Journal of Engineering Management and Systems Engineering
https://www.acadlore.com/journals/JEMSE

Evaluating Performance-Based Logistics in Manufacturing Through Polytopic Fuzzy SWARA: A Criterion Assessment Approach

Ahmet Aytekin[1], Selçuk Korucuk[2*]

[1] Department of Business Administration, Artvin Çoruh University, 08600 Artvin, Turkey
[2] Department of Logistics Management, Giresun University, 28000 Giresun, Turkey

[*] Correspondence: Selçuk Korucuk (selcuk.korucuk@giresun.edu.tr)

Received: 03-10-2024 **Revised:** 04-15-2024 **Accepted:** 04-26-2024

Citation: A. Aytekin and S. Korucuk, "Evaluating performance-based logistics in manufacturing through polytopic fuzzy SWARA: A criterion assessment approach," *J. Eng. Manag. Syst. Eng.*, vol. 3, no. 2, pp. 65–71, 2024. https://doi.org/10.56578/jemse030201.

Abstract: Effective management of supply chains, pivotal for sustaining business operations, is increasingly challenged by rising costs and complexity in logistics processes. Performance-Based Logistics (PBL) emerges as a critical strategy to enhance logistical effectiveness and competitiveness by focusing on performance targets rather than merely procuring products or services for maintenance and repair. This study examines the implementation of PBL in manufacturing enterprises and explores the factors influencing its benefits. By employing the polytopic fuzzy Stepwise Weight Assessment Ratio Analysis (SWARA) method, a sophisticated Multi-criteria Decision Analysis (MCDA) technique, criteria were weighted to determine their impact on PBL effectiveness. It was found that the paramount criterion affecting PBL advantages is the capability to manage operations more effectively, whereas the reduction in system lifecycle costs through savings in labor and training was identified as the least impactful. This analysis not only underscores the necessity of designing reliable systems that align with customer expectations but also highlights the added value PBL provides by integrating reduced support elements essential for logistics and sustainability. The findings advocate for meticulous emphasis on PBL practices within business models to optimize operational efficiency and strategic advantage.

Keywords: Performance; Performance-Based Logistics (PBL); Polytopic Fuzzy Sets; Stepwise Weight Assessment Ratio Analysis (SWARA); Multi-criteria Decision Analysis (MCDA)

1 Introduction

Today, competition for businesses is realized through supply chain management, and PBL measurements have become very important. Supply chain management performance factors require an effective decision mechanism, thus forcing businesses to make decisions continuously in rapidly challenging and ever-changing market conditions [1]. In this context, PBL applications, a method that has been used in both civilian and military fields for nearly thirty years, come to the fore. In particular, applications, which are an approach that envisages the purchase of the required service at the performance level instead of purchasing logistics elements, offer various gains to businesses [2].

PBL is the procurement of logistics support as an integrated, cost-acceptable performance package designed to meet a system's performance objectives and ensure that the system is ready for the appropriate level of value through long-term logistics support contracts with clearly defined authorities and responsibilities. Instead of purchasing spare parts, equipment, and information (the classical approach), it is defined as purchasing a predetermined level of services to meet operational objectives [3]. In another definition, it is stated that it is a product/material support approach that ensures that systems are reliable, sustainable, and readily available when and where end users need them to ensure mission success, focusing on the performance outputs of the systems and aiming to operate and maintain these systems in a cost-effective manner in the life cycle [4]. The aim of these applications is to provide life-cycle product support where the required reliability and availability are provided at a lower cost and the use of inventory in the procurement process is maximized through PBL [5].

The PBL strategy aims to purchase performance targets rather than supply products. With the PBL approach, it is aimed at creating an environment where the requirements of the end customer are determined, performance values are purchased instead of material supply, the supplier is told what is desired, not how, a strategic link is established, risk sharing is made, a program management perspective is dominant, all partners focus on their core capabilities, and the focus is on the life cycle [6]. In fact, while increasing the availability of systems, subsystems, or components with effective applications, it also reduces the cost of services per performance unit. In addition, it has been observed that PBL provides 20–40% performance efficiency while reducing costs by 15-20% [7].

Again, with PBL applications, the increase in the level of readiness and reliability of the systems leads to savings in total life cycle costs and shorter waiting times for the end user. It also provides reduced inventory quantities, increased consistency in meeting mission requirements, reduced risks in achieving expected performance, and early detection of errors using predictive and diagnostic analysis. In addition, thanks to the related applications, the support provider has flexibility in producing solutions without compromising the performance of the system, keeps the budget under control by establishing a performance-based cost calculation system, and contributes to allocating more share to innovation by including long-term contracts and sharing the profits obtained with the support providers [8].

On the other hand, PBL applications also enable the measurement of efficiency through performance parameters. Performance-based parameters are optimized through contract management [9]. The PBL approach also serves to create an environment where the real needs of the end-user are determined, the supplier is told what is desired, not how, performance is purchased instead of individual products, strategic relationships are established, risk sharing is made, the program management perspective is dominant, all stakeholders focus on their own capabilities, and the focus is on the life cycle [5]. In conclusion, when we look at the benefits of a PBL system, it can be said that it is a strategic approach that focuses on the procurement of reliable, maintainable, and readily available systems in line with the needs of the user and the cost-effective operation, maintenance, and sustainment of these systems [4].

Based on the above-mentioned issues, it is seen that PBL practices affect critically important issues such as efficiency, competitiveness, effectiveness, performance, and end-user satisfaction for both businesses and users. Therefore, PBL application advantages are seen as extremely important issues and are considered to be issues that need to be emphasized meticulously. Because making supply chain management flexible and agile affects not only production management but also the entire process up to the end consumer, related practices are defined as critical components. At the same time, it provides important indicators at the point of creating the motivation source of the study. Based on all these issues, the study aims to identify and rank the advantages of PBL applications by using MCDA methods in manufacturing enterprises with corporate identity in Ordu province.

2 Literature

A literature review on PBL and PBL practices is presented below:

• Hypko et al. [10] created a new conceptual model for PBL practices in their detailed literature review.

• Kaczmarski [11] examined the issue of funding as a barrier to achieving the strategic objectives of PBL considerations. In addition, he investigated the potential impact of contractor-funded procurement on system readiness and cost.

• Guajardo et al. [12] empirically investigated how product reliability is affected by the use of two different aftermarket maintenance support contracts (traditional, i.e., time and materials contracts, and performance-based contracts) using a real data set provided by a major aircraft engine manufacturer.

• Ahmad [13] a quantitative investigation for investigating the effectiveness of performance-based logistics. It also investigated the relationships between performance-based logistics facilitators and performance-based logistics effectiveness.

• Micklich and Lasch [14] designed a contract by proposing a morphological box for performance-based contracts.

• Kim et al. [15] compared traditional support strategies and PBL strategies using the game theory.

• Dirican [7], a mathematical model was developed to determine the contract terms in the PBL application and was run for scenarios varying in terms of contract duration, number of supported systems, incentive amount, and order response time for a helicopter engine in the inventory.

• Ivan et al. [16] performance-based logistics theory and explores the potential of applying the service model under the theory to Taiwan's heavy-duty truck supply chains. A multiple case study approach is used to explore this research question.

• Hur et al. [17] addressed the problem of inventory control of aircraft spare parts at the end of their life cycle and developed an algorithm that calculates the final order quantity.

• Wang et al. [18] presented a new optimal maintenance policy under performance-based contracting that improves system readiness while maximizing suppliers' profits.

• Glas [19] presented case studies of PBL in the military as a lesson.

• Zhu et al. [20] presented a framework for integrating prognostics and health management into PBL.

• Agdas and Gencer [21] proposed a dynamic performance evaluation model to support the material availability of the public organization and select the most appropriate service provider within PBL.

• Stiller [22] conducted a qualitative study investigating the interest of non-governmental organizations in participating in PBL.

In the detailed literature review given above, PBL applications have been investigated in different ways. It is thought that the proposed study will contribute to the literature both in terms of the method used in the application and the province where the application is made.

3 The Proposed Methodology

Uncertainties arise from the variety of elements involved in decision-making problems. In order to process the uncertainties in the problems and reach feasible solutions, many fuzzy sets have been developed. Bet et al.'s Polytopic Fuzzy Sets (PtFSs) are one of them [23]. PTFSs are considered a generalization of picture fuzzy sets (PFSs), and q-rung orthopair fuzzy sets (q-ROFSs). In particular, it has been stated that PtFSs can be used as an effective tool to solve decision-making problems where SFSs, PFSs, and q-ROFSs cannot be applied [23].

The decision-making problem in this study will be solved using the SWARA technique as defined under PtFS. SWARA makes it possible to effectively obtain problem-related evaluations from evaluators who are unfamiliar with MCDA methods. SWARA has a simple-to-understand and easy-to-apply structure. PtFS-SWARA, proposed in this study, enables the modeling of uncertainties in addition to the mentioned features.

The basic PtFS operations will be presented first in this section. Following that, the PtFS-SWARA processing steps will be explained.

Assuming that X is a universe of discourse, then a PtFS H of X can be stated as $H = \{\langle x, \alpha_H(x), \eta_H(x), \beta_H(x)\rangle : x \in X\}$, where $0 \leq \alpha_H(x)^q + \eta_H(x)^q + \beta_H(x)^q \leq 1$. Also, $\alpha_H : X \to [0,1]$ is the positive membership degree, $\eta_H : X \to [0,1]$ is the neutral membership degree, and $\beta_H : X \to [0,1]$ is the negative membership degree of $x \in X$ to PtFS H. The triplet $\langle \alpha, \eta, \beta\rangle$ is called a PTF number (PtFN) for the simplicity. The basic operations for PtFNs are presented below, where $h = \langle \alpha, \eta, \beta\rangle, h_1 = \langle \alpha_1, \eta_1, \beta_1\rangle, h_2 = \langle \alpha_2, \eta_2, \beta_2\rangle$ are three PtFNs [23].

$$h_1 \otimes h_2 = \left\langle \alpha_1\alpha_2, \eta_1\eta_2, (\beta_1^q + \beta_2^q - \beta_1^q\beta_2^q)^{1/q} \right\rangle, \tag{1}$$

$$h_1 \oplus h_2 = \left\langle (\alpha_1^q + \alpha_2^q - \alpha_1^q\alpha_2^q)^{1/q}, \eta_1\eta_2, \beta_1\beta_2 \right\rangle \tag{2}$$

$$h^c = \langle \beta, \eta, \alpha\rangle \tag{3}$$

$$h^\lambda = \left\langle \alpha^\lambda, \eta^\lambda, \left(1 - (1-\beta^q)^\lambda\right)^{1/q} \right\rangle, \tag{4}$$

$$h\lambda = \left\langle \left(1 - (1-\alpha^q)^\lambda\right)^{1/q}, \eta^\lambda, \beta^\lambda \right\rangle, \tag{5}$$

The score function ($\mathcal{S}(h)$) and accuracy function ($\mathcal{A}(h)$) are calculated using Eqs. (6)-(7), respectively [23].

$$\mathcal{S}(h) = \frac{1 + \alpha^q + \eta^q - \beta^q}{3} \tag{6}$$

$$\mathcal{A}(h) = \frac{1 + \max(\alpha^q, \eta^q) - \beta^q}{2} \tag{7}$$

The PtF weighted aggregation operator (PtFWA) is calculated using Eq. (8), where h_i for $i = 1, \ldots, m$ are PtFNs [23].

$$\text{PtFWA}(h_1, \ldots, h_m) = \left\langle \left(\left(1 - \prod_{i=1}^{m} (1-\alpha_i^q)^{k_i} \right)^{1/q} \right), \prod_{i=1}^{m} \eta_i^{k_i}, \prod_{i=1}^{m} \beta_i^{k_i} \right\rangle \tag{8}$$

In Eq. (8), k is the weight vector, where $k = 1, \ldots, r$.

The PtF-SWARA implementation steps are presented below [24].

Step 1. The decision-making problem is defined. The criteria to be considered in solving the problem and the experts to be consulted for their evaluations are determined. In this context, $C_1, \ldots, C_n$ represent criteria, and $U_1, \ldots, U_r$ represent decision-makers or experts.

Table 1. Linguistic terms for evaluation criteria

Linguistic Terms for Importance of Criteria	Notations	Related PTFNs		
		α	η	β
Extremely	EXT	0.9	0.1	0.1
Very High	VEH	0.8	0.2	0.2
High	HIG	0.7	0.3	0.3
Slightly More	SMO	0.6	0.4	0.4
Medium	MED	0.5	0.5	0.5
Slight Low	SLO	0.4	0.4	0.6
Low	LOW	0.3	0.3	0.7
Very Low	VEL	0.2	0.2	0.8
Extremely Unimportant	EUN	0.1	0.1	0.9

Step 2. Experts use the linguistic terms in Table 1 to express the criteria's levels of importance [24]. As a result, $\iota_{jk} = \langle \alpha_{jk}, \eta_{jk}, \beta_{jk} \rangle$ shows the importance of the j-th criterion determined by the k-th expert.

Step 3. The experiences, occupations, and positions of experts may influence how they are evaluated. This might require giving expert assessments different weight values. In this case, Table 1's linguistic terms are used to estimate the importance of expert evaluations. Expert weight values are then computed using Eq. (9), where ι_k is the PtF importance value of k-th expert, and $\mathcal{S}(\iota_k)$ depicts the score function of ι_k.

$$\xi_k = \frac{\delta(\iota_k)}{\sum_{k=1}^{r} \delta(\iota_k)} \tag{9}$$

Step 4. Expert judgments regarding the importance of the criteria are merged using Eq. (10). As a result, the integrated PTF importance values are obtained, where $k = 1, \ldots, r$ and $j = 1, \ldots, n$.

$$\iota_j = \left\langle \left(\left(1 - \prod_{k=1}^{r} \left(1 - \alpha_{jk}^{q} \right)^{\xi_k} \right)^{1/q} \right), \prod_{k=1}^{r} \eta_{jk}^{\xi_k}, \prod_{k=1}^{r} \beta_{jk}^{\xi_k} \right\rangle \tag{10}$$

Step 5. The score function value of each criterion is computed using Eq. (6). Here, $\mathcal{S}(\iota_j)$ shows the score function value of the j-th criterion.

Step 6. The ranking order of criteria is created based on $\mathcal{S}(\iota_j)$ values. Thus, θ_j shows the ranking place of.

Step 7. The comparative significance of criteria (θ_j) is calculated using the $\mathcal{S}(\iota_j)$ values. The θ_j value for the firstranked criterion is 0 . The θ_j value of the second-ranked criterion is calculated by subtracting its $\mathcal{S}(\iota_j)$ value from that of the first-ranked criterion. A similar procedure is followed for the two consecutive criteria in the ranking.

Step 8. The revised comparative value of each criterion (ζ_j) is obtained using Eq. (11).

$$\zeta_j = \begin{cases} 1, & \text{If criterion } j \text{ is in the first place of the ranking based on } \mathcal{S}(\iota_j) \text{ values} \\ \theta_j + 1, & \text{in other cases} \end{cases} \tag{11}$$

Step 9. The comparative importance value of each criterion (λ_j) is calculated using Eq. (12). λ_{j-1} is the comparative importance value of the criterion that is one position ahead of criterion j in the ranking.

$$\lambda_j = \begin{cases} 1, & \text{If criterion } j \text{ is in the first place of the ranking based on } \mathcal{S}(\iota_j) \text{ values} \\ \frac{\lambda_{j-1}}{\zeta_j}, & \text{in other cases} \end{cases} \tag{12}$$

Step 10. The weight coefficient of each criterion (ι_j) is computed by applying Eq. (13), where $\sum_{j=1}^{n} w_j = 1$, and $0 \leq w_j \leq 1$.

$$w_j = \frac{\lambda_j}{\sum_{j=1}^{n} \lambda_j} \tag{13}$$

4 Results

The studied problem includes ten criteria, denoted as C1-C10. Three logistics managers were invited to provide their opinions on the problem. Table 2 shows these judgments and the clear names of the criteria.

Equal weights were assigned to experts in this study due to their similar characteristics. Table 3 shows the results obtained after following the PtF-SWARA application steps. Besides, Table 3 lists the criteria in ranking order of weight values.

Table 2. The linguistic importance assessments of criteria

Criterion	Source	Notation	Experts		
			U1	U2	U3
Improving performance and quality while keeping costs low	[25, 26]	C1	EXT	VEH	VEH
Following technological innovations	[27]	C3	VEH	HIG	EXT
Concentrating on essential tasks and improving core capabilities	[1, 28]	C2	EXT	VEH	EXT
Increasing flexibility and resource transfer	[27, 28]	C4	HIG	SMO	VEH
Using outsourcing qualifications	[1]	C5	VEH	SLO	HIG
Providing more effective management	[27, 28]	C6	EXT	EXT	EXT
Extending the system life cycle and increasing system readiness	[25]	C7	VEH	VEH	VEH
Preventing systems from early modernization, out-of-stock, and renovation	[1, 25]	C8	VEL	HIG	VEH
Reducing problems in the legislation	[29–31]	C9	VEH	MED	HIG
System life cycle cost reduction through labor and training savings	[25, 32, 33]	C10	EUN	VEL	HIG

Table 3. Key parameters of our model

Criterion	$\mathcal{S}(\iota_j)$	θ_j	ζ_j	λ_j	w_j	Rank
C6	0.5763	0	1.0000	1.0000	0.1100	1
C2	0.5568	0.0196	1.0196	0.9808	0.1079	2
C1	0.5330	0.0238	1.0238	0.9580	0.1054	3
C3	0.5190	0.0139	1.0139	0.9448	0.1039	4
C7	0.5040	0.0150	1.0150	0.9308	0.1024	5
C4	0.4563	0.0477	1.0477	0.8885	0.0977	6
C9	0.4485	0.0078	1.0078	0.8816	0.0970	7
C5	0.4395	0.0090	1.0090	0.8737	0.0961	8
C8	0.4271	0.0124	1.0124	0.8631	0.0949	9
C10	0.3078	0.1194	1.1194	0.7710	0.0848	10

According to the results, the most important criterion is C6 (Providing more effective management). The second most important criterion is C2 (Concentrating on essential tasks and improving core capabilities). Moreover, the importance ranking order of criteria is obtained as C6 $\succ$ C2 $\succ$ C1 $\succ$ C3 $\succ$ C7 $\succ$ C4 $\succ$ C9 $\succ$ C5 $>$ C8 $\succ$ C10.

5 Conclusions

In recent years, the increase in globalization and the determinants of customer satisfaction have brought sustainable production practices to the forefront. As in every sector, in the manufacturing sector, reducing energy consumption, minimizing waste, increasing efficiency in production processes, and ensuring competitiveness have turned PBL applications into vital components. Therefore, PBL applications are seen as indispensable components for manufacturing enterprises. As such, PBL application advantages have played a critical role for manufacturing enterprises.

In this context, the advantages of PBL applications were determined and ranked by using MCDA methods in manufacturing enterprises with corporate identities in Ordu province. The most important PBL application advantages in manufacturing enterprises are "Providing more effective management," "Concentrating on essential tasks and improving core capabilities," and "Improving performance and quality while keeping costs low." When the results of the study are evaluated, effective management and senior management practices come to the forefront and should be supported by ownership of essential tasks and capability development in providing flexibility to businesses. One way to ensure effective PBL practices is to increase performance and quality by reducing costs and utilizing economies of scale with the support of senior management by prioritizing core competencies. This is also an important indicator of waste reduction and efficiency.

In conclusion, there are many theoretical and practical contributions of PBL implementation benefits to manufacturing enterprises. The adoption of PBL implementation benefits enables business managers to improve important components such as productivity, efficiency, effectiveness, customer satisfaction, flexibility, and generally contributes to increasing operational efficiency. Therefore, adopting PBL execution benefits will enable businesses to gain a competitive advantage, optimize production management operations, and achieve overall success in today's market conditions.

Finally, the study includes the usage of PtFSs in a decision-making problem and the PtF-SWARA technique, a novel SWARA extension. With these features, it can be stated that the study will be a guide for future studies on PtFSs, SWARA, and different MCDA methods.

Note

This study is a revised and expanded version of the study titled "An analysis of PBL advantages using a polytopic fuzzy subjective weighting approach: A case study of manufacturing firms in Ordu province," which was presented as a full-text oral presentation at the 9th International Conference on Transport and Logistics (til 2023).

Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] S. Korucuk, "ÇKKV yöntemleri İle İmalat İşletmelerinde TZY performans faktörlerinin Önem derecelerinin belirlenmesi ve en İdeal rekabet stratejisi seçimi: Ordu İli Örneği," *Dokuz Eylül Üniv. İktisadi İdari Bilim. Fak. Derg.*, vol. 33, no. 2, pp. 569–593, 2018. https://doi.org/10.24988/deuiibf.2018332782

[2] Z. Stević, A. Ulutaş, S. Korucuk, S. Memiş, E. Demir, A. Topal, and C. Karamaşa, "Supply chain management (SCM) breakdowns and SCM strategy selection during the COVID-19 pandemic using the novel rough MCDM model," *Complexity*, 2023.

[3] C. Cicio, "Savunma sanayinde performansa dayalı lojistik," Uzmanlık Tezi, Ankara, SSM, 2007. https://www.researchgate.net/publication/327673125_Performansa_Dayali_Lojistik_Stratejisi_ve_Uygulamalari

[4] B. Kobren, "What performance based logistics and what it is not – and – what it can and what it can not do," *Defence AT&L*, pp. 254–267, 2009.

[5] D. Berkowitz, J. N. Gupta, J. T. Simpson, and J. B. Mcwilliams, "Defining and implementing performance-based logistics in government," *Def. Acq. Rev. J.*, vol. 11, no. 3, pp. 255–267, 2005.

[6] D. Goure, "Back to the future (depots)," Lexington Institute, 2010. http://www.ndia.org/Advocacy/LegislativeandFederalIssuesUpdate/Documents/May2010/LexingtonInstitute-BacktotheFuture(Depots)5,2010.pdf

[7] Ü. Dirican, "Model proposal for design alternative selection in performance-based logistics contract: Helicopter application," Master's thesis, Military Academy Command Defense Sciences Institute, Ankara, 2016.

[8] S. J. Gansler and W. Lucyshyn, *Evaluation of Performance Based Logistics*. Maryland: University of Maryland, 2006.

[9] J. S. Cerreta, "Exploring performance based logistics predictors of earned value management outcomes: A quantitative study," Ph.D. dissertation, Northcentral University, Arizona, USA, 2012.

[10] P. Hypko, M. Tilebein, and R. Gleich, "Clarifying the concept of performance-based contracting in manufacturing industries: A research synthesis," *J. Serv. Manag.*, vol. 21, no. 5, pp. 625–655, 2010. https://doi.org/10.1108/09564231011079075

[11] L. C. D. M. Kaczmarski, "Performance based logistics: optimizing total system availability and reducing program cost," U.S. Army War College, Civilian Research Project, Pennsylvania, USA, Tech. Rep., 2011. https://apps.dtic.mil/sti/tr/pdf/ADA565579.pdf

[12] J. A. Guajardo, M. A. Cohen, S. H. Kim, and S. Netessine, "Impact of performance-based contracting on product reliability: An empirical analysis," *Manag. Sci.*, vol. 58, no. 5, pp. 961–979, 2012. https://doi.org/10.1287/mnsc.1110.1465

[13] S. Ahmad, "Exploring the effectiveness of performance-based logistics: A quantitative examination," *Int. J. Oper. Logist. Manag.*, vol. 2, no. 3, pp. 71–81, 2013.

[14] J. Micklich and R. Lasch, "Contract design of logistics performance-based contracting: A morphological box," in *Logistics Management: Products, Actors, Technology-Proceedings of the German Academic Association for Business Research, Bremen*, 2014, pp. 355–367. https://doi.org/10.1007/978-3-319-13177-1_28

[15] S. H. Kim, M. A. Cohen, and S. Netessine, "Reliability or inventory? An analysis of performance-based contracts for product support services," *Handbook of Inf. Exch. in Supply Chain Manag.*, pp. 65–88, 2015. https://doi.org/10.1007/978-3-319-32441-8_4

[16] S. I. Ivan Su, L. Cui, and S. Hertz, "Assessing the performance-based logistics service model for taiwan's heavy vehicle supply chains," *Transp. J.*, vol. 56, no. 1, pp. 77–103, 2017. https://doi.org/10.5325/transportationj.56.1.0077

[17] M. Hur, B. B. Keskin, and C. P. Schmidt, "End-of-life inventory control of aircraft spare parts under performance based logistics," *Int. J. Prod. Econ.*, vol. 204, pp. 186–203, 2018. https://doi.org/10.1016/j.ijpe.2018.07.028

[18] J. Wang, X. Zhao, and X. Guo, "Optimizing wind turbine's maintenance policies under performance-based contract," *Renew. Energy*, vol. 135, pp. 626–634, 2019. https://doi.org/10.1016/j.renene.2018.12.006

[19] A. H. Glas, "Case studies of performance based logistics in the military: International lessons learned," *Necesse*, vol. 5, no. 3, pp. 99–117, 2020.

[20] X. Zhu, Q. Hu, and Y. Bai, "A framework to integrate prognostics and health management into performance-based logistics," *IOP Conf. Ser.: Mater. Sci. Eng.*, vol. 1043, no. 5, p. 052003, 2021. https://doi.org/10.1088/1757-899X/1043/5/052003

[21] M. Agdas and C. Gencer, "A dynamic performance evaluation model suggestion for performance-based logistics," *Kybernetes*, vol. 51, no. 8, pp. 2578–2602, 2022. https://doi.org/10.1108/K-12-2020-0867

[22] R. Stiller, "A qualitative study exploring the interest of non-government organizations for participation in performance-based logistics (PBL)," Ph.D. dissertation, Colorado Technical University, 2023.

[23] I. Beg, M. Abbas, and M. W. Asghar, "Polytopic fuzzy sets and their applications to multiple-attribute decision-making problems," *Int. J. Fuzzy Syst.*, vol. 24, no. 6, pp. 2969–2981, 2022. http://doi.org/10.1007/s40815-022-01303-1

[24] C. Kahraman, F. K. Gundogdu, S. C. Onar, and B. Oztaysi, "Hospital location selection using spherical fuzzy TOPSIS," in *Proceedings of the 2019 Conference of the International Fuzzy Systems Association and the European Society for Fuzzy Logic and Technology*, 2019, pp. 77–82. http://doi.org/10.2991/eusflat-19.2019.12

[25] A. Balafas, S. Krimizas, and J. Stage, "Impact of logistics on readiness and life cycle cost: A life cycle management approach," Naval Postgraduate School Monterey CA, Tech. Rep., 2010.

[26] A. Önel and Ç. Kambur, "Performance-based logistics (PDL) approaches and applications," in *VII. National Aircraft, Aerospace and Aeronautical Engineering Congress, Eskişehir*, 2013, pp. 181–186.

[27] M. Sade, "Seven steps to performance-based services acquisition," An Interagency Industry Partnership in Performance Report, Tech. Rep., 2005.

[28] A. Aytekin, B. O. Okoth, S. Korucuk, Ç. Karamaşa, and E. B. Tirkolaee, "A neutrosophic approach to evaluate the factors affecting performance and theory of sustainable supply chain management: Application to textile industry," *Manag. Decis.*, vol. 61, no. 2, pp. 506–529, 2022. http://doi.org/10.1108/MD-05-2022-0588

[29] S. Korucuk, E. B. Tirkolaee, A. Aytekin, D. Karabasevic, and Ç. Karamaşa, "Agile supply chain management based on critical success factors and most ideal risk reduction strategy in the era of industry 4.0: Application to plastic industry," *Oper. Manag. Res.*, vol. 16, no. 4, pp. 1698–1719, 2023. https://doi.org/10.1007/s12063-023-00360-5

[30] A. Aytekin, S. Korucuk, and Ö. F. Görçün, "Determining the factors affecting transportation demand management and selecting the best strategy: A case study," *Transp. Policy*, vol. 146, pp. 150–166, 2024.

[31] Ç. Karamaşa, M. Ergün, B. Gülcan, S. Korucuk, S. Memiş, and D. Vojinović, "Ranking value-creating green approach practices and choosing ideal green marketing strategy for logistics companies," *Oper. Res. Eng. Sci. Theory Appl.*, vol. 4, no. 3, pp. 21–38, 2021. http://doi.org/10.31181/oresta20402021k

[32] S. Korucuk, "Erzurum, erzincan ve bayburt illerindeki imalat işletmelerinde depolama ve satin alma kararlarinin üretime etkisine yönelik bir karşilaştırma," *Atatürk Üniv. Sos. Bilim. Enst. Derg.*, vol. 22, no. 2, pp. 1171–1202, 2018.

[33] S. Korucuk, E. B. Tirkolaee, A. Aytekin, D. Karabasevic, and Ç. Karamaşa, "Agile supply chain management based on critical success factors and most ideal risk reduction strategy in the era of industry 4.0: Application to plastic industry," *Oper. Manag. Res.*, vol. 16, no. 4, pp. 1698–1719, 2023. https://doi.org/10.1007/s12063-023-00360-5