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SUPPLIER SELECTION FOR COLD CHAIN PRODUCTS IN THE TOURISM SECTOR

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Abstract

This study performs an evidence-based supplier selection (SS) for five-star hotels to procure cold chain products (CCP). Research on this topic is limited. Despite a few attempts to provide insights into SS in the sector, there is still a substantial gap in SS for CCP. This study addresses the gap in research on CCP procurement in the tourism sector. In this research, while the first phase includes evaluating three suppliers through the Analytic Hierarchy Process (AHP), the second phase employs ELECTRE I to rank participants' supplier preferences. Our findings are limited to fresh fruits and vegetables as CCP. The sample consists of the purchasing specialists of seven different five-star hotels operating in Antalya-Turkey that depend on CCP. We collected the data through two face-to-face meetings. The first meeting focused on identifying and comparing the hotels' CCP procurement criteria. In the second meeting, we performed pairwise comparisons of three alternative suppliers by each criterion. The AHP demonstrates Quality (K1) and Delivery (K2) are the most important criteria with equal weights for CCP procurement. The ELECTRE I method results in the final preference ranking as *Supplier 1>Supplier 3>Supplier 2*. This result shows that Supplier 1 is the most suitable supplier for CCP supply for the participating hotels.

Keywords: Cold Chain, Procurement, Supply Chain Management, AHP and ELECTRE I, Tourism, Accommodation Businesses

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Turizm Sektöründe Soğuk Zincir Ürünleri İçin Tedarikçi Seçimi

Öz

Bu çalışma, beş yıldızlı oteller için soğuk zincir ürünlerini tedarik etmek amacıyla kanıta dayalı bir tedarikçi seçimi gerçekleştirmektedir. Bu konu hakkındaki araştırmalar sınırlıdır. Sektörde tedarikçi seçimine yönelik ilişkin birkaç içgörü sağlama girişimine rağmen, soğuk zincir ürünlerine yönelik tedarikçi seçiminde hala önemli bir boşluk vardır. Bu çalışma, turizm sektöründe soğuk zincir ürünlerinin tedarikine ilişkin araştırma boşluğunu ele almaktadır. Araştırmanın ilk aşaması üç tedarikçinin Analitik Hiyerarşi Süreci aracılığıyla değerlendirilmesini içerirken, ikinci aşama katılımcıların tedarikçi tercihlerini sıralamak için ELECTRE I yöntemini içermektedir. Bulgularımız soğuk zincir ürünü olan taze meyve ve sebzelerle sınırlıdır. Çalışmanın Örneklemini Antalya-Türkiye'de faaliyet gösteren ve soğuk zincir ürünü dış kaynaktan temin eden yedi farklı beş yıldızlı otelin satın alma uzmanları oluşturmaktadır. Çalışma için gerekli olan veriler, söz konusu satın alma uzmanlarının katıldığı iki toplantı sonucunda elde edilmiştir. İlk toplantıda, otellerin soğuk zincir ürününe yönelik satın alma kriterlerinin belirlenmesine ve kriterlerin karşılaştırılmasına odaklanıldı. İkinci toplantıda, üç alternatif tedarikçinin her kritere göre ikili karşılaştırması yapıldı. AHS yöntemi, Kalite (K1) ve Teslimat (K2) kriterlerinin eşit ağırlıkta olduğunu ve en önemli kriterler olduğunu göstermiştir. ELECTRE I yöntemi, nihai tercih sıralamasını Tedarikçi 1>Tedarikçi 3>Tedarikçi 2 olarak sonuçlandırmıştır. Bu sonuç katılımcı oteller için Tedarikçi 1'in soğuk zincir ürünlerinin tedarikinde en uygun tedarikçi olduğunu göstermektedir.

Anahtar Kelimeler: Soğuk Zincir, Tedarik, Tedarik Zinciri Yönetimi, AHP ve ELECTRE I, Turizm, Konaklama İşletmeleri

Introduction

A supply chain is a set of processes involving locating, supplying, and processing raw materials, converting them into products, and delivering them to final customers, as well as return and recycling processes. Managing the forward and reverse flow of information, materials, and cash between businesses integrated within the supply chain then underlines the significance of supply chain management. Additionally, effective logistics planning is integral to supply chain success.

Food products vulnerable to losing their inherent physical and chemical properties when stored in unsuitable conditions are referred to as "*perishable food products*." Such products must be delivered to the final consumer by maintaining ideal temperature and humidity conditions throughout all supply chain processes.

The cold chain emphasizes managing temperature-sensitive supply chains effectively. In this sense, a cold chain is an integrated system consisting of logistics activities, records, bureaucratic procedures, cold storage, temperature-controlled transport containers, and coolers, as well as the tracking and monitoring of temperature-sensitive products (Vesper, Kartoglu, Bishara & Bishara, 2010). More precisely, fresh fruit and vegetable products, meat and meat products, milk and dairy products, and aquatic products are perishable foods that should be handled within a cold chain system.

Tourism is among the leading, fastest-growing sectors across the globe and occupies a consequential seat in the economies and culture-disseminating activities of many countries. Fortunately, countries recognize the potential of tourism and prioritize their tourism-promoting policies. In light of their peculiarities, tourism businesses situated in a globally active environment endeavor to maintain their activities amidst an intensely competitive environment (Okutmuş & Ergül, 2013). Within this harsh competition, top service quality can secure the sustainability and revenues of tourism businesses. Thus, accommodation and food-beverage businesses are a key component of the tourism sector, and the performance of these businesses is evidently associated with tourism-induced economic growth (Zailani, Omar & Kopong, 2011). Thus, accommodation businesses attach pretty much value to their services and always seek guest satisfaction, highlighting the significance of fresh food supply for such businesses. Indeed, every single step must go smoothly in supplying and purchasing quality, fresh products from external sources and offering them to customers. In this regard, accommodation businesses, therefore, pay careful attention to the selection of suppliers within the cold chain.

Delving into seven different five-star hotels' supplier selection processes, this research is limited to the procurement of fresh fruit and vegetable products in the tourism sector. We collected the data through two face-to-face meetings attended by the purchasing specialists of the mentioned hotels and analyzed the

data obtained using the Analytical Hierarchy Process (AHP) and ELECTRE I methods on MS Excel.

Within five sections of the study, we present an overall description of the concepts addressed in the manuscript in the first section. The second section is dedicated to the originality of the study through a detailed literature review. While we introduce the methodology (the AHP and ELECTRE I methods) in the third section, the fourth section presents data analysis and findings. We conclude the paper with the interpretation of the findings and recommendations for prospective research.

1. Literature Review

Contemporary businesses should be able to remain highly competitive to survive in the market, which predominantly requires minimizing costs or keeping them acceptably low (Zengin etc., 2024). It is apparent that purchased goods and services are considered a significant burden on business expenditures. In this sense, carrying out procurement processes effectively and efficiently becomes rather labor-intensive for businesses. The supply chain is a network consisting of all resources, technologies, institutions, organizations, companies, individuals, and activities involved in the process from the creation of a product to its sale (Talih ve Dönmez, 2024). Supply chain activities assume an important seat in the agenda of businesses to catch market advantage (Tursun & Özkoç, 2019). Yazarkan (2012) describes supply as procuring all kinds of materials, services, and facilities from external sources and making them ready for use to achieve pre-determined business goals. It has a key role in achieving cost advantage by ensuring production or service quality and, thus, customer satisfaction (Tursun & Özkoç, 2019).

Accommodation businesses collaborate with external suppliers to enhance quality and reduce costs. What is critical here may be not receiving any harm to the business image from procurement or outsourcing activities or, in other words, finding the right supplier (Öncü & Işkın, 2009). Many accommodations businesses resort to procurement and outsourcing to be able to offer excellent food and

beverage service as it promotes business image (Hemmington & King, 2000). Thereby, food supply always remains among the principal issues on the agenda of accommodation and food/beverage businesses. As in most sectors, suppliers are central to maintaining activities efficiently in the tourism sector since well-managed supply chain activities flourish businesses in the tourism sector (Sutono, 2019). A supply chain may be construed as a whole subsuming of suppliers, manufacturers, distributors, retailers, and logisticians involved in all processes of a product, from the raw material phase to delivery to consumers and recycling. In other words, it is a system created by businesses undertaking the supply for subsequent businesses (Tanyaş, 2015). It is defined by Keleş and Oya (2020) as an organizational network of stakeholders and related activities that work collectively to produce value for consumers. In the contemporary era, the expansion of globalization and exports has led to a proliferation of supply chains across a broad spectrum of locations, which, in turn, has elevated the strategic importance of supply chains, given the intensifying competition between businesses exchanging the roles of being partners or competitors in diverse geographical regions (Torğul *et al.,* 2021). Procurement in accommodation businesses is, on the other hand, known as the acquisition of materials and services required for the continued operation of businesses (Torğul, Demiralay & Paksoy, 2021). Supply chain management is a process that utilizes all of a company's internal resources to effectively manage the shipment processes outside the organization (Koyuncu & Öztürk, 2024). It encompasses the flow of information, services, and production between suppliers and customers. In this process, accommodation businesses that act as a link between customers and suppliers must implement effective supply chain management strategies to avoid customer dissatisfaction and to remain competitive (Kothari, Hu & Roehl, 2005). The robust importance of a supply chain then necessitates a strong integration between businesses and vendors to boost the performance of activities subject to supply chain management (Arifin, Ibrahim & Nur, 2019). Supply chain management comprises material and information flow

processes, including production, distribution, and retail. Supply chain management is also critical in the tourism sector; nevertheless, what we focus on is the supplier selection for the procurement of cold chain products. A reliable and adequate food supply is a crucial aspect for hospitality businesses since continued customer satisfaction and patronage may, in fact, be dependent upon the quality and safety of the foods offered. In this regard, the food supply chain can be construed as a complex whole that begins with the sourcing and supply of high-quality and safe raw materials, continues with the food processing and the logistics of both intermediate and finished products, and encompasses all other activities until finished products reach the end consumer (Keleş & Oya, 2020). The supply of fresh food is a significant issue for both businesses and customers, requiring rigorous and meticulous management. To ensure effective management of the food supply chain, it is essential to facilitate effective communication between stakeholders, secure the adaptability of the chain to technological and standard developments, and implement efficient logistics management (Mahalik & Kim, 2016).

Managing the logistics of perishable foods is generally referred to as cold chain management (Ovca & Jevšnik, 2009) and may create splendid challenges for tourism businesses in the current market conditions (Singh, Gunasekaran & Kumar, 2018). İpekçi and Tanyaş (2021) present cold chain logistics as logistics operations to control the temperature regime of specific products, particularly in the food and pharmaceutical industries, up to the point of consumption. Temperature control is highly needed to retain food safety, prevent waste, and deliver products retaining their properties (İpekçi & Tanyaş, 2021). Briefly, the significance of cold chain services lies in avoiding spoilage and loss of quality by ensuring that food is delivered and stored within a prescribed temperature range.

One of the most significant challenges throughout human history has been the preservation of food without compromising its quality (Çevik, 2021). What peculiarity distinguishes fresh food products from others may be their delivery.

Fresh foods need successful supply chain operations to be delivered to the final consumer at optimal quality (Tursun & Özkoç, 2019). Such products must be monitored at every step of the supply chain to be able to retain their vitality and must be stored in appropriate conditions, which can only be ensured thanks to a well-organized cold chain. Besides, increased delivery distance, consumption amount, and product variety put substantial pressure on cold chain supply to retain optimal conditions of products delivered (İzer, 2017). Thus, tourism businesses should act picky when choosing their suppliers. A competent supplier should be open to cooperation and innovation, offer quality products, comply with delivery times and orders, have suitable storage and shipment facilities, and integrate cutting-edge technology into its facilities and business processes. On the other hand, supply and purchasing activities (e.g., supplier selection, demand management, planning of material needs, and order and warehouse management) should be carried out through a separate, dedicated department in accommodation businesses. Supplier selection may be the prominent one among activities carried out in such a department, and there are a plethora of factors to consider when selecting the right supplier. In its simplest form, the supply chain in accommodation businesses can be depicted as a chain of supplier-hotel-customer (Erdem, 2023).

The selection of a suitable supplier is regarded as a crucial process that directly affects the quality of service offered in accommodation businesses. The characteristics of food and beverages (e.g., perishable nature and the need for prompt consumption) necessitate a precise determination of supply requirements in this industry. A meticulous examination of factors such as quality, dependability, costs, adaptability, and sustainability allows a business to maintain control over its expenditures while enhancing operational proficiency and client gratification. Identifying the optimal supplier ensures cost-effectiveness in procurement and services, which in turn contributes to the competitive advantages of businesses (Xia & Wu, 2007; Avcıkurt, Sarıoğlan, Çaylı & Saylan, 2010).

A relative dependence of accommodation businesses on the cooperation of suppliers to satisfy their needs for various goods and materials (Koçak, 2006), increased competition, and diverse consumer demands in the service sector have led to more suppliers seeking a share of the market, highlighting the significance of creating trust-based cooperation with suppliers for tourism businesses (Erdem, 2023; Davras & Karaatlı, 2014). Yet, choosing the right supplier necessitates a rigorous evaluation and continuous monitoring process.

A business should cooperate with efficient suppliers to retain its competitive advantage in the global market (Hahn, Kim & Watts, 1990) and follow four fundamental stages below in supplier selection (De Boer, Labro & Morlacchi, 2001):

- Problem definition: This step covers a comprehensive study of whether procurement is necessary and, if so, deciding if to work with a new supplier or continue with the existing one(s).
- Formulation of criteria: The purchasing team should follow a path to decide which supplier to choose based on pre-determined criteria (e.g., price, production capacity, technological competence, distribution performance, etc.).
- Pre-qualification: The most suitable suppliers are identified and ranked in line with the method applied and decisions in the previous step.
- Final choice: While involving observation and brainstorming more, the first two steps should also cover quantitative methods to make efficient, risk-free decisions. The final supplier is selected based on the most appropriate decision-making method.

Today, multi-criteria decision-making approaches are extensively adopted when selecting appropriate suppliers. Strategic collaborations with suppliers and a well-established supply chain inevitably bring positive impacts on product and service quality. A well-established and managed supply chain plays a pivotal role in enhancing the efficiency of businesses, curbing costs, guaranteeing customer

satisfaction, and securing a competitive edge. Efficient supply chain management ensures the seamless integration of all processes, ensuring their smooth and consistent operation within an established framework of controls.

1. Methodology

1.1. Aim

The present study attempts to perform an evidence-based supplier selection for participating five-star hotels to procure cold chain products.

1.2. Limitations

Our findings are limited to fresh fruits and vegetables as cold chain products. In addition, the personal/commercial credentials of the purchasing specialists (sample), the hotels, and the suppliers are kept confidential.

1.3. Sample

The sample consists of seven different five-star hotels operating in Antalya-Turkey that depend on cold chain products and the purchasing specialists of these hotels.

1.4. Data Collection

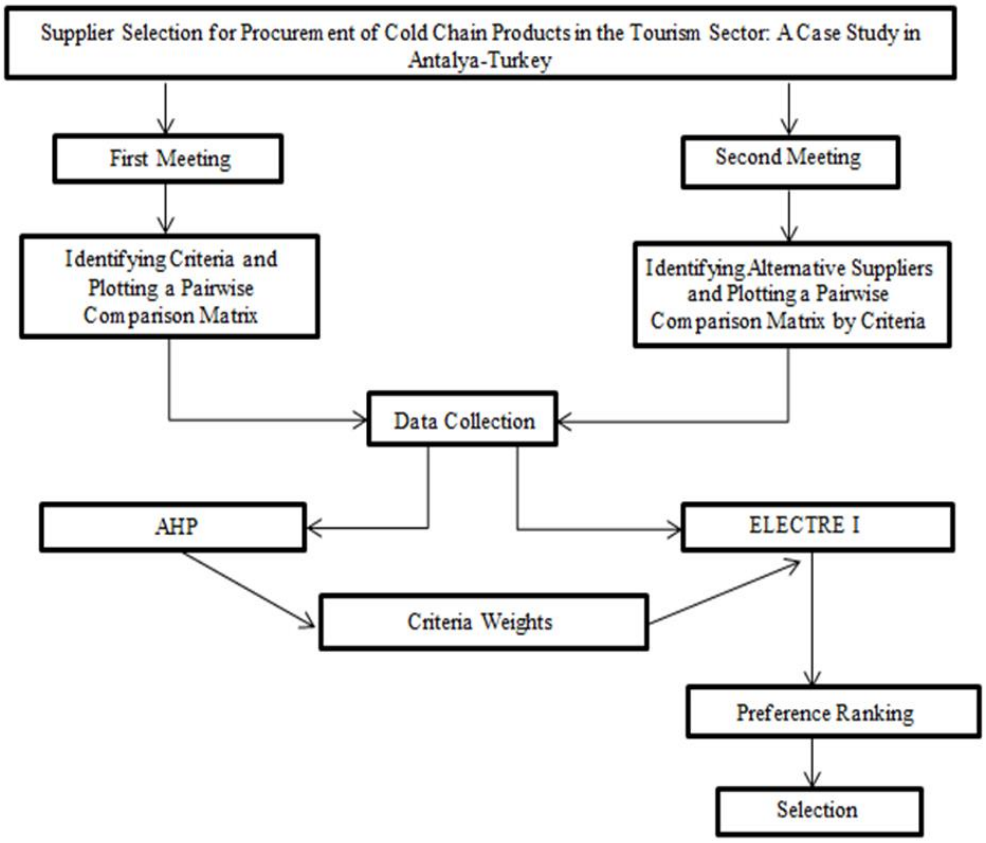

Figure 1. *Research Methodology*

Data were collected through two face-to-face meetings with purchasing experts. The first meeting focused on determining the criteria that these hotels consider when sourcing fresh fruit and vegetables and creating a pairwise comparison matrix to determine the intensity of these criteria. The selection of criteria adopted the criteria that Dickson determined for supplier selection (Weber, Current, & Benton, 1991). These criteria were evaluated in the first meeting and 11 criteria consistent with the objectives of the study were determined. These criteria are; Quality (K1), Delivery (K2), Warranty Policy (K3), Production Facility and Capacity (K4), Price (K5), Financial Status (K6), Communication Skills (K7), Business Control (K8), Attitude (K9), Geographical Location (K10) and Number

of Previous Successful Transactions (K11). In the second meeting, we identified alternative supplier companies and performed pairwise comparisons between these companies by the pre-determined criteria. Then, we analyzed the data in two phases using two multi-criteria decision-making methods, Analytical Hierarchy Process (AHP) and ELECTRE I. The first phase includes AHP to derive criteria weights. The second phase incorporates criteria weights into the ELECTRE I method to rank participating hotels' preferences for three supplier companies and select the most suitable supplier. The overall methodology is summarized below (Figure 1).

1.5. Analytical Hierarchy Process

Analytical Hierarchy Process is applied as in Figure 2 and consists of the following four steps.

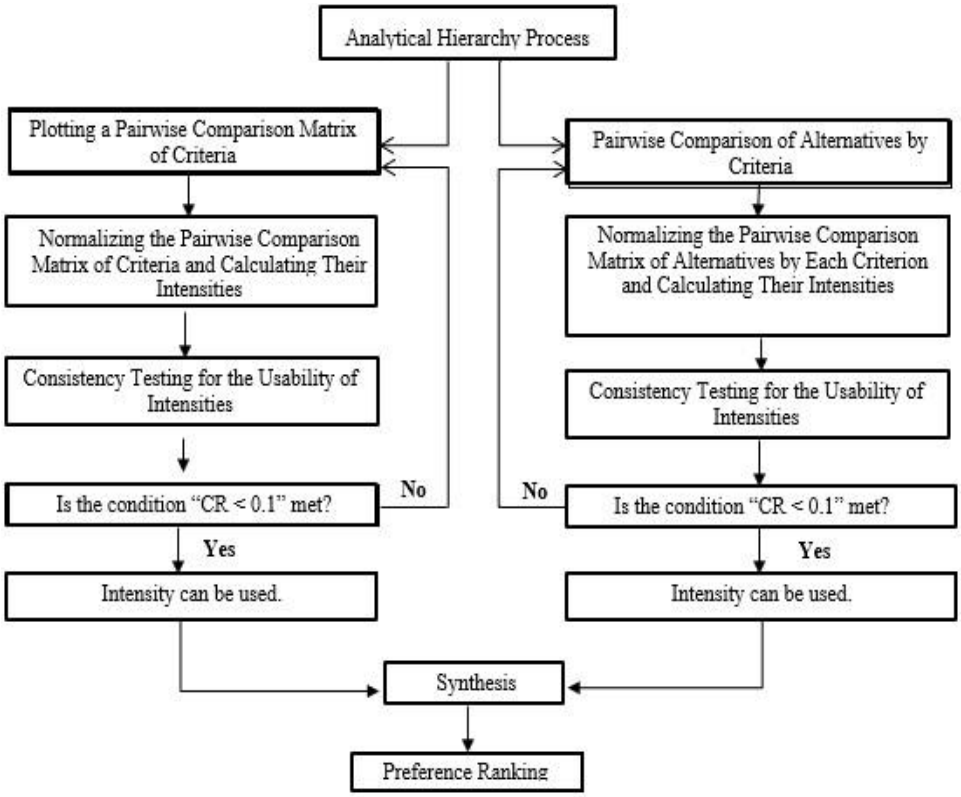

Figure 2. *Analytical Hierarchy Process*

Step 1: This step applies the following two operations using the Fundamental Scale (Table 1):

Table 1. *Fundamental Scale (Saaty T. L., 1995)*

Intensity of importance	**Definitions**	**Explanations**
1	Equal importance	Two alternatives contribute equally to the objective
3	Moderate importance (Slight dominance)	One alternative is slightly more important than the other.
5	Strong importance (High dominance)	One alternative is relatively more important than the other.
7	Very strong importance (Very high dominance)	One alternative is much more important than the other.
9	Extreme importance (Absolute dominance)	One alternative has extremely higher importance than the other.
2, 4, 6, 8	Intermediate values (Compromise values)	To be used when it is needed to interpolate a compromise.

Operation 1: A pairwise comparison matrix is plotted, as in Table 2, to determine the dominance of the criteria over each other.

Table 2*. Pairwise Comparison Matrix of Criteria*

	Criterion 1	**Criterion 2**	**…**	**Criterion n**
Criterion 1	K_1/K_1	K_1/K_2	**…**	K_1/K_n
Criterion 2	K_2/K_1	K_2/K_2	**…**	K_2/K_n
.	.	.		.
.	.	.		.
Criterion n	K_n/K_1	K_n/K_2	**…**	K_n/K_n
Column Total	X	Y	**…**	Z

Operation 2: A pairwise comparison matrix is plotted, as in Table 3, to determine the dominance of the alternatives by criteria.

Table 3. *Pairwise Comparison Matrix of Alternatives by Criteria*

Criterion (1, 2, 3, …n)	***Alternative 1***	***Alternative 2***	**…**	***Alternative m***
Alternative 1	K_1/K_1	K_1/K_2	**…**	K_1/K_n
Alternative 2	K_2/K_1	K_2/K_2	**…**	K_2/K_n

.	.	.		.
.	.	.		.
Alternative m	K_n/K_1	K_n/K_2	…	K_n/K_n
Column Total	X	Y	…	Z

Step 2: This step applies the following two operations.

Operation 1: Pairwise comparison matrices are normalized as in Table 4.

Table 4. *Normalizing Pairwise Comparison Matrices*

	Criterion 1 / Alternative 1	**Criterion 2 / Alternative 2**	…	**Criterion n / Alternative m**
Criterion 1 / Alternative 1	$\frac{K_1/K_1}{X} = A$	$\frac{K_1/K_2}{Y} = D$	…	$\frac{K_1/K_n}{Z} = G$
Criterion 2 / Alternative 2	$\frac{K_2/K_1}{X} = B$	$\frac{K_2/K_2}{Y} = E$	…	$\frac{K_2/K_n}{Z} = H$
.	.	.		.
.	.	.		.
Criterion n / Alternative m	$\frac{K_n/K_1}{X} = C$	$\frac{K_n/K_2}{Y} = F$	…	$\frac{K_n/K_n}{Z} = I$
Column Total	A + B +…+ C = 1	D + E+…+F = 1	…	G + H +…+I = 1

Operation 2: Criteria weights of normalized matrices are derived as in Table 5.

Table 5. *Deriving Criteria Weights*

	Criterion 1/ Alternative 1	**Criterion 2/ Alternative 2**	…	**Criterion n / Alternative m**	**Criteria Weight (W)**
Criterion 1/ Alternative 1	$\frac{K_1/K_1}{X} = A$	$\frac{K_1/K_2}{Y} = D$	…	$\frac{K_1/K_n}{Z} = G$	$\frac{\mathrm{A} + \mathrm{D} + \cdots + \mathrm{G}}{(Sütun\ Sayısı)} = P$
Criterion 2/ Alternative 2	$\frac{K_2/K_1}{X} = B$	$\frac{K_2/K_2}{Y} = E$	…	$\frac{K_2/K_n}{Z} = H$	$\frac{\mathrm{B} + \mathrm{E} + \cdots + \mathrm{H}}{(Sütun\ Sayısı)} = Q$
.	.	.		.	.
Criterion n/ Alternative m	$\frac{K_n/K_1}{X} = C$	$\frac{K_n/K_2}{Y} = F$	…	$\frac{K_n/K_n}{Z} = I$	$\frac{\mathrm{C} + \mathrm{F} + \cdots + \mathrm{I}}{(Sütun\ Sayısı)} = T$
Column Total	A + B +…+ C = 1	D + E+…+F = 1	…	G + H +…+I = 1	P + Q +…+ T = 1

Step 3: In this step, criteria weights are subjected to consistency testing to uncover their validity. Consistency testing relies on Formulas 1 and 2 and random consistency indices in Table 6. Criteria weights are considered valid when the test result yields a value less than or equal to 0.1 (Saaty R. W., 1987). Otherwise, values in pairwise comparison matrices need to be reconsidered.

$$\text{Consistency Index (CI)} = \frac{\lambda max - n}{n-1} \quad (1)$$

$$\text{Consistency Ratio (CR)} = \frac{\text{Consistency Index(CI)}}{\text{Radom Consistency Index (RI)}} \quad (2)$$

where n is matrix size.

Calculating $\tilde{A}_{max}$ value:

Pairwise Comparison Matrix	Criteria Weight (W)	Calculation (V)	V/W
$K_1/K_1 \quad K_1/K_2 \ldots K_1/K_n$	P	$P\ x\ [(K_1/K_1) + (K_1/K_2) + \cdots + (K_1 + K_n)] = a$	$a/P = m$
$K_2/K_1 \quad K_2/K_2 \ldots K_2/K_n$	Q	$Qx\ [(K_2/K_1) + (K_2/K_2) + \cdots + (K_2 + K_n)] = b$	$b/Q = s$
. . .	.	.	.
. . .	.	.	.
$K_n/K_1 \quad K_n/K_2 \ldots K_n/K_n$	T	$T\ x\ [(K_1/K_1) + (K_1/K_2) + \cdots + (K_n + K_n)] = c$	$c/T = d$

$$\tilde{A}_{Max} = \frac{m + s + d}{n}$$

Table 6. *Random Consistency Indices (Saaty T. L., 1990)*

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RG	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Step 4: This step involves a synthesis of the combination of criteria weights (Formula 3).

$$S_i = \sum_{I=1}^{n} W_j\ P_{ij} \quad (3)$$

Where
S_i: ith alternative (i=1.2, …, m),
W_j: weight of jth criterion (i=1.2, …, n),
P_{ij}: criteria-related weight of ith alternative by the jth criterion (i:1, 2, …, m; j=1, 2, …, n).

1.6. ELECTRE I

ELECTRE I is another multi-criteria decision-making method. What distinguishes ELECTRE I from other multi-criteria decision-making methods is that it allows a comparison of the dominance of alternatives over each other by concordance-discordance indices. The method consists of eight steps (Figure 3).

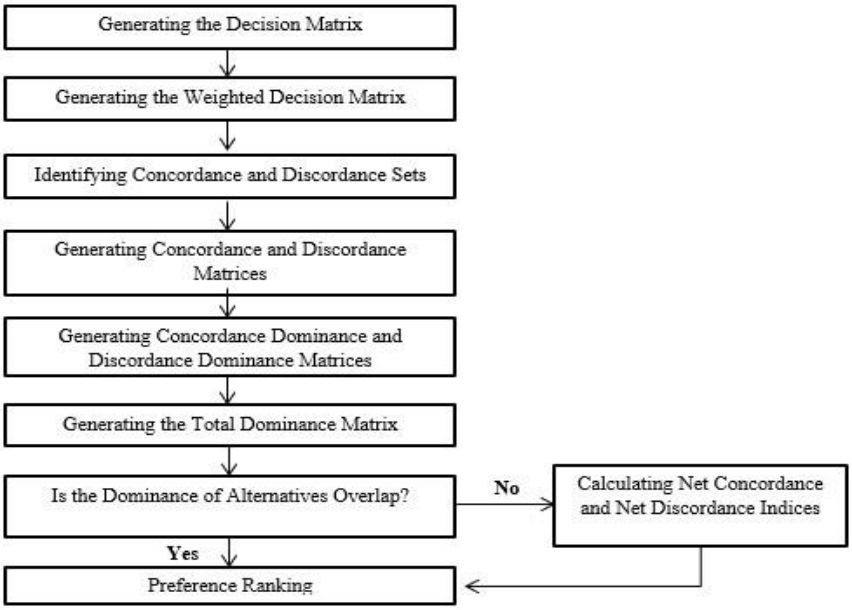

Figure 3. *ELECTRE I Method (Özkan & Özkan, 2023)*

Step 1: A decision matrix is generated to compare alternatives by criteria (Table 7).

Table 7. *Decision Matrix*

	Criteria (K)			
Alternatives (A)	***Criterion 1***	***Criterion 2***	**…**	***Criterion n***
Alternative 1	A_1/K_1	A_1/K_2	**…**	A_1/K_n
Alternative 2	A_2/K_1	A_2/K_2	**…**	A_2/K_n
. .	. .	. .	**…**	. .
Alternative m	A_n/K_1	A_n/K_2	**…**	A_n/K_n
Column Total	X	Y	**…**	Z

Step 2: The decision matrix is normalized to compare criteria with different units (Table 8).

Table 8. *Normalizing the Decision Matrix*

	Criteria (K)			
Alternatives (A)	***Criterion 1***	***Criterion 2***	**…**	***Criterion n***
Alternative 1	$\frac{A_1/K_1}{X} = a$	$\frac{A_1/K_2}{Y} = d$	**…**	$\frac{A_1/K_n}{Z} = g$
Alternative 2	$\frac{A_2/K_1}{X} = b$	$\frac{A_2/K_2}{Y} = e$	**…**	$\frac{A_2/K_n}{Z} = h$
. .	. .	. .		. .
Alternative m	$\frac{A_n/K_1}{X} = c$	$\frac{A_n/K_2}{Y} = f$	**…**	$\frac{A_n/K_n}{Z} = k$
Column Total	a + b +…+ c = 1	d + e +…+ f = 1	**…**	g + h +…+ k = 1

Step 3: Criteria weights are multiplied by normalized matrix values to elicit the weighted decision matrix (Table 9).

Table 9. *Weighted Decision Matrix*

Criteria Weights (W)	W_1	W_2	…	W_n
	Criteria (K)			
Alternatives (A)	***Criterion 1***	***Criterion 2***	**…**	***Criterion n***
Alternative 1	a x W_1	d x W_2	**…**	g x W_n
Alternative 2	b x W_1	e x W_2	**…**	h x W_n
. .	. .	. .	**…**	. .
Alternative m	c x W_1	f x W_1	**…**	k x W_1

Step 4: In this step, alternatives are compared by criteria using concordance-discordance sets (Table 9). The following operations are applied to generate these sets:

Indices:

$\boldsymbol{C_{ab}}$: *Concordance Set*

$\boldsymbol{D_{ab}}$: *Discordance Set*

$\boldsymbol{a}$: $ath\ alternative$

$\boldsymbol{b}$: $bth\ alternative$

$\boldsymbol{j}$: $jth\ criterion$

$\boldsymbol{y_{aj}}$: $value\ of\ the\ ath\ alternative\ by\ the\ jth\ criterion$

y_{bj}: $value\ of\ the\ bth\ alternative\ by\ the\ jth\ criterion$

For concordance sets : $C_{ab} = \{ y_{aj} \geq y_{bj} \}$ $a \neq b$ $j = 1.2.3, \ldots\ldots . . n$

For discordance sets : $D_{ab} = \{ j, y_{aj} < y_{bj} \}$ $a \neq b$ $j = 1.2.3, \ldots\ldots . . n$

Step 5: This step involves generating concordance-discordance matrices with (mxm) dimensions.

- A concordance matrix is generated by inserting values, calculated using Formula 4, into relevant cells in Table 10.

$$c_{ab} = y_{aj} - y_{bj}\ , \qquad j \in C_{ab} \tag{4}$$

Table 10. *Concordance Matrix*

C =

	Alternatives (A)			
Alternatives (A)	***Alternative 1***	***Alternative 2***	**…**	***Alternative m***
Alternative 1	-	c_{12}	…	c_{1m}
Alternative 2	c_{21}	-	…	c_{2m}
. . .	. .	. .	…	. .
Alternative m	c_{m1}	c_{m1}	…	-

- A discordance matrix is generated by inserting values, calculated using Formula 5, into relevant cells in Table 11.

$$d_{ab} = \frac{max|y_{aj} - y_{bj}|}{max|y_{aj} - y_{bj}|} \tag{5}$$

where $j \in D_{ab}$

Table 11. *Discordance Matrix*

		Alternatives (A)			
D **=**	**Alternatives (A)**	***Alternative 1***	***Alternative 2***	**…**	***Alternative m***
	Alternative 1	-	$\mathbf{d_{12}}$	…	$\mathbf{d_{1m}}$
	Alternative 2	$\mathbf{d_{21}}$	-	…	$\mathbf{d_{2m}}$
	. .	. .	. .	…	. .
	Alternative m	$\mathbf{d_{m1}}$	$\mathbf{d_{m1}}$	…	-

Step 6: This step involves generating concordance-discordance dominance matrices.

- Formula 6 and Table 10 are utilized to generate the concordance dominance matrix in Table 12.

$$\underline{c} = \frac{1}{m(m-1)} \sum_{a=1}^{m} \sum_{b=1}^{m} c_{ab} \quad , \quad a \neq b \qquad 6)$$

$$c_{ab} \geq \underline{c} \; ise \; f_{ab} = 1,$$

$$c_{ab} < \underline{c} \; ise \; f_{ab} = 0$$

where $\underline{c}$ = concordance threshold value.

Table 12. *Concordance Dominance Matrix*

		Alternatives (A)			
F **=**	**Alternatives (A)**	***Alternative 1***	***Alternative 2***	**…**	***Alternative m***
	Alternative 1	-	$\boldsymbol{f_{12}}$	…	$\boldsymbol{f_{1m}}$
	Alternative 2	$\boldsymbol{f_{21}}$	-	…	$\boldsymbol{c_{2m}}$
	. .	. .	. .	…	. .
	Alternative m	$\boldsymbol{f_{m1}}$	$\boldsymbol{f_{m1}}$	…	-

- Formula 7 and Table 11 are considered to generate the discordance dominance matrix in Table 13.

$$\underline{d} = \frac{1}{m(m-1)} \sum_{a=1}^{m} \sum_{b=1}^{m} d_{ab} \quad , \quad a \neq b \qquad 7)$$

$$d_{ab} \geq \underline{d} \; ise \; g_{ab} = 1,$$

$$d_{ab} < \underline{d} \; ise \; g_{ab} = 0$$

where $\underline{d}$ = concordance threshold value

Table 13. *Discordance Dominance Matrix*

		Alternatives (A)			
	Alternatives (A)	***Alternative 1***	***Alternative 2***	**…**	***Alternative m***
	Alternative 1	-	$\mathbf{g_{12}}$	…	$\mathbf{g_{1m}}$
G =	***Alternative 2***	$\mathbf{g_{21}}$	-	…	$\mathbf{g_{2m}}$
	. .	. .	. .	…	. .
	Alternative m	$\mathbf{g_{m1}}$	$\mathbf{g_{m1}}$	…	-

Step 7: This step involves creating a total dominance matrix (E) by multiplying all f_{ab} values in the matrix F with all g_{ab} values in the matrix G (Table 14).

Table 14. *Total Dominance Matrix (F x G = E)*

		Alternatives (A)			
	Alternatives (A)	***Alternative 1***	***Alternative 2***	**…**	***Alternative m***
	Alternative 1	-	$\boldsymbol{e_{12}}$	…	$\boldsymbol{e_{1m}}$
E =	***Alternative 2***	$\boldsymbol{e_{21}}$	-	…	$\boldsymbol{e_{2m}}$
	. .	. .	. .	…	. .
	Alternative m	$\boldsymbol{e_{m1}}$	$\boldsymbol{e_{m1}}$	…	-

Step 8: This final step involves making a preference ranking of the alternatives using the total dominance matrix. If the dominance of the alternatives cannot be clearly understood in the matrix, net concordance (c_a) and net discordance (d_a) indices are calculated using Table 10 and Table 11 (Table 15). While net concordance values are ranked in descending order, net discordance values are ranked in ascending order. Then, the alternatives are listed by preference ranking.

Table 15. *Calculation of Net Concordance-Discordance Indices*

c_a	Net Concordance Indices	Net Discordance Indices	d_a
c_1	$(c_{12}+c_{13}+\cdots+c_{1m})-(c_{21}+c_{31}+\cdots+c_{m1})$	$(d_{12}+d_{13}+\cdots+d_{1m})-(d_{21}+d_{31}+\cdots+d_{m1})$	d_1
c_2	$(c_{21}+c_{23}+\cdots+c_{2m})-(c_{12}+c_{32}+\cdots+c_{m2})$	$(d_{21}+d_{23}+\cdots+d_{2m})-(d_{12}+d_{32}+\cdots+d_{m2})$	d_2
. .	. .	. .	. .
c_m	$(c_{m1}+c_{m2}+\cdots+c_{m(m-1)})-(c_{1m}+c_{2m}+\cdots+c_{(m-1)m})$	$(d_{m1}+d_{m2}+\cdots+d_{m(m-1)})-(d_{1m}+d_{2m}+\ldots+d_{(m-1)m})$	d_m

2. Results

In this study, we perform a supplier selection for participating five-star hotels to procure cold chain fruit and vegetable products using the AHP and ELECTRE I methods.

2.1. Results of AHP

We first apply AHP to identify the weights of the criteria settled in the meetings. Table 16 presents a pairwise comparison matrix of the mentioned criteria.

Table 16. *Pairwise Comparison Matrix of Criteria*

	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11
K1	**1.00**	1.00	9.00	7.00	7.00	3.00	3.00	5.00	9.00	9.00	5.00
K2	1.00	**1.00**	9.00	7.00	7.00	3.00	3.00	5.00	9.00	9.00	5.00
K3	0.11	0.11	**1.00**	0.33	0.33	0.14	0.14	0.20	1.00	1.00	0.20
K4	0.14	0.14	3.00	**1.00**	1.00	0.20	0.20	3.00	3.00	3.00	0.33
K5	0.14	0.14	3.00	1.00	**1.00**	0.20	0.20	3.00	3.00	3.00	0.33
K6	0.33	0.33	7.00	5.00	5.00	**1.00**	1.00	3.00	7.00	7.00	3.00
K7	0.33	0.33	7.00	5.00	5.00	1.00	**1.00**	3.00	7.00	7.00	3.00
K8	0.20	0.20	5.00	0.33	0.33	0.33	0.33	**1.00**	5.00	5.00	1.00
K9	0.11	0.11	1.00	0.33	0.33	0.14	0.14	0.20	**1.00**	1.00	0.20
K10	0.11	0.11	1.00	0.33	0.33	0.14	0.14	0.20	1.00	**1.00**	0.20
K11	0.20	0.20	5.00	3.00	3.00	0.33	0.33	1.00	5.00	5.00	**1.00**
Total	3.69	3.69	51.00	30.33	30.33	9.50	9.50	24.60	51.00	51.00	19.27

Accordingly, we derive criteria weights by normalizing the criteria to the pairwise comparison matrix and perform consistency testing on the weights. As

shown in Table 17, the test results of < 0.1 demonstrate the validity of criteria weights.

Table 17. *Criteria Weights*

	K1	***K2***	***K3***	***K4***	***K5***	***K6***	***K7***	***K8***	***K9***	***K10***	***K11***	***Criteria Weights(W)***
K1	0.27	0.27	0.18	0.23	0.23	0.32	0.32	0.20	0.18	0.18	0.26	0.24
K2	0.27	0.27	0.18	0.23	0.23	0.32	0.32	0.20	0.18	0.18	0.26	0.24
K3	0.03	0.03	0.02	0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02
K4	0.04	0.04	0.06	0.03	0.03	0.02	0.02	0.12	0.06	0.06	0.02	0.05
K5	0.04	0.04	0.06	0.03	0.03	0.02	0.02	0.12	0.06	0.06	0.02	0.05
K6	0.09	0.09	0.14	0.16	0.16	0.11	0.11	0.12	0.14	0.14	0.16	0.13
K7	0.09	0.09	0.14	0.16	0.16	0.11	0.11	0.12	0.14	0.14	0.16	0.13
K8	0.05	0.05	0.10	0.01	0.01	0.04	0.04	0.04	0.10	0.10	0.05	0.05
K9	0.03	0.03	0.02	0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02
K10	0.03	0.03	0.02	0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02
K11	0.05	0.05	0.10	0.10	0.10	0.04	0.04	0.04	0.10	0.10	0.05	0.07
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Consistency Ratio												0.06

2.2. Results of the ELECTRE I Method

We then apply ELECTRE I using the decision matrix in Table 18, covering pairwise comparisons of alternatives by criteria and criteria weights.

Table 18. *Decision Matrix*

	Criteria										
Alternatives	*K1*	*K2*	*K3*	*K4*	*K5*	*K6*	*K7*	*K8*	*K9*	*K10*	*K11*
Supplier 1	89	88	23	45	54	75	72	63	31	22	71
Supplier 2	85	82	22	43	52	75	67	62	31	21	67
Supplier 3	87	82	22	42	52	75	67	61	31	21	67
Total	261	252	68	129	158	224	205	186	93	65	204
Criteria Weights	0.24	0.24	0.02	0.05	0.05	0.13	0.13	0.05	0.02	0.02	0.07

However, the dominance states of the alternatives are not clear in the total dominance matrix in Table 19. Thus, we calculate net concordance-discordance indices (Table 20).

Table 19. *Total Dominance Matrix*

Total Dominance Matrix (F x G = E)			
	Supplier 1	*Supplier 2*	*Supplier 3*
Supplier 1	-	0.00	0.00
Supplier 2	0.00	-	1.00
Supplier 3	0.00	0.00	-

Supplier 1 ranks first according to c_a and d_a values (Table 20). While the d_a values of Supplier 2 and Supplier 3 are equal, the c_a value of Supplier 3 outranks the c_a value of Supplier 2. In this case, we reach a preference ranking of Supplier 1 > Supplier 3 > Supplier 2. Ultimately, Supplier 1 should be selected as the most suitable supplier of cold chain products for participating hotels.

Table 20. *Net Concordance-Discordance Indices*

c_a	**Net Concordance Index**	**Net Discordance Index**	d_a
c_1	**1.74**	**-2.00**	d_1
c_3	-0.73	1.00	d_3
c_2	-1.01	1.00	d_2
Preference Ranking	Supplier 1 > Supplier 3 > Supplier 2		

3. Conclusion

In this study, we perform an evidence-based supplier selection for participating five-star hotels to supply cold chain fruit and vegetable products. For this purpose, we first derive the weights of the criteria determined in two face-to-face meetings attended by purchasing experts from seven different five-star hotels using the AHP method. In the second stage, we apply ELECTRE I to the criteria weights. The findings yield a preference ranking of "Supplier 1 > Supplier 3 > Supplier 2". In other words, Supplier 1 seems to be the most suitable supplier to supply cold chain fruit and vegetable products. It should be noted that this result may differ in the case of any alterations in the dominance values in pairwise comparison matrices.

The study provides hoteliers with valuable insights on choosing reliable suppliers that can increase operational efficiency, reduce costs, and increase customer satisfaction and profitability.

Finally, in future research, other multi-criteria decision-making methods can be re-evaluated with the same criteria or the same methods in this study can be re-evaluated with different criteria.

References

Arifin, M., Ibrahim, A., Nur, M. (2019). Integration of Supply Chain Management and Tourism: An Empirical Study from The Hotel Industry of Indonesia, *Management Science Letters*, Vol. 9 No 2, pp. 261-270.

Avcıkurt, C., Sarıoğlan, M., Çaylı, B. and Saylan U. (2010). Fast-Food Yiyecek-İçecek İşletmeleri ile Slow-Food Yiyecek-İçecek İşletmeleri Arasındaki Tedarikçi Seçim Kriterleri Kullanım Eğilimleri Açısından Benzerliklerinin ve Farklılıklarının Araştırılması (İzmir Yöresinde Bir Araştırma), Çolakoğlu O. E. (Ed.), *11. Ulusal Turizm Kongresi (2-5 Aralık 2010) Bildiriler Kitabı*. Detay Yayıncılık, Ankara, pp. 334-345.

Çevik, V. A. (2021). Tarihin En Kapsamlı Soğuk Zincir Uygulaması: Koronavirüs (Covid-19) Aşısının Lojistiğinde Karşılaşılan Zorluklar, *Üsküdar Üniversitesi Sosyal Bilimler Dergisi*, No 12, pp. 155-204.

Davras, G. M. and Karaatlı, M. (2014). Otel İşletmelerinde Tedarikçi Seçimi Sürecinde AHP ve BAHP Yöntemlerinin Uygulanması, *Hacettepe University İktisadi ve İdari Bilimler Fakültesi Dergisi*, Vol. 32 No 1, pp. 87-112.

De Boer, L.; Labro, E. and Morlacchi, P., (2001). A Review of Methods Supporting Supplier Selection, *European Journal of Purchasing and Supply Management*, Vol. 7 No. 2, pp.75-89.

Erdem, M. B. (2023). Otel İşletmelerinde Oluşan Gıda İsrafında Tedarikçi Rolünün Değerlendirilmesi, Journal of Eurasia Tourism Research, Vol. 4 No. Special Issue, pp.78-89.

Hahn**,** C., K.; Kim, K., Y. and Watts, C., A., (1990). The Supplier Development Program: A Conceptual Model, *International Journal of Purchasing and Materials Management*, Vol. 26 No. 2, pp.2–7.

Hemmington, N. and King, C., (2000). Key Dimensions of Outsourcing Hotel Food and Beverage Services, *International Journal of Contemporary Hospitality Management*, Vol. 12 No. 4, pp. 256- 261.

İpekçi, E. and Tanyaş, M. (2021). Soğuk Zincir Lojistiği Uygulamalari ve Türkiye'de Soğuk Zincir Lojistiğinin Swot Analizi, *Dicle University Sosyal Bilimler Enstitüsü Dergisi*, No. 26, pp. 46-64.

İzer, D., A., (2017). Soğuk Zincir Lojistiği İçinde Risklerin Azaltılmasında Yeni Teknolojiler, Access Adress: https://s3.amazonaws.com/academia.edu.documents/53484161/Bildiri_soguk_zincir.pdf, (accessed 28.02.2024).

Keleş, B., & Ova, G. (2020). Gıda Tedarik Zinciri Yönetiminde Bilgi Teknolojileri Kullanımı, *Adnan Menderes Üniversitesi Ziraat Fakültesi Dergisi*, vol.17 No. 1, pp. 137-143.

Koçak, N. (2006). Yiyecek İçecek Hizmetleri Yönetimi, Detay Yayıncılık, Ankara.

Kothari, T., Hu, C. & Roehl, W.S. (2005). E-Procurement: An Emerging Tool For The Hotel Supply Chain Management. Hospitality Management, Vol. 24 No.3, pp. 369 – 389.

Koyuncu, M. C., & Öztürk, E. (2024). Tedarik Zinciri Yönetimi Kapsamında Sevkiyat Sürecinin Barkod Teknolojisi ile Entegrasyonu. *International Anatolia Academic Online Journal Social Sciences Journal*, *10*(2), 154-165.

Mahalik, N. And Kim, K. (2016). The Role of Information Technology Developments in Food Supply Chain Integration and Monitoring, Innovation and Future Trends in Food Manufacturing and Supply Chain Technologies, pp. 21-37. https://doi.org/10.1016/B978-1-78242-447-5.00002-2

Okutmuş, E. and Ergül, A. (2013). Konaklama İşletmelerinin Yiyecek İçecek Faaliyetlerinde Tedarik Zinciri Maliyetlerinin Hedef Maliyetleme İle Birlikte Uygulanması, *Journal Of Yasar University*, Vol. 8 No. 32, pp 5409- 5432.

Ovca, A. and Jevšnik, M. (2009). Maintaining A Cold Chain from Purchase to The Home and At Home: Consumer Opinions, Food Control, Vol. 20 No. 2, pp. 167–172.

Öncü, M. A. and Işkın, M. (2009). Otel İşletmelerinde Dış Kaynak Kullanımı Üzerine Kavramsal Bir Çalışma, *Elektronik Sosyal Bilimler Dergisi*, Vol. 8 No 29, pp.143-156.

Özkan, H., & Özkan, M. (2023). Lojistik Merkez Yeri Kuruluş İlinin ELECTRE I Yöntemiyle Belirlenmesi:TR 61 Bölgesinde Uygulama. *Lojistik Dergisi*(58), pp. 142-153.

Saaty, R. W. (1987). The analytic hierarchy process—what it is and how it is used, *Mathematical Modelling Mathematical Modelling*, Vol. *9 No.* (3-5), pp. 161-176.

Saaty, T. L. (1990). How to make a decision: The analytic hierarchy process, *European Journal of Operational Research, Vol. 48 No.*1, pp. 9-26.

Saaty, T. L. (1995). Transport planning with multiple criteria: The analytic hierarchy process applications and progress review, *Journal of Advanced Transportation, Vol. 29* No. 1, pp. 81-126.

Singh, R. K., Gunasekaran, A., Kumar, P. (2018). Third party logistics (3PL) selection for cold chain management: a fuzzy AHP and fuzzy TOPSIS approach, *Annals of Operations Research*, Vol. 267, pp. 531–553.

Sutono, A. (2019). Supply Chain Management: Implementation Issues and Research Opportunities in Tourism İndustry, *Uncertain Supply Chain Management*, Vol. 7 No.3, pp. 427-438.

Tanyaş, M.(2015). Tedarik Zinciri Yönetimi, Access Adress: http://docplayer.biz.tr/2948974- Tedarik-zinciri-yonetimi-ders-notlari-hafta-1-2-3.html, (accessed 01.03.2024).

Talih, Ö., & Dönmez, E. (2024). Tedarik Zincirine Genel Bakış: Akıllı Tedarik Zincirinde Risk ve Güvenlik. *İstanbul Gelişim Üniversitesi Sosyal Bilimler Dergisi*, *11*(2), 836-854.

Tursun, S. S., Özkoç, H. (2019). Taze Gıda Ürünlerinde Tedarikçi Seçim Kararı Üzerine Karma Bir Araştırma, *Girişimcilik İnovasyon ve Pazarlama Araştırmaları Dergisi*, Vol. 3 No. 6, pp. 75-94.

Torğul, B., Demiralay, E., Paksoy, T. (2021). Tarım-Gıda Tedarik Zincirinde Ağ Tasarımı ve Optimizasyonu: Bir Meyve Suyu İşletmesi Örneği, *Journal of Transportation and Logistics*, Vol. 6 No. 1, pp. 49-70.

Vesper, J., Kartoglu, U., Bishara, R., Bishara, T. C. (2010). A Case Study in Experiential Learning: Pharmaceutical Cold Chain Management on Wheels, *Journal of Continuing Education in The Health Professions, Vol. 30 No.* 4, pp. 229-236.

Weber, C. A., Current, J. R., & Benton, W. C. (1991). Vendor selection criteria and methods. *European Journal of Operational Research, 50*(1), 2-18.

Xia, W. and Wu, Z. (2007). Supplier Selection with Multiple Criteria in Volume Discount Environments. Omega, Vol. 35 No.5, pp. 494-504. https://doi.org/10.1016/j.omega.2005.09.002

Yazarkan, H. (2012). Bir Stratejik Maliyet Yönetimi Aracı Olarak Sahipliği Toplam Maliyeti Yaklaşımının Tedarikçi Seçimindeki Rolü: 500 Büyük Sanayi İşletmesinde Bir Uygulama, PhD Thesis, Atatürk university, Erzurum, Access Adress: https://tez.yok.gov.tr/UlusalTezMerkezi/ (accessed 24.06.2024).

Zailani, S., Omar, A. and Kopong, S. (2011). An Exploratory Study on The Factors Influencing the Non-Compliance to Halal Among Hoteliers in Malaysia, *International Business Management*, Vol. 5 No 1, pp. 1-12.

Zengin, Z. H., Bayarçelik, E. B., & Apak, S. (2024). Gıda Sektöründe Yalın Tedarik Zinciri Yönetimi ile Tedarik Zinciri Yönetimi Arasında Performans Değerlendirmesi. *Yaşar Üniversitesi E-Dergisi*, *19*(73), 40-61.