that crisis management will be more important criterion due to the increasing uncertainty with the pandemic.

One of the findings of this study is that catering managers attach less importance to the quality of the supplied product than the supplier firm's crisis management capability. It was observed that the catering firms that were evaluated in this study expect to receive service from the suppliers with the same quality standards as they have in their own quality assurance (food safety) systems.

It is a promising development that catering managers take the green production criterion among the basic supplier selection criteria in line with the healthy food awareness of people and efforts to provide sustainable food supply in recent years.

Despite the fierce competition and tight profit margins in the catering industry, the study showed that catering managers placed relatively less importance on the cost factor. In harsh economic conditions, it may seem contradictory at first glance that the cost is less favourable criteria. This is a noteworthy development showing that catering managers understand the competition's challenging and complex structure and are aware that supply chain management based on cost will no longer function properly.

The desire to work with a reliable supplier is essential for a long-term cooperation as a strategic partner. Choosing the best supplier by considering many criteria as a strategic partner will increase the profitability and sustainability of catering firms. Managing multiple suppliers can make issues such as performance tracking, design collaboration, and synchronization more complex. The cost of purchasing from a larger number of suppliers and also managing a relationship with them can be very high for firms. Using fewer suppliers can lead to value for the buyer and produce lower transaction in conjunction with lower manufacturing costs. With a decreasing number of suppliers, the importance of establishing solid relations with suppliers increases. Mutual trust is established more easily in long-term cooperative relations with a small number of suppliers. Thus, higher levels of customer service will be achieved with solid partnerships.

Choosing the best supplier will contribute to the reduction of transaction costs along with mutual trust, information sharing and reducing uncertainty. Transaction costs are simply the costs of conducting any exchange between firms in a marketplace. Transaction costs are usually divided into three main groups: information costs, negotiation costs, and monitoring costs (Luzzini et al., 2012). Trust and information sharing are central tenets of supply chains in reducing the transaction cost. Trust creates lower transaction costs in exchange relationships and provides flexibility in responding to changing market conditions. Therefore, firms in the selection of suppliers should measure all aspects of the performance of alternative suppliers, not only the cost, but also the risk factors of suppliers.

5 Conclusion

This study aims to reveal the perceived priority criteria (crisis management, quality, cost, reliability, green production, etc.)

of catering firms in their supplier selection. The study further attempts to determine the relative importance of the supplier's desired qualities to be selected.

The AHP analysis has shown that a supplier's desired criteria can differ when evaluated independently or evaluated in relation to other desired criteria. Most desirable criterion in a catering supplier (crisis management in this case) may not be a reason for choice when considered together with other criteria. If the purchasing managers attribute more value to the compared criteria, they can choose a supplier that does not have the most desired criteria. This result shows us the superiority of the AHP model in decision-making. Simultaneously, it underlines the need to analyze all the criteria that must be desired in a supplier not only alone but also by comparing with each other.

This study confirms that the rank of suppliers will be varied with the importance of the considered criteria. The considered criteria can vary in every case study. The results are indicators of the personal preferences which the experts have, as the pairwise comparison was based on their knowledge and judgments.

This study has some limitations. Research participants were purchasing managers of catering firms operating in Bursa province. The sample can be spread over more expansive geography, and the opinions of a larger number of catering firms can be applied. Different criteria of importance can be obtained by involving other people in the purchase process and obtaining their views. Although catering firms are not classified according to their production capacity in this research. A new study can reveal how production capacity will affect supplier selection criteria. Catering firms have not looked at whether their customers are corporate or individual, or order volume has not been taken into account. A customer-oriented study can reveal different selection criteria.

5.1 Managerial implications

This study provides an important tool for catering firms to assign the best supplier. It also provides an important tool for catering firms to assign the will benefit those who are involved in the supplier selection process or have authority to choose suppliers in determining the criteria for selecting the best supplier in practice. It will also be able to choose the best supplier among the alternatives.

This study can also provide practical applications for selecting the best supplier to other service sector managers such as hotels, restaurants, and cafes that provide supplies from the food and agricultural sectors. We expect this research to assist purchasing managers and other managers in purchasing decisions at other manufacturing firms other than catering.

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