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An Integrated BSC–FAHP–ORESTE Model for Evaluating and Ranking the Commercial Performance of Iranian Container Terminals

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ABSTRACT

Purpose: This study develops an integrated Balanced Scorecard–Fuzzy Analytic Hierarchy Process–ORESTE framework for evaluating and ranking the commercial performance of Iranian container terminals. Design/methodology/approach: The study used an applied descriptive-survey design. Performance dimensions and indicators were identified and localized within the four Balanced Scorecard perspectives using the literature and expert judgment. Pairwise comparisons from 50 port managers and specialists were aggregated and analyzed through Chang's fuzzy extent analysis to derive the relative weights of dimensions and indicators. The commercial performance of the Shahid Rajaee, Imam Khomeini, Bushehr, Khorramshahr, and Shahid Bahonar container terminals was then evaluated and ranked using the ORESTE method. Findings: The financial perspective received the highest weight (0.292), followed by the customer (0.273), learning and growth (0.223), and internal business process (0.212) perspectives. Profitability improvement had the highest local weight (0.306) within the financial perspective and the highest global weight (0.089) among all indicators. The ORESTE analysis ranked Shahid Rajaee first, followed by Imam Khomeini, Bushehr, Khorramshahr, and Shahid Bahonar. Research limitations/implications: The analysis was limited to five Iranian terminals and partly relied on expert judgments; broader applications and longitudinal data are recommended. Originality/value: The proposed model integrates strategic performance measurement, fuzzy weighting, and preference-based ranking in a single localized decision-support framework for container-terminal commercial performance. The framework enables port authorities to diagnose performance gaps, prioritize improvement initiatives, allocate resources more transparently, and compare terminals using a consistent strategic and analytical basis for evidence-based port governance.

1. Introduction

The rapid growth of global trade, the expansion of international supply chains, and the increasing volume of maritime transportation have significantly enhanced the strategic importance of ports, particularly container terminals, as critical components of the global logistics system and international trade infrastructure. Today, more than 80% of global trade is transported by sea, with a substantial proportion of this trade being handled through container terminals [1]. Under such circumstances, the efficiency and competitiveness of container terminals have become essential not only for improving supply chain performance and reducing logistics costs but also for promoting foreign trade, attracting investment, and strengthening national competitiveness within the global trading system [2].

Over the past decades, increasing competition among ports, rapid technological advancements, the emergence of smart and digital ports, and evolving stakeholder expectations have challenged the adequacy of traditional performance evaluation systems. Conventional performance measurement approaches have largely focused on financial and operational indicators while paying limited attention to strategic, customer-oriented, organizational learning, and internal process dimensions [3]. Consequently, the multidimensional and complex nature of container terminal performance has highlighted the need for comprehensive, intelligent, and integrated performance evaluation frameworks capable of capturing both tangible and intangible aspects of organizational performance [4]. As a result, multi-criteria decision-making (MCDM) approaches and hybrid evaluation models have become increasingly important in port and terminal performance assessment studies.

Among contemporary performance evaluation frameworks, the Balanced Scorecard (BSC) has emerged as one of the most influential strategic management tools due to its ability to balance financial and non-financial performance indicators [5]. The BSC evaluates organizational performance from four complementary perspectives, namely financial, customer, internal business processes, and learning and growth, thereby facilitating the alignment of operational activities with strategic objectives. Previous studies have demonstrated that the application of the Balanced Scorecard in transportation, logistics, and port industries can significantly improve managerial decision-making, operational efficiency, and competitive advantage [6, 7].

Despite the advantages of the Balanced Scorecard, determining the relative importance of performance indicators and analyzing the complex relationships among evaluation criteria require the integration of advanced multi-criteria decision-making techniques. In this regard, the Fuzzy Analytic Hierarchy Process (FAHP) has been widely recognized as an effective tool for handling uncertainty, ambiguity, and subjective expert judgments in complex managerial decision-making problems [8, 9]. Furthermore, the ORESTE method represents a robust multi-criteria ranking technique that enables the prioritization of alternatives based on ordinal preference structures and the simultaneous consideration of multiple evaluation criteria. In recent years, ORESTE has attracted increasing attention in logistics, transportation, and operations management research due to its ability to support complex decision-making processes [10, 11].

A review of the existing literature indicates that although numerous studies have examined port and container terminal performance, most have focused primarily on operational or financial indicators while giving limited attention to the strategic and commercial dimensions of performance. Moreover, the integrated application of the Balanced Scorecard, Fuzzy Analytic Hierarchy Process, and ORESTE method for the evaluation of commercial performance in container terminals remains relatively underexplored, particularly within the context of Iranian ports. Therefore, the absence of a comprehensive, localized, and multi-criteria decision-support framework for assessing the commercial performance of container terminals in Iran represents a significant research and managerial gap.

Accordingly, this study aims to develop and apply an integrated BSC–FAHP–ORESTE framework for evaluating and ranking the commercial performance of Iranian container terminals. First, a set of performance indicators was identified and customized based on the Balanced Scorecard framework and the specific characteristics of the port industry. Subsequently, the identified indicators were weighted using the FAHP method. Finally, the commercial performance of selected container terminals was evaluated and ranked through the ORESTE method.

2. Theoretical Background

2.1. Container Terminal Performance Evaluation

Container terminals, as one of the most critical components of maritime transportation infrastructure and key nodes within global supply chains, play a fundamental role in facilitating international trade, promoting economic development, and enhancing national competitiveness. Over recent decades, the expansion of global trade, the development of logistics networks, and the continuous growth of containerized cargo flows have made port and container terminal performance a crucial determinant of supply chain efficiency and competitive advantage [1]. Under such circumstances, performance evaluation is not merely a mechanism for assessing the achievement of operational and economic objectives; rather, it serves as a strategic tool for managerial decision-making, optimal resource allocation, and continuous improvement of port operations [2].

Historically, port performance evaluation has been primarily based on traditional financial and operational indicators, such as cargo throughput, vessel turnaround time, container dwell time, and equipment productivity. Although these indicators remain important, the increasing complexity of the competitive environment and evolving customer and stakeholder expectations have rendered purely quantitative and financially oriented performance assessment approaches insufficient for the contemporary port industry [3]. Consequently, container terminal performance evaluation requires a comprehensive and multidimensional perspective that incorporates strategic, customer-oriented, technological, and organizational learning dimensions in addition to financial and operational indicators [4].

Accordingly, the adoption of integrated and intelligent performance evaluation models capable of simultaneously assessing financial, operational, strategic, and commercial dimensions has become an essential requirement for modern port management. In this regard, the integration of the Balanced Scorecard with multi-criteria decision-making methods and fuzzy techniques offers significant potential for developing comprehensive performance evaluation systems for container terminals and can facilitate evidence-based decision-making, productivity enhancement, and improved port competitiveness.

2.2. Balanced Scorecard (BSC)

In today's dynamic and highly competitive business environment, organizations particularly those operating in infrastructure-intensive and service-oriented sectors such as maritime transportation and port management require comprehensive performance evaluation systems that extend beyond traditional financial indicators to achieve sustainable competitive advantage. In response to this need, the Balanced Scorecard (BSC) was introduced by Kaplan and Norton in the early 1990s and rapidly evolved into one of the most influential and widely adopted strategic management and performance measurement frameworks in both public and private organizations [13].

The Balanced Scorecard was developed to address the limitations of traditional performance measurement systems, which primarily focused on financial outcomes and short-term results. By establishing a balance between financial and non-financial indicators, the BSC evaluates organizational performance from four complementary perspectives: financial, customer, internal business processes, and learning and growth [5]. The primary objective of the framework is to translate an organization's vision and strategy into a coherent set of objectives, performance measures, and action plans, thereby enabling continuous performance monitoring and alignment between operational activities and strategic goals [14].

Despite its significant advantages, one of the major challenges associated with the Balanced Scorecard is determining the relative importance of performance indicators and analyzing the complex interrelationships among evaluation criteria. Since many performance indicators are qualitative in nature and rely heavily on subjective judgments, integrating the BSC with multi-criteria decision-making methods and fuzzy techniques can substantially improve the reliability and accuracy of the evaluation process [9]. Consequently, numerous researchers have advocated combining the BSC with methods such as AHP, FAHP, ANP, and other MCDM techniques to facilitate scientific weighting of indicators and more rigorous ranking of alternatives [7].

Within the maritime transportation and port management sectors, the application of the Balanced Scorecard is particularly valuable because container terminal performance is inherently multidimensional, dynamic, and influenced by the interaction of financial, operational, technological, and customer-related factors. Under such circumstances, the BSC framework provides an effective basis for comprehensive commercial performance evaluation, identification of strengths and weaknesses, improvement of managerial processes, and development of performance-based policies. From this perspective, the Balanced Scorecard represents not only a performance measurement tool but also a strategic framework for enhancing competitiveness and promoting sustainable port development.

2.3. FAHP and ORESTE in Performance Evaluation

To address the ambiguity and uncertainty inherent in human judgments, the present study employs a fuzzy logic approach. Fuzzy set theory, first introduced by Zadeh [18], provides an effective mathematical framework for modeling vague, imprecise, and uncertain information. In multi-criteria decision-making problems, particularly within complex managerial and logistics environments, fuzzy logic enhances the accuracy, flexibility, and realism of analytical processes [19]. Given that container terminal performance evaluation relies heavily on expert judgments and qualitative indicators, the application of fuzzy approaches can significantly reduce ambiguity and improve decision-making quality [9].

The Fuzzy Analytic Hierarchy Process (FAHP), an extension of the classical Analytic Hierarchy Process (AHP), is among the most widely used multi-criteria decision-making techniques under uncertain conditions. The method was initially developed by Chang [8] based on the Extent Analysis Method. In this approach, expert judgments are represented through pairwise comparisons using triangular fuzzy numbers, enabling the derivation of relative weights for criteria and sub-criteria. The ability of FAHP to capture subjective judgments, handle ambiguous information, and reduce uncertainty-related errors has led to its extensive application in performance evaluation, supply chain management, logistics, and transportation studies [7].

The ORESTE method was originally proposed by Roubens [10] as a decision-making framework based on ordinal preference structures. The method operates by analyzing preferential relationships among criteria and alternatives. Unlike many conventional MCDM techniques that require precise numerical weights for criteria, ORESTE enables decision-makers to express their preferences in an ordinal and relative manner. This characteristic is particularly valuable in complex managerial contexts and decision environments that rely heavily on expert judgment and subjective assessments [10].

One of the principal advantages of the ORESTE method is its ability to simultaneously accommodate both quantitative and qualitative criteria without requiring fully precise and deterministic information. The method begins by establishing ordinal rankings of criteria and alternatives and subsequently employs preference distances and dominance relationships to derive the final ranking of alternatives. This feature has positioned ORESTE as an effective decision-making tool for addressing complex and multidimensional problems in transportation, logistics, operations management, and performance evaluation [10, 11].

The integration of ORESTE with the Balanced Scorecard and the Fuzzy Analytic Hierarchy Process provides a comprehensive, multidimensional, and intelligent performance evaluation framework. This integrated framework enhances the accuracy and robustness of the evaluation process and supports port managers and policymakers in performance analysis, identification of strengths and weaknesses, optimal resource allocation, and improvement of container terminal competitiveness.

2.4. Previous Studies and Research Gap

To establish the position of the present study within the existing body of knowledge and to identify current research gaps, previous studies related to port and container terminal performance evaluation were systematically reviewed. The literature indicates that the application of multi-criteria decision-making models, fuzzy approaches, and the Balanced Scorecard framework in port performance evaluation has expanded considerably in recent years. Researchers have employed methodologies such as BSC, FAHP, DEA, TOPSIS, and other MCDM techniques to evaluate port and container terminal performance from financial, operational, customer-oriented, and strategic perspectives.

However, the review of prior studies reveals that most investigations have focused on only a subset of performance indicators and have paid limited attention to the development of a comprehensive integrated framework for evaluating the commercial performance of container terminals. Moreover, the combined application of the Balanced Scorecard, Fuzzy Analytic Hierarchy Process, and ORESTE method for the evaluation and ranking of container terminals has received limited attention, particularly in the context of Iranian ports. Therefore, the present study seeks to address this gap by proposing an integrated multidimensional framework that provides a comprehensive and practical approach for evaluating the commercial performance of Iranian container terminals.

A concise synthesis of the most relevant studies is presented in Table 1.

Table 1. Selected studies on port and container-terminal performance evaluation

Author(s)	Year	Method	Context	Key finding
Cullinane et al. [24]	2004	DEA	Container ports	DEA window analysis enabled intertemporal comparison of port production efficiency.
Hung et al. [25]	2010	BSC	Container ports	The balanced-scorecard approach supported multidimensional operating-efficiency benchmarking.
Sayareh and Alizmini [26]	2014	Hybrid MCDM	Iranian ports	Financial and service-quality indicators were emphasized in terminal performance evaluation.
Lirn et al. [27]	2015	AHP	Transshipment ports	AHP enabled the prioritization of port-selection criteria from a global perspective.
Heilig et al. [12]	2017	Digital framework	Maritime ports	Digital transformation was identified as a major driver of future port management.
Tseng and Cullinane [7]	2018	MCDM	Container terminals	Multiple service and operational criteria influenced terminal choice and competitiveness.
Parola et al. [4]	2021	Systematic review	Port performance	The literature increasingly emphasized multidimensional and stakeholder-oriented performance measurement.
Munim et al. [30]	2022	Systematic review	Port benchmarking	Integrated indicators were recommended for robust port-performance measurement and benchmarking.

Source: Compiled by the authors from the reviewed literature.

The literature confirms the value of strategic and multi-criteria approaches, but it provides limited evidence on integrated commercial-performance assessment in Iranian container terminals. The present study addresses this gap by combining BSC, FAHP, and ORESTE within one localized framework.

- Integration of strategic, financial, customer, process, and learning dimensions in a unified terminal-performance model;
- Use of fuzzy weighting to reduce uncertainty in expert judgments and ORESTE to rank terminals using preference structures;
- Development of a practical decision-support tool for performance improvement and resource prioritization in Iranian ports.

3. Materials and Methods

The present study is classified as an applied research project in terms of its objective, as its findings can serve as a strategic decision-support tool for managers, policymakers, and planners in the maritime transportation industry to evaluate and improve the commercial performance of container terminals. From a methodological perspective, the study adopts a descriptive-survey design and is conducted using a quantitative multi-criteria decision-making approach. Given the complexity of container terminal performance evaluation and the multidimensional nature of performance indicators, an integrated framework based on the Balanced Scorecard (BSC), the Fuzzy Analytic Hierarchy Process (FAHP), and the ORESTE multi-criteria decision-making method was employed to provide a comprehensive, realistic, and analytically rigorous assessment framework.

3.1. Study Area

The study area consisted of five major Iranian container terminals: Shahid Rajaee, Imam Khomeini, Bushehr, Khorramshahr, and Shahid Bahonar ports. These terminals were selected because they represent different commercial, operational, and regional roles within the Iranian port system and provide a suitable basis for comparing container terminal performance across diverse managerial and infrastructural conditions.

3.2. Study Design and Participants

The target population consisted of managers, specialists, experts, and professionals involved in the management, planning, and operation of container terminals at selected Iranian ports. Considering the specialized nature of the study and the necessity of incorporating expert judgments into the weighting and evaluation processes, purposive sampling based on expert judgment was adopted [20]. Accordingly, a sample of 50 experts with substantial professional experience in port operations management, maritime logistics, and container terminal performance evaluation was selected from Shahid Rajaee, Imam Khomeini, Bushehr, Khorramshahr, and Shahid Bahonar ports.

The selection criteria included professional experience in the port industry, familiarity with operational and managerial processes of container terminals, experience in maritime transportation decision-making, and expertise in performance evaluation indicators. The use of expert-based samples is widely recognized in multi-criteria decision-making studies, particularly in contexts characterized by uncertainty and subjective judgments [9].

The evaluation and ranking of container terminal commercial performance were conducted using an integrated framework combining the Balanced Scorecard (BSC), the Fuzzy Analytic Hierarchy Process (FAHP), and the ORESTE method. The research procedure was implemented through four sequential stages.

The analytical procedure comprised four stages: identifying and localizing BSC indicators, weighting dimensions and indicators using FAHP, constructing the terminal decision matrix from expert evaluations, and ranking the alternatives using ORESTE. Figure 1 summarizes the workflow.

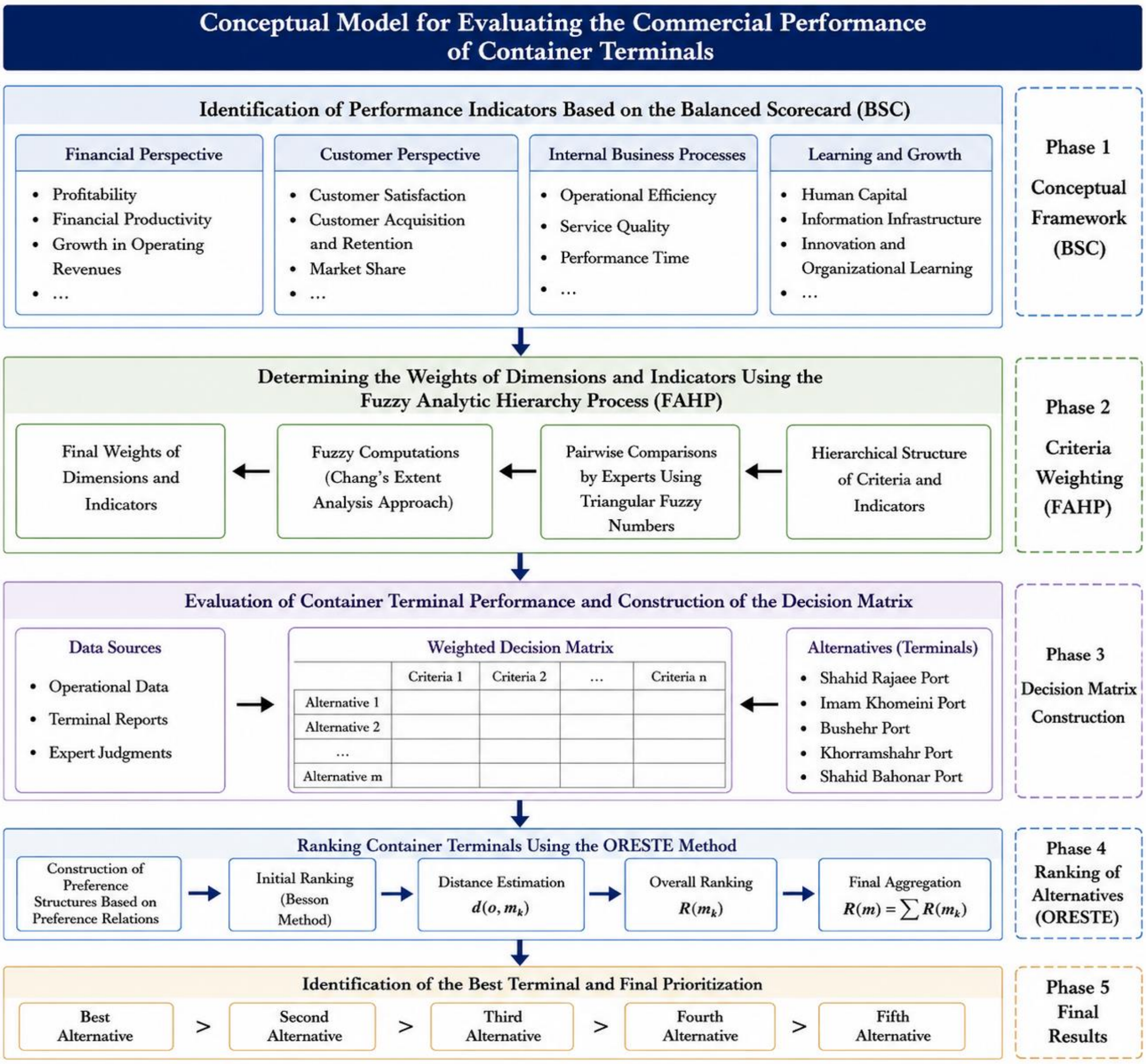

Figure 1. Conceptual framework for evaluating and ranking container-terminal commercial performance using the integrated BSC–FAHP–ORESTE approach

Table 2. Linguistic scale of triangular fuzzy numbers used in the FAHP method

Linguistic Variable	Triangular Fuzzy Number
Equal	(1, 1, 1)
Weak	(0.66, 1, 1.50)
Moderately Strong	(1.50, 2.00, 2.50)
Very Strong	(2.50, 3.00, 3.50)
Absolutely Strong	(3.50, 4.00, 4.50)

Source: Adapted from Chang [8] and Kahraman et al. [9].

3.3. Data Collection

The required data were collected from both documentary and field sources. In the documentary phase, scientific articles indexed in reputable international databases, specialized books, reports published by international organizations, and relevant studies in port management and multi-criteria decision-making were reviewed to establish the theoretical framework, identify performance evaluation indicators, and examine the existing literature.

In the field phase, a structured expert questionnaire was developed based on the dimensions of the Balanced Scorecard and adapted to the characteristics of the port industry. The questionnaire consisted of two sections. The first section focused on pairwise comparisons of indicators for determining the weights of performance evaluation dimensions and criteria. The second section was devoted to the assessment of the commercial performance of container terminals based on the selected indicators.

To improve data accuracy and reduce perceptual biases, the questionnaires were completed through expert interviews, face-to-face meetings, and direct consultations with respondents. Furthermore, the geometric mean was employed to aggregate expert judgments, as it is one of the most commonly used approaches in group decision-making and fuzzy analysis studies [21].

3.4. Data Analysis

All calculations associated with the FAHP and ORESTE methods were performed using MATLAB software. In the first phase of data analysis, the weights of the performance dimensions and indicators were determined using the FAHP technique. Subsequently, the ranking of container terminals was conducted through the ORESTE method. The results of these analyses constituted the basis for evaluating commercial performance and deriving the final ranking of the selected container terminals.

In the extent analysis approach, the fuzzy synthetic extent value for each criterion is calculated using the following equation:

$$S_i = \sum_{j=1}^{m} M_{g_i}^{j} \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^{j} \right]^{-1} \quad (1)$$

In Eq. (1), S_i denotes the fuzzy synthetic extent of criterion i, M represents a triangular fuzzy comparison value, and the operator denotes fuzzy multiplication. The normalized final weight of each criterion was then calculated as follows:

$$W_i = \frac{w_i}{\sum_{i=1}^{n} w_i} \quad (2)$$

In Eq. (2), the final weight of each criterion is obtained through the normalization of the initial weights, such that the sum of all normalized weights equals one. The resulting normalized weights represent the relative importance of the performance evaluation criteria and provide the basis for the subsequent evaluation and ranking of container terminals in the later stages of the study.

4. Results and Discussion

4.1. Operationalization of Criteria

In the first stage of the analysis, the Balanced Scorecard dimensions and indicators were identified and localized based on the literature review, previous studies, and expert opinions from the port industry. Subsequently, the relative importance of the dimensions and indicators was determined using the Fuzzy Analytic Hierarchy Process (FAHP) based on Chang's extent analysis approach. Pairwise comparisons were conducted using expert judgments, and the final weights of the dimensions and indicators were calculated according to their relative importance in evaluating container terminal performance. The results of the weighting process are presented in Table 3.

Table 3. Operationalization and final weights of the Balanced Scorecard dimensions and indicators

Perspective	Weight	Code	Performance Indicator	Local Weight	Global Weight
Financial Perspective	0.292	F1	Increase in Total Revenue	0.289	0.084
Financial Perspective	0.292	F2	Cost Reduction	0.241	0.070
Financial Perspective	0.292	F3	Reduction of Trade Receivables	0.164	0.048
Financial Perspective	0.292	F4	Profitability Improvement	0.306	0.089
Customer Perspective	0.273	C1	Retention of Existing Customers	0.241	0.066
Customer Perspective	0.273	C2	Acquisition of New Customers	0.214	0.058
Customer Perspective	0.273	C3	Improvement of Customer Satisfaction	0.262	0.072
Customer Perspective	0.273	C4	Enhancement of Service Quality	0.283	0.077

Perspective	Weight	Code	Performance Indicator	Local Weight	Global Weight
Internal Business Process Perspective	0.212	I1	Reduction of Administrative Process Time	0.212	0.045
Internal Business Process Perspective	0.212	I2	Reduction of Vessel Service Time	0.234	0.050
Internal Business Process Perspective	0.212	I3	Reduction of Truck Turnaround Time	0.181	0.038
Internal Business Process Perspective	0.212	I4	Availability of Container Handling Equipment	0.203	0.043
Internal Business Process Perspective	0.212	I5	Increase in Cargo Throughput	0.170	0.036
Learning and Growth Perspective	0.223	L1	Electronic Information Exchange with Stakeholders	0.214	0.048
Learning and Growth Perspective	0.223	L2	Mechanization of Terminal Processes	0.234	0.052
Learning and Growth Perspective	0.223	L3	Productivity Improvement	0.181	0.040
Learning and Growth Perspective	0.223	L4	Implementation of a Participatory Management System	0.161	0.036
Learning and Growth Perspective	0.223	L5	Development and Enhancement of Workforce Training	0.210	0.047

Source: Research findings.

4.2. Weighting Model Analysis

4.2.1. Validity and Reliability

Content validity was assessed through consultations with academic scholars and experts in the port industry. During this stage, the questionnaire items and indicators were evaluated in terms of clarity, relevance, comprehensiveness, and consistency with the research objectives, and the necessary modifications were incorporated. Expert review is widely regarded as one of the most reliable approaches for establishing content validity in management and multi-criteria decision-making research [22].

Reliability was examined using Cronbach's alpha coefficient. The results indicated that the Cronbach's alpha values for all questionnaire dimensions exceeded the recommended threshold of 0.70, confirming an acceptable level of internal consistency and measurement reliability [23].

4.2.2. FAHP Weighting Results

The findings indicate that among the four Balanced Scorecard dimensions, the Financial Perspective received the highest final weight (0.292), highlighting the critical role of economic performance, revenue generation, and profitability in enhancing the competitiveness of Iranian ports. In contrast, the Internal Business Process Perspective obtained the lowest weight (0.212). This finding suggests that, under current conditions in the Iranian port industry, financial and customer-oriented indicators exert a greater influence on the evaluation of container terminal commercial performance than operational and process-related indicators.

At the indicator level, profitability improvement had the highest local weight in the financial perspective (0.306) and the highest global weight overall (0.089). Service quality enhancement led the customer perspective (0.283), reduction of vessel service time led internal processes (0.234), and terminal process mechanization led learning and growth (0.234).

4.2.3. Decision Matrix Construction

In the second stage of the study, the performance of the selected container terminals was evaluated based on the four Balanced Scorecard perspectives, namely Financial, Customer, Internal Business Processes, and Learning and Growth. To assess the performance level of each terminal, expert evaluations were collected and the indicators were scored using a scale ranging from 1 to 100. Based on these scores, the ORESTE decision matrix was constructed and the required data for the ranking process were prepared. The structure of the decision matrix and the corresponding evaluation results are presented in Table 4.

The FAHP weights were incorporated into the ORESTE decision matrix so that terminal performance could be assessed jointly across strategic and operational dimensions.

Table 4. ORESTE decision matrix for evaluating container-terminal performance

Container Terminal	Financial Perspective	Customer Perspective	Internal Business Processes	Learning and Growth
Criteria Weight	0.292	0.273	0.212	0.223
Shahid Rajaee Port	86	81	90	95
Imam Khomeini Port	84	78	89	92

Container Terminal	Financial Perspective	Customer Perspective	Internal Business Processes	Learning and Growth
Bushehr Port	77	71	83	84
Khorramshahr Port	72	70	77	78
Shahid Bahonar Port	61	60	68	72

Source: Research findings.

According to the results presented in Table 4, Shahid Rajaee Port achieved the highest scores across most performance dimensions, indicating its superior level of infrastructural development, managerial effectiveness, service quality, and technological adoption among the evaluated container terminals. Imam Khomeini Port also demonstrated a strong performance profile across the majority of evaluation criteria and ranked second overall. These findings suggest that ports characterized by advanced operational infrastructure, efficient management systems, higher levels of mechanization, and greater technological capability tend to exhibit stronger commercial performance within the increasingly competitive maritime transportation environment.

Lower scores in customer, process, and learning dimensions among some terminals indicate the need for investment in service quality, workforce development, managerial processes, and digital infrastructure.

4.3. ORESTE Ranking Model

To implement the ranking procedure using the ORESTE method, preference structures for both criteria and alternatives were first established. The preference structure of the criteria was derived from the weights obtained through the Fuzzy Analytic Hierarchy Process (FAHP). In addition, the preference structure of the alternatives was developed by comparing the performance of the container terminals across each of the Balanced Scorecard dimensions using the data contained in the decision matrix. Accordingly, preference relationships among the alternatives were determined based on their performance levels for each evaluation criterion.

Following the construction of the preference structures, the initial ranking of criteria and alternatives was performed using Besson's average ranking approach. At this stage, ordinal ranks were assigned according to the relative importance of each criterion and the performance of each alternative. Rank 1 represented the best performance, whereas Rank 5 indicated the lowest performance level. The results of the preliminary ranking of the alternatives are presented in Table 5.

Table 5. Initial ranking of alternatives based on Balanced Scorecard dimensions

Container Terminal	Financial Perspective	Customer Perspective	Internal Business Process Perspective	Learning and Growth Perspective
Shahid Rajaee Port	1	1	1	2
Imam Khomeini Port	2	2	2	1
Bushehr Port	3	4	3	3
Khorramshahr Port	4	3	4	4
Shahid Bahonar Port	5	5	5	5

Source: Research findings.

According to the results presented in Table 5, Shahid Rajaee Port achieved the first rank in the Financial, Customer, and Internal Business Process perspectives, reflecting its superior performance across the key dimensions of commercial performance evaluation. Imam Khomeini Port obtained the highest rank in the Learning and Growth perspective, indicating its relatively advanced position in technological development, process mechanization, organizational capability enhancement, and innovation-oriented initiatives.

Imam Khomeini Port ranked first in learning and growth, whereas Shahid Bahonar Port ranked last across all four dimensions, indicating comparatively weaker organizational, technological, and operational capabilities.

4.4. Aggregation and Distance Analysis

After determining the initial rankings of the criteria and alternatives, the direct linear estimation approach was applied to calculate the distance of each alternative from the origin point in the ORESTE method. At this stage, the distances of the alternatives were estimated based on the ranking of the criteria and the performance rank of each alternative across the Balanced Scorecard dimensions. The use of the direct linear estimation approach enables a more accurate assessment of the relative proximity or distance of each alternative from the ideal position.

Accordingly, the estimated distances for all container terminals were calculated based on the Financial, Customer, Internal Business Process, and Learning and Growth perspectives. The results are presented in Table 6.

Table 6. Estimated distances of alternatives based on Balanced Scorecard dimensions

Container Terminal	Financial Perspective	Customer Perspective	Internal Business Process Perspective	Learning and Growth Perspective
Shahid Rajaee Port	1.000	1.648	2.405	3.298
Imam Khomeini Port	1.648	2.000	2.590	3.185
Bushehr Port	2.405	3.298	3.000	3.564
Khorramshahr Port	3.185	2.590	3.564	4.000
Shahid Bahonar Port	3.972	4.046	4.228	4.548

Source: Research findings.

According to the results presented in Table 6, Shahid Rajaee Port recorded the lowest distance values across most evaluation dimensions, indicating its closer position to the ideal performance condition and its superior performance in the key indicators of commercial performance evaluation. Imam Khomeini Port also exhibited relatively low distance values in most dimensions and therefore occupied a favorable position among the evaluated terminals. In contrast, Shahid Bahonar Port showed the greatest distance from the ideal condition, highlighting the need for improvement in operational infrastructure, managerial processes, technological capabilities, and service delivery performance.

Smaller distances indicate closer proximity to the ideal condition. Shahid Rajaee and Imam Khomeini therefore occupied the strongest positions, while Shahid Bahonar showed the greatest improvement requirement.

Table 7. Overall ranking of alternative distances

Container Terminal	Financial Perspective	Customer Perspective	Internal Business Process Perspective	Learning and Growth Perspective
Shahid Rajaee Port	1.0	2.5	5.5	12.0
Imam Khomeini Port	2.5	4.0	7.0	10.5
Bushehr Port	5.5	12.0	9.0	14.5
Khorramshahr Port	10.5	7.0	14.5	17.0
Shahid Bahonar Port	16.0	18.0	19.0	20.0

Source: Research findings.

According to the results presented in Table 7, Shahid Rajaee Port achieved the lowest overall ranking values across most evaluation dimensions, indicating a shorter distance from the ideal performance condition and a superior level of performance compared with the other evaluated alternatives. Imam Khomeini Port also obtained favorable ranking values in most dimensions, reflecting its relatively strong performance across the assessed criteria. In contrast, Shahid Bahonar Port recorded the highest overall ranking values, indicating a greater distance from the desired performance condition.

4.5. Final Ranking and Comparison of Alternatives

After calculating the values for all alternatives across the different Balanced Scorecard dimensions, the aggregation stage of the ORESTE method was conducted. At this stage, the final value, denoted as , for each alternative was obtained by summing the overall ranking scores derived from all evaluation dimensions. Accordingly, alternatives with lower cumulative ranking values were considered to exhibit superior performance and a closer proximity to the ideal condition. The results of the aggregation process and the final ranking of the container terminals are presented in Table 8.

Table 8. Final ranking of container terminals

Container Terminal	Total Ranking Score (R(m))	Final Rank
Shahid Rajaee Port	21.0	1
Imam Khomeini Port	24.0	2
Bushehr Port	41.5	3
Khorramshahr Port	48.5	4
Shahid Bahonar Port	72.0	5

Source: Research findings.

According to the results presented in Table 8, Shahid Rajaee Port, with the lowest cumulative ranking score, was identified as the highest-performing container terminal in terms of commercial performance evaluation. This result reflects the port's superior performance across the Financial, Customer, Internal Business Process, and Learning and Growth perspectives. Imam Khomeini Port ranked second with a relatively small difference, indicating a strong level of managerial, operational, and service performance compared with the other evaluated ports.

In contrast, Shahid Bahonar Port recorded the highest cumulative ranking score, indicating a greater distance from the desired performance condition. This outcome may be attributed to infrastructural limitations, lower levels of mechanization, deficiencies in managerial processes, and constraints in delivering competitive services. Furthermore, the findings suggest that ports equipped with more advanced infrastructure, modern technologies, higher service quality standards, and more efficient management systems tend to achieve superior performance in commercial and logistics-related activities.

Shahid Rajaee Port ≻ Imam Khomeini Port ≻ Bushehr Port ≻ Khorramshahr Port ≻ Shahid Bahonar Port

This ranking indicates that Shahid Rajaee Port outperformed the other evaluated terminals across the Financial, Customer, Internal Business Process, and Learning and Growth perspectives, thereby achieving the highest level of commercial performance within the integrated BSC–FAHP–ORESTE framework. Moreover, the second-place ranking of Imam Khomeini Port reflects its favorable performance in both strategic and operational indicators. In contrast, the lower ranking of Shahid Bahonar Port highlights the need to reconsider managerial processes, develop operational infrastructure, enhance service quality, and increase the level of mechanization in this terminal.

4.6. Discussion

The present study aimed to develop an integrated framework for evaluating and ranking the commercial performance of Iranian container terminals through the combined application of the Balanced Scorecard (BSC), the Fuzzy Analytic Hierarchy Process (FAHP), and the ORESTE multi-criteria decision-making method. The findings demonstrate that the adoption of integrated and multidimensional performance evaluation approaches can provide a more comprehensive, realistic, and strategically oriented assessment of port performance. Unlike traditional evaluation approaches, which predominantly focus on operational and financial indicators, the framework proposed in this study simultaneously incorporates financial, customer, internal business process, and learning and growth dimensions. Consequently, performance evaluation is elevated from a purely operational measurement exercise to a strategic management and decision-support process.

The results revealed that indicators associated with the Financial and Customer perspectives exert the greatest influence on the commercial performance evaluation of container terminals. This finding suggests that, within the increasingly competitive maritime transportation environment, the ability of terminals to generate economic value, attract and retain customers, enhance service quality, and improve stakeholder satisfaction plays a decisive role in strengthening performance and sustaining competitive advantage. Furthermore, the ranking results indicate that differences in terminal performance cannot be attributed solely to operational capacity or physical infrastructure. Managerial effectiveness, process efficiency, service responsiveness, organizational capabilities, and technological readiness also represent critical determinants of commercial performance within the port sector.

From a theoretical perspective, the findings are consistent with previous studies in the fields of port performance evaluation and maritime logistics management. Prior research has demonstrated that the application of multi-criteria decision-making techniques and strategic management approaches can significantly enhance the effectiveness and accuracy of performance assessment in port organizations [4, 7]. Moreover, the results confirm that integrating the Balanced Scorecard with fuzzy techniques and multi-criteria ranking methods provides a robust analytical framework for addressing complex decision environments characterized by uncertainty and ambiguity [9]. In this regard, the proposed BSC–FAHP–ORESTE framework contributes to the advancement of intelligent performance evaluation literature within the domains of port management and maritime transportation.

From a managerial standpoint, the proposed framework can serve as a strategic decision-support tool for port authorities, terminal operators, and maritime transportation policymakers. The model facilitates the identification of organizational strengths and weaknesses, prioritization of critical performance indicators, optimization of resource allocation, and formulation of performance-based management policies. The findings further suggest that enhancing the competitiveness of container terminals requires more than investments in physical infrastructure. Sustainable performance improvement also depends on strengthening managerial capabilities, developing human capital, improving service quality, promoting organizational learning, and adopting advanced performance management practices. Therefore, port organizations are encouraged to move toward the implementation of intelligent, data-driven, and strategically oriented performance evaluation systems.

5. Conclusions

The study developed and applied an integrated BSC–FAHP–ORESTE model for evaluating and ranking the commercial performance of Iranian container terminals. The findings showed that the Financial Perspective had the highest importance among the Balanced Scorecard dimensions, while Profitability Improvement was the most influential individual indicator. The ORESTE results identified Shahid Rajaee Port as the best-performing terminal, followed by Imam Khomeini Port, Bushehr Port, Khorramshahr Port, and Shahid Bahonar Port.

The proposed framework can support port authorities and terminal operators in identifying performance gaps, prioritizing improvement actions, allocating resources more effectively, and developing performance-based managerial policies. By integrating strategic performance dimensions with fuzzy weighting and preference-based ranking, the model provides a practical decision-support tool for improving competitiveness in the maritime transportation sector.

Despite its contributions, the present study is subject to several limitations. First, the empirical analysis was restricted to a selected group of Iranian container terminals, which may limit the generalizability of the findings. Second, part of the evaluation process relied on expert judgments, introducing an inherent degree of subjectivity into the analysis. Third, access to certain operational and performance-related data was constrained due to confidentiality considerations within the port industry. Additionally, the dynamic nature of the maritime transportation sector may alter the relative importance of performance indicators over time, potentially affecting the applicability of the results under different market conditions.

Future studies should validate the framework across a broader set of ports and incorporate longitudinal operational data, dynamic weighting, and digital analytics to examine how smart-port technologies influence commercial performance over time.

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