UNIVERSITY OF NIS FACULTY OF MECHANICAL ENGINEERING

THE TENTH INTERNATIONAL CONFERENCE
TRANSPORT AND LOGISTICS
https://doi.org/10.46793/TIL2025.083A

til 2025

EVALUATION OF COLD SUPPLY CHAIN CHALLENGES USING THE q-RUNG ORTHOPAIR FUZZY SUBJECTIVE WEIGHTING APPROACH: THE CASE OF ORDU PROVINCE

Ahmet AYTEKİN[1], Selçuk KORUCUK[2]

[1)] *Samsun University, Depart Department of International Trade and Business, Faculty of Political Sciences, ahmet.aytekin@samsun.edu.tr.tr*
[2)] *Giresun University, Department of Logistics Management,* selcuk.korucuk@giresun.edu.tr

ORCID iDs: Ahmet AYTEKİN https://orcid.org/0000-0002-1536-7097
Selçuk KORUCUK https://orcid.org/0000-0003-2471-1950

Abstract

Effective In businesses, the planning, execution, and distribution of efficient and effective cold supply chain practices are vital components for reducing food losses and fulfilling customer orders on time. In this context, identifying the relevant barriers in businesses engaged in cold chain transportation is of significant importance to ensure the uninterrupted operation of the supply chain. Therefore, defining the challenges faced by businesses in cold chain transportation has become not an option, but a necessity. Moreover, a review of the existing literature reveals that cold supply chain challenges have been addressed only to a limited extent and have not been sufficiently emphasized. To fill this gap, supply chain barriers were ranked using the q-Rung Orthopair Fuzzy Subjective Weighting Approach. Within the scope of the study, "Time Constraint" was identified as the most significant barrier, whereas "Temperature-Controlled Vehicle Cost" was found to be the least important.

Keywords: *Supply Chain, Cold Supply Chain, Cold Supply Chain Barriers, q-Rung Orthopair Fuzzy Sets.*

1. INTRODUCTION

In recent years, access to qualified and healthy food and the assurance of food security have become increasingly significant concerns. In addition to international organizations, governments, local authorities, and individuals have become seriously concerned about developments such as the rapid growth of the world population, accelerated urbanization, climate change, global warming, and environmental pollution over the past decades [1]. In particular, cold chain logistics plays a vital role in the economy. As a critical component of the supply chain, the cold chain must remain unbroken [2].

The cold chain includes storage, distribution, handling, transportation, and monitoring activities for temperature-sensitive products. In addition, it is an integrated system consisting of records, procedures, and equipment such as cold rooms, refrigerators, transport containers, and vehicles [3]. The cold supply chain, on the other hand, refers to a type of supply chain that ensures the preservation of products that must be kept within a specific temperature range throughout the process from production to final delivery to the consumer. It encompasses maintaining and controlling proper temperature conditions during the production, storage, distribution, and consumption of frozen foods, fresh/green products, pharmaceuticals, and other perishable goods [4]. Another definition describes this concept as a process in which all activities, from raw material storage to final product distribution, are carried out under temperature-controlled conditions [5]. The cold supply chain is a continuous and uninterrupted process designed to preserve the freshness of products and ensure their safe delivery to end users. Alongside supply chain activities, the personnel and equipment involved in the process must be assigned and managed to maintain temperature control at every stage [6]. As the population increases, the demand for perishable goods also rises, necessitating the development of cold chain infrastructure such as packaging facilities, refrigerated transportation, and cold storage warehouses [7]. However, cold chain operations are more costly than other logistics activities and require significant energy consumption. Approximately 15% of global electricity use is dedicated to refrigeration processes within cold chain logistics [8].

Furthermore, in cold supply chains, products must be stored and transported at low temperatures close to or below the freezing point. This requires the use of refrigerated warehouses and trucks that consume large amounts of energy for cooling. Higher energy consumption is directly associated with increased carbon dioxide (CO_2) emissions from power generation facilities. Additionally, refrigeration systems utilize large quantities of hydrofluorocarbon (HFC) gases, which have high global warming potential and long atmospheric lifespans. Regular or catastrophic leaks of HFC gases from cold supply chains represent a significant contributor to global warming. Therefore, these gases must be carefully considered when designing and operating cold supply chains [9].

From this perspective, the challenges encountered in cold supply chains are not only operational issues for businesses but also multidimensional parameters affecting society as a whole. These challenges are directly related to food safety, public health, environmental sustainability, and economic stability. They also play a decisive role in critical areas such as sustainability, supply continuity, cost management, efficiency, competitiveness, performance, effectiveness, and customer satisfaction. Therefore, systematically identifying, analyzing, and prioritizing the challenges faced in cold supply chains is of critical importance for effective supply chain management. Determining these challenges represents a strategic necessity for businesses seeking to transform their processes into agile, flexible, and resilient structures. Minimizing disruptions in cold supply chains not only optimizes resource utilization but also ensures supply continuity, thereby creating economic and social benefits.

In line with these considerations, this study aims to identify the challenges encountered in the cold supply chains of corporate and specialized businesses operating in Ordu Province. Within the scope of the research, the identified challenges were evaluated using multi-criteria decision-making (MCDM) methods and classified according to their level of importance. In addition, the study provides a comprehensive review of the theoretical background, concepts, and existing literature on cold supply chain applications. In the final section, the findings are presented, their potential implications for industry practice are discussed, and recommendations for future research are proposed.

2. LITERATURE REVIEW

Below are some of the national and international studies found in the literature regarding the cold supply chain:

- James & James (2010) examined the practical and theoretical factors that food manufacturers and suppliers should consider when determining refrigeration systems for the food supply chain [10].
- Faisal (2011) conducted an extensive literature review on cold supply chains to formulate a hierarchical structure of agility in supply chains [11].
- Putri et al. (2012) compared the environmental impacts of traditional and cold chain management systems and made several recommendations for the distribution process [12].
- Laguerre et al. (2013) presented deterministic modeling in cold chain equipment and proposed the integration of deterministic and stochastic modeling for food processing and cold chain operations [13].
- Asadi & Hosseini (2014) examined the traceability and monitoring tools for ensuring the safety and quality of major agricultural products within the cold supply chain [14].
- Shashi & Singh (2015) reviewed previous research on all stages of agricultural product supply chains and provided several improvement suggestions [15].
- Xiao et al. (2016) developed a WSN-based Temperature Monitoring System for Frozen and Refrigerated Aquatic Products integrated with data compression transmission [16].
- Ashok et al. (2017) analyzed initiatives in ten countries aimed at improving vaccine cold chains and identified the root causes and potential solutions for three common issues limiting cold chain performance [17].
- Korucuk (2018) applied the Analytic Hierarchy Process (AHP) and Grey Relational Analysis (GRA) techniques to select third-party logistics (3PL) firms in cold chain transportation companies operating in Istanbul [18].
- Aygün & Çağıl (2019) addressed cold chain applications an important issue in the food industry by solving two different vehicle routing problems under specific vehicle and cost constraints[19].
- Babagolzadeh et al. (2020) investigated the impact of storage- and transportation-based carbon emissions in cold supply chains under carbon tax regulations and uncertain demand conditions [20].
- İpekçi & Tanyaş (2021) examined current cold chain practices worldwide and revealed the status of applications and the general situation of the sector in Turkey [21].
- Khan et al. (2022) conducted a comprehensive literature review and identified 40 distinct risks related to cold chains in a developing country context[22].
- Turgut (2023) provided an extensive discussion on the use of next-generation technologies in cold chain logistics [23].
- Bentyn & Konecka (2024) evaluated the adequacy of existing cold chain technologies under increasing temperatures, growing demand, and necessary environmental protection conditions [24].
- Fatorachian & Pawar (2025) analyzed the main determinants by forecasting demand trends in medium-scale cold chain operations [25].

After an extensive review of the literature, it was found that studies focusing specifically on barriers within the cold supply chain are quite limited. Most existing studies are confined to particular sectors or countries, lacking comprehensive analyses that examine the causes of these barriers, their interrelationships, and their overall impacts in depth. This observation highlights a significant gap in the literature. Therefore, a study of this nature could fill this gap by classifying and prioritizing the identified barriers and proposing solution strategies, thereby providing a valuable contribution to both academia and industry practice.

3. METHODOLOGY

This study employs a q-ROF subjective weighting approach. In this context, the prerequisites for q-ROFSs are given first. Assume tht X be a nonempty set. A q-ROFS A of X is given in Eq. (1), where $a_A(\mathrm{x})$ is the membership degree and b(x) is the non-membership degree.

$$A = \{\langle x, (a_A(\mathrm{x}), b_A(\mathrm{x}))\rangle | \mathrm{x} \in \mathrm{X}\} \qquad (1)$$

The conditions $a_A(\mathrm{x}) \in [0,1], b_A(x) \in [0,1], 0 \leq (a_A(x)^q + b_A(\mathrm{x})^q) \leq 1, (q \geq 1)$ should be satisfied in q-ROFSs. The uncertainty membership degree is defined as $\pi_A(\mathrm{x}) = (a_A(x)^q + b_A(\mathrm{x})^q - a_A(x)^q b_A(\mathrm{x})^q)^{1/q}$.

For convenience, let $g_1 = \langle a_1, b_1\rangle$ and $g_2 = \langle a_2, b_2\rangle$ be two q-ROF numbers (q-ROFNs). The fundamental operations, the score function ($\mathcal{S}(g_1)$), and the accuracy function ($\mathcal{A}(g_1)$) are presented in Eq.s (2)- (8) (Yager, 2016; Pinar and Boran, 2020; Aytekin et al., 2025).

$$g_1 \oplus g_1 = \left(\sqrt[q]{(a_1)^q + (a_2)^q - (a_1)^q (a_2)^q}, b_1 b_2\right) \qquad (2)$$

$$g_1 \otimes g_2 = \left(a_1 a_2, \sqrt[q]{(b_1)^q + (b_2)^q - (b_1)^q (b_2)^q}\right) \qquad (3)$$

$$\xi g_1 = \left(\sqrt[q]{1-(1-(a_1)^q)^\xi}, (b_1)^\xi\right), \xi \geq 0 \qquad (4)$$

$$g_1{}^\xi = \left((a_1)^\xi, \sqrt[q]{1-(1-(b_1)^q)^\xi}\right), \xi \geq 0 \qquad (5)$$

$$(g_1)^c = (b_1, a_1) \qquad (6)$$

$$\mathcal{S}(g_1) = \frac{1}{2}((a_1)^q - (b_1)^q + 1), \qquad \mathcal{S}(g_1) \in [0,1] \qquad (7)$$

$$\mathcal{A}(g_1) = (a_1)^q + (b_1)^q, \qquad \mathcal{A}(g_1) \in [0,1] \qquad (8)$$

Assume that $g_j = \langle a_j, b_j\rangle$ is a collection of q-ROFNs, where $j = 1, \ldots, \mathrm{n}$. The q-ROF weighted arithmetic average (q-ROFWAA) operator and the q-ROF weighted geometric average (q- ROFWGA) operator providen in Eq.s (9)-(10), respectively (Yager, 2016; Pinar and Boran, 2020; Aytekin et al., 2025).

$$\text{q} - \text{ROFWAA}(g_j) = \langle\left(1 - \prod_{j=1}^{n}(1 - a_j^q)^{w_j}\right), \prod_{j=1}^{n} b_j^{w_j}\rangle \quad (9)$$

$$\text{q} - \text{ROFWGA}(g_j) = \langle\prod_{j=1}^{n} a_i^{w_j}, \left(1 - \prod_{j=1}^{n}(1 - b_j^q)^{w_j}\right)\rangle \quad (10)$$

Here $W = (w_1, \ldots, w_n)^T$ is the weight vector, $0 \leq w_j \leq 1$, and $\sum_{j=n}^{n} w_i = 1$. Following the clarification of the basic operations, the next part will outline the q-ROF-Subjective Weigting Approach (Aytekin et al., 2024).

Step 1. The lists of criteria and experts are identified. In this context, $C = \{C_1, \ldots, C_j, \ldots C_n\}$ represents the list of criteria, while $E = \{E_1, \ldots, E_k, \ldots E_z\}$ represents the list of experts.

Step 2. The weight coefficient of each expert λ_k is determined, where $k = 1, \ldots, z$, $0 \leq \lambda_k \leq 1$ and $\sum_{k=1}^{z} \lambda_k = 1$.

Step 3. The importance of criteria are evaluated by eperts using linguistic terms given in Table 1.

Table 1. The linguistic terms and their corresponding q-ROFNS equvalients.

Linguistic Terms	Notations	q-ROFNs a	b
Absolutely High	AH	0.99	0.20
Very Very High	VVH	0.91	0.28
Very High	VH	0.83	0.36
High	H	0.75	0.44
Medium High	MH	0.67	0.52
Medium	M	0.60	0.60
Medium Low	ML	0.52	0.67
Low	L	0.44	0.75
Very Low	VL	0.36	0.83
Very Very Low	VVL	0.28	0.91
Absolutely Low	AL	0.20	0.99

The importance ratings of k-th expert for j-th criterion is denoted as $\iota_j^{(k)} = \left(a_j^{(k)}, b_j^{(k)}\right)$.

Step 4. The q-ROF integrated importance of j-th criterion ι_j is obtained via Eq. (9).

Step 5. The score function given in Eq. (7) is applied to determine the crisp values of ι_j.

Step 6. The subjective weight coefficient of each criterion is calculated by applying Eq. (11).

$$w_j = \frac{\mathcal{S}(\iota_j)}{\sum_{j=1}^{n} \mathcal{S}(\iota_j)} \quad (15)$$

where $0 \leq w_j \leq 1$ and $\sum_{j=1}^{n} w_j = 1$.

4. FINDINGS

Six operations managers rated the importance of the criteria. These evaluations are shown in Table 2.

Table 2. The List of Criteria.

Criteria	Source	Notations
Energy Costs	[1]	C1
Lack of Infrastructure	[26]	C2
Inadequate Facilities	[27]	C3
Lack of Effective Distribution Planning	[28]	C4
Temperature Controlled Vehicle Cost	[27].	C5
Time Constraint	[16]	C6
Humidity and pH	[29].	C7
Other Factors (packaging conditions, materials, and storage conditions)	[1] and [19].	C8

In this study, six experts having high knowledge and experience on the subject were consulted to solve the problem. The assessments provided by experts are displayed in Table 3.

Table 3. The Linguistic Importance Assessments of Criteria Provided by Experts.

	C1	C2	C3	C4	C5	C6	C7	C8
E1	H	H	M	M	M	M	M	M
E2	H	M	H	L	L	H	M	H
E3	H	H	M	H	M	H	H	M
E4	H	H	M	L	L	H	H	M
E5	VL	L	L	M	M	H	H	M
E6	H	H	H	M	M	VH	H	M

The calculations regarding q-ROF-Subjective Weighting Approach was carried out, and the results given in Table 4 were obtained.

Table 4. The weighting results.

	C1	C1	C2	C2	C3	C3	C4	C4
	a	B	a	b	a	b	a	b
ι_j	0.718	0.489	0.700	0.506	0.648	0.561	0.599	0.613
$\mathcal{S}(\iota_j)$	0.627		0.606		0.548		0.492	
Rank	2		4		5		7	
w_j	0.137		0.133		0.120		0.108	

	C5	C5	C6	C6	C7	C7	C8	C8
	a	B	a	b	a	b	a	b
ι_j	0.558	0.646	0.749	0.448	0.711	0.487	0.634	0.569
$\mathcal{S}(\iota_j)$	0.452		0.665		0.622		0.534	
Rank	8		1		3		6	
w_j	0.0994		0.1463		0.1367		0.1176	

The results in Table 4 indicate that the most important criterion is “C6- Time Constraint.

5. CONCLUSION

Challenges in the supply chain can reduce business competitiveness and flexibility while limiting customer satisfaction. In cold supply chains, these challenges are particularly critical, as they increase operational costs and negatively impact efficiency. Maintaining products within specific temperature ranges is essential, and any disruption can directly affect product quality and consumer trust.

Furthermore, cold chain inefficiencies have implications beyond individual businesses, potentially causing inventory disruptions, transportation delays, product losses, and financial damages. Such disruptions can hinder the supply of essential temperature-sensitive goods, including food and pharmaceuticals, leading to significant economic and social consequences..

In this context, the study aims to identify the existing barriers in cold supply chain businesses with corporate identity operating in Ordu Province. The research findings indicate that the most significant challenges in the cold supply chain are, in order of importance, "*Time Constraint*", "*Energy Costs*", and "*Humidity and pH*". These factors are critical for both maintaining product quality and ensuring timely execution of operations. The study also found that the least significant barriers are "*Temperature Controlled Vehicle Costs*" and "*Lack of Effective Distribution Planning*". These findings suggest that while these factors can be partially managed within current systems, they can still indirectly affect overall supply chain performance.Consequently, addressing these challenges in the cold supply chain is essential for businesses to regain competitiveness and enhance customer satisfaction. The adoption of energy-efficient technologies, modernization of transportation vehicles, integration of digital solutions to improve process traceability, and providing technical training to personnel are effective measures to mitigate these barriers. Future research can further analyze the impact of these barriers on business performance using quantitative methods and offer strategic recommendations to ensure the sustainability of cold supply chain management.

In this context, the study serves as a guide by identifying the challenges encountered in the cold supply chain, thereby filling a significant gap in the literature. The findings obtained from businesses operating in Ordu Province provide unique insights into cold chain management at a regional level. Future research could examine the topic using various multi-criteria decision-making (MCDM) methods. Furthermore, applying these methods under different fuzzy sets and comparing the results would allow for more reliable and comprehensive evaluations.It is also recommended that future studies expand the geographical scope, compare different sectors, and investigate the impact of digital technologies such as IoT, big data, and artificial intelligence. Such efforts could contribute to the development of a sustainable and efficiency-oriented cold supply chain structure.

REFERENCES

1. Görçün, Ö. F., Aytekin, A., & Korucuk, S. (2023). Fresh food supplier selection for global retail chains via bipolar neutrosophic methodology. *Journal of cleaner production*, *419*, 138156.S. https://doi.org/10.1016/j.jclepro.2023.138156
2. Izikki, K., El Alami, J., & Hlyal, M. (2021), The use of the ınternet of things in the cold chain logistics for a better vaccine transportation: A State of The Art, In 4th International Conference on Innovative Research in Science Engineering and Technology, Milan, 2-13.
3. Korucuk, S. (2018). Soğuk Zincir Taşımacılığı Yapan İşletmelerde 3PL Firma Seçimi: İstanbul Örneği. *Iğdır Üniversitesi Sosyal Bilimler Dergisi*(*16*), 341-366.
4. Kabadayı, N., & Dağ, S. (2020). DEMATEL ve ELECTRE Yöntemi ile Tedarik Zincirinde Bayi Performans Değerlendirmesi. Pamukkale Univ Muh Bilim Derg, 26(1), 241-253. https://doi.org/10.5505/pajes.2019.39214.
5. Gogou, E., Katsaros, G., Derens, E., Alvarez, G., & Taoukis, P. S. (2015). Cold chain database development and application as a tool for the cold chain management and food quality evaluation. International Journal of Refrigeration, 52(1), 109–121. https://doi.org/10.1016/j.ijrefrig.2015.01.019
6. Mallik, S., Mandal, P. K., Chatterjee, C., Ghosh, P., Manna, N., & Chakrabarty, D., et al. (2011). Assessing cold chain status in a metro city of India: an intervention study. African Health Sciences, 11(1), 128–133.
7. Bhatnagar, A., Vrat, P., & Shankar, R. (2019). Multi-criteria clustering analytics for agrobased perishables in cold-chain. Journal of Advances in Management Research, 16(4), 563-593. https://doi.org/10.1108/JAMR-10-2018-0093
8. Meneghetti, A., &7 Monti, L. (2015), Greening the food supply chain: an optimization model for sustainable design of refrigerated automated warehouses, International Journal of Production Research, 53:21, s.6567-6587, DOI: 10.1080/00207543.2014.985449
9. Saif, A., & Elhedhli, S. (2016). Cold supply chain design with environmental considerations: A simulation-optimization approach. *European Journal of Operational Research*, *251*(1), 274-287. https://doi.org/10.1016/j.ejor.2015.10.056.
10. James, S. J., & James, C. (2010). Advances in the cold chain to improve food safety, food quality and the food supply chain. In *Delivering performance in food supply chains* (pp. 366-386). Woodhead Publishing. https://doi.org/10.1533/9781845697778.5.366
11. Faisal, M. N. (2011). Prioritising agility variables for cold supply chains. *International Journal of Logistics Systems and Management*, *10*(3), 253-274. https://doi.org/10.1504/IJLSM.2011.043117
12. Putri, E. A., Dowaki, K., Yudoko, G., & Koido, K. (2012). Comparison of environment impact between conventional and cold chain management system in paprika distribution process. *The Asian Journal of Technology Management (AJTM)*, *5*(1).
13. Laguerre, O., Hoang, H. M., & Flick, D. (2013). Experimental investigation and modelling in the food cold chain: Thermal and quality evolution. Trends in Food Science & Technology, 29(2), 87-97. https://doi.org/10.1016/j.tifs.2012.08.001
14. Asadi, G., & Hosseini, E. (2014). Cold supply chain management in processing of food and agricultural

products.. Scientific Papers. Series D. Animal Science. Vol. Lvii, 2014 Issn 2285-5750.
doi: 10.5267/j.msl.2015.6.005

15. Shashi, S., & Singh, R. (2015). A key performance measures for evaluating cold supply chain performance in farm industry. Management Science Letters, 5(8), 721-738.
16. Xiao, X., He, Q., Fu, Z., Xu, M., & Zhang, X. (2016). Applying CS and WSN methods for improving efficiency of frozen and chilled aquatic products monitoring system in cold chain logistics. *Food Control*, *60*,656-666.
https://doi.org/10.1016/j.foodcont.2015.09.012
17. Ashok, A., Brison, M., & LeTallec, Y. (2017). Improving cold chain systems: Challenges and solutions. Vaccine, 35(17),2217-2223.
https://doi.org/10.1016/j.vaccine.2016.08.045
18. Korucuk, S. (2018). Soğuk Zincir Taşımacılığı Yapan İşletmelerde 3PL Firma Seçimi: İstanbul Örneği. *Iğdır Üniversitesi Sosyal Bilimler Dergisi*(*16*), 341-366.
19. Aygün, N., & Çağil, G. (2019). Comparison of Vehicle Routing Problems in Cold Chain . *Ejons International Journal on Mathematic, Engineering and Natural Sciences*, *3*(9), 79–90.
20. Babagolzadeh, M., Shrestha, A., Abbasi, B., Zhang, Y., Woodhead, A., & Zhang, A. (2020). Sustainable cold supply chain management under demand uncertainty and carbon tax regulation. Transportation Research Part D: Transport and Environment, 80, 102245. https://doi.org/10.1016/j.trd.2020.102245
21. İpekçi, E., & Tanyaş, M. (2021). Soğuk zincir lojistiği uygulamalari ve Türkiye'de soğuk zincir lojistiğinin swot analizi. Dicle Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, (26), 46-64. empirical analysis in Organisation for Economic Co-operation and Development countries. *Competition and Regulation in Network Industries*, *24*(2-3), 97-119.
22. Khan, A. U., Ali, Y., Pamucar, D., & Vasa, L. (2022). Risk management for cold supply chain: case of a developing country. *Acta Polytechnica Hungarica*, *19*(8), 161-185.
23. Turgut, A. (2023). Soğuk Zincir Lojistiğinde Yeni Nesil Teknolojilerin Kullanımı. Abant Sosyal Bilimler Dergisi, 23(2), 772-782. https://doi.org/10.11616/asbi.1211537
24. Bentyn, Z., & Konecka, S. (2024). Cold chain as a resilience feature of the supply chain in changing conditions of the environment. Journal of Civil Engineering and Transport, 6(4).
25. Fatorachian, H., & Pawar, K. (2025). Sustainable cold chain management: An evaluation of predictive waste management models. *Applied Sciences*, *15*(2), 770. https://doi.org/10.3390/app15020770.
26. Khan, S., Imran Khan, M., & Haleem, A. (2018, September). Towards effective management of cold chain: a DEMATEL approach. In IOP conference series: materials science and engineering (Vol. 404, p. 012019). IOP Publishing. doi; 10.1088/1757-899X/404/1/012019
27. Chukwu, O. A., & Adibe, M. (2022). Quality assessment of cold chain storage facilities for regulatory and quality management compliance in a developing country context. *The International journal of health planning and management*, *37*(2), 930-943.
https://doi.org/10.1002/hpm.3385Citations: 20.
28. Tsai, K. M., & Pawar, K. S. (2018). Special issue on next-generation cold supply chain management: research, applications and challenges. *The International Journal of Logistics Management*, *29*(3), 786-791. https://doi.org/10.1108/IJLM-08-2018-340.

29.Brzozowska, A., Brzeszczak, A., Imiołczyk, J., & Szymczyk, K. (2016, June). Managing cold supply chain. In *5th IEEE International Conference on Advanced Logistics and Transport (ICALT 2016)*.

Aytekin, A., Korucuk, S., & Görçün, Ö. F. (2024). Determining the factors affecting transportation demand management and selecting the best strategy: A case study. *Transport policy*, 146, 150-166.

Aytekin, A., İstanbullu, B., & Kara, K. (2025). Current Problems and Solutions of Certified Public Accountants in Türkiye. *Spectrum of Engineering and Management Sciences*, 3(1), 210-227.

Pinar, A., & Boran, F. E. (2020). A q-rung orthopair fuzzy multi-criteria group decision making method for supplier selection based on a novel distance measure. *International Journal of Machine Learning and Cybernetics*, *11*, 1749–1780.

Yager, R. R. (2016). Generalized orthopair fuzzy sets. *IEEE Transactions on Fuzzy Systems*, *25*(5), 1222–1230.