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The Evaluation of Logistics Enterprise Performance Index Based on TOPSIS-Grey Relational Analysis

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ABSTRACT

Performance assessment is a pivotal facet within the operational framework of logistics enterprises, functioning as a mechanism to gauge business outcomes and growth potential. For this study, the authors developed a performance evaluation system for logistics enterprises under the paradigm of sustainable development to reveal the fissures and quandaries within the operational milieu by scrutinizing the current state of logistics enterprises. Drawing on pertinent references and empirical inquiries, they employed the entropy weight method to allocate weights to the performance evaluation metrics of logistics enterprises and TOPSIS–grey relational analysis method to comprehensively assess the performance of such enterprises. Empirical findings show that during the period of 2016–2018, a majority of the sampled logistics enterprises demonstrated an ascending trajectory in their comprehensive proximity, and a minority exhibited fluctuating and descending trends. These findings suggest the favorable trajectory of the evolution of logistics enterprises.

KEYWORDS

Entropy Method, Grey Relational Analysis, Logistics Enterprise Performance, TOPSIS, Weight Distribution

INTRODUCTION

Contemporary logistics embodies the burgeoning and all-encompassing realm of service provision, seamlessly amalgamating warehousing, transportation, packaging, and other facets. The advent of internet technology played a pivotal role in nurturing the exponential expansion of e-commerce enterprises (Agdas & Gencer, 2022), concurrently opening novel vistas for the logistics industry. The aggregate scale of social logistics in China has undergone substantial growth, surging from 125.4 trillion yuan to 283.1 trillion yuan between 2010 and 2018 (Yang, 2021; Pan & Niu, 2022; Yang, 2020; Malindzakova et al., 2022). The data corroborate the escalating exigency for social logistics services; nevertheless, the logistics sphere faces profound societal conundrums, including resource scarcity and environmental degradation. According to the *China Post*, the number of express parcels in China

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escalated to a staggering 49 billion in 2018, marked by a recycling rate below 20%. Consequently, this phenomenon induced an annual generation of solid waste of more than 100 billion tons (Xue et al., 2022; Song & Huang, 2022; Deng, 2021). Regrettably, the quandary confronting the logistics domain extends beyond express packaging waste. For instance, the cumulative energy consumption of the logistics sector reached an unprecedented 431.782 million tons in 2018, highlighting the challenges underscored by the inordinate energy use and contamination within the industry. Hence, enterprises and nations should prioritize the pursuit of sustainable development. Although economic advancement remains a cardinal facet, the heedless fixation on transient pecuniary gains, at the cost of enterprise maturation, would be an injudicious course.

Nonetheless, the implementation of sustainable development practices in China persists primarily at the macroscopic level, leaving the microcosmic facet to attain holistic embodiment. As an emerging industry, the logistics sector has struggled to comprehend sustainable development principles. Extant performance evaluation systems tailored to logistics enterprises fixate predominantly on the assessment of fiscal performance. Although some scholars combined pecuniary and nonmonetary indicators in their development of performance evaluation frameworks for logistics enterprises, the ultimate evaluative aim is the prioritization of economic gain, and the pivotal tenets intrinsic to sustainable development are generally neglected (Orji et al., 2022). Thus, the establishment of a performance evaluation apparatus for logistics enterprises within the aegis of sustainable development has become essential. Such an apparatus can not only afford enterprises a panoramic cognizance of their operational terrain but also unravel the lacunae and predicaments ingrained in their operational paradigm. A meticulously crafted performance evaluation framework can galvanize the robust and sustainable growth of an enterprise, fortify its administrative stratagems, and expedite the realization of precise strategic blueprints. Therefore, the conceptualization of such a framework assumes paramount practical and theoretical import vis-à-vis enterprise progression.

By harkening to the theoretical and methodological purview of sustainable development and performance assessment within logistics enterprises, we undertake an analytical examination of the present state of logistics enterprises and their performance evaluation methodologies. Specifically, for this study, we devised an index matrix to gauge the performance of logistics enterprises within the contours of sustainable development, encompassing monetary and nonmonetary benchmarks. The former encapsulates indicators such as solvency, profitability, operational capability, and growth potential, whereas the latter includes indicators, such as innovation acumen, environmental responsibility, and societal responsibility. This composite framework forms the foundation of the evaluative construct proposed in this study. Furthermore, we used a synergistic amalgamation of grey relational analysis and technique for order preference by similarity to ideal solution (TOPSIS) to assess the performance of logistics enterprises within the tapestry of sustainable development.

RELATED WORKS

The concept of sustainable development was initially proposed by Higgins (1977), who emphasized its relevance to enterprise development in an active market economy. Meanwhile, other scholars (e.g., Hill, 2001) argued that sustainable development entails achieving economic growth while ensuring a favourable ecological environment and improved quality of life.

A review of the literature reveals a gradual shift in the performance evaluation index system of logistics enterprises from a singular focus on financial indicators to a comprehensive evaluation system encompassing financial and nonfinancial indicators. In the early stages, performance evaluation systems consisted primarily of financial indicators. Feng and Wang (2000) asserted that enterprises should not concentrate solely on profits and advocated for the creation of performance evaluation systems based on financial indicators to enable the comprehensive assessment of overall company operations. O'Hanlon and Peasnell (2003) emphasized the significance of financial

information within an enterprise's business processes because this data can considerably impact its overall performance. However, as logistics enterprises experienced rapid development, some scholars (Jian et al., 2022) recognized the inadequacy of evaluation systems that relied solely on financial indicators and contended that the logistics industry, as a third-party service provider, should pay attention to operational aspects, such as procurement, distribution, and customer satisfaction. Consequently, nonfinancial indicators related to such aspects were incorporated into the performance evaluation system of logistics enterprises. Moreover, Xie et al. (2023) studied the monitoring and early warning of SMEs' shutdown risk under the impact of global pandemic. Huang et al. (2021) proposed the flow of government expenditure and intergenerational income in the context of economic research; Wang et al. (2021) studied the moderating effect of management power, research and development, and enterprise performance; Yin and Song (2023) conducted research based on the background of big cities, and raised the question of whether the concept of intelligent governance will promote business investment. Luo et al. (2023) proposed a question of whether the optimal scale of nongovernmental organization (NGO) human resources and the quality of circular economy entrepreneurial governance determine the quality of management. For instance, Zhao and Zhou (2022) combined a back propagation (BP) neural network and vector autoregressive model to analyze the business conflicts between commercial banks and traditional financial enterprises within the realm of internet finance. Qiu (2021) devised an artificial intelligence accounting information web system by integrating various subsystems and then assessed the feasibility of the system's theoretical and technological foundations. Li et al. (2022) proposed a data-driven approach based on deep learning algorithms and introduced finance-related content, and Parada et al. (2018) proposed an anomaly detection method based on information management in the Internet of Things (IoT) environment that can provide ideas for related research. Zhao and Zhou (2022) proposed a deep learning digital economy scale measurement method based on a big data cloud platform as well as related applications. Ta and Gao (2022) proposed an enterprise financial management model based on deep learning under big data; this research promoted related development in the financial industry. Meie (2021) emphasized the importance of professional logistics management in the optimal development of enterprises and advocated for the increased training of logistics professionals. In addition, Meie (2021) deemed the establishment of a robust logistics management performance evaluation system crucial. Recently, logistics enterprises transitioned from being labor intensive to being technology driven. Chen (2018) proposed a performance evaluation framework for logistics clusters based on big data and cloud computing. Li et al. (2018) employed grey relational analysis and TOPSIS to evaluate the innovation performance of sample logistics enterprises and then combined the two methods to conduct a comprehensive evaluation of the sample enterprises.

Luyen and Thanh (2022) examined 40 counties and districts in Chongqing, employed the entropy weight method to determine the economic indicator weight of the area, and evaluated their economic development level using TOPSIS. These authors also provided recommendations for addressing the existing developmental issues in the counties and districts. Shen and Liu (2018) focused on the evaluation of bridge durability and employed a combination of grey relational analysis and TOPSIS.

Through empirical analysis, the authors obtained ranking results and validated the applicability of the combined approach. Existing research also explored various quantitative and qualitative methodologies for evaluating logistics performance. Traditional methods are widely employed to measure performance across multiple dimensions, including finance, customers, internal processes, and learning and growth. Although such methods can offer a comprehensive view, they may not be able to adequately address the dynamic and uncertain nature of the logistics environment. Furthermore, despite the plethora of research, certain gaps remain in the literature. One notable gap is the limited consideration of the uncertainty and ambiguity of logistics operations, particularly in complex and rapidly changing environments. Existing methodologies can provide valuable insights, but they may not be able to fully capture the interconnectedness of performance dimensions and underlying causal relationships.

In this study, we seek to address the gaps in the literature by proposing a novel approach that integrates the entropy weight method and TOPSIS–grey relational analysis method. By combining the methods, we aim to provide a holistic, adaptable framework for evaluating the performance of logistics enterprises that can account for uncertainties and interdependencies across performance dimensions.

RESEARCH ANALYSIS

Logistics Enterprises

Green Logistics Development

China currently stands as the preeminent global goods exporter and ranks as the world's second-largest economy. Nonetheless, the trajectory of its economic advancement is inexorably entwined with ecological deterioration. In 2001, the energy consumption of China's logistics sector was approximately 110 million tons of standard coal. By 2016, this coal consumption surged to an astounding 360 million tons. Furthermore, the logistics milieu of China discharged a staggering 740 million tons of carbon dioxide, solidifying the country's status as one of the foremost contributors to the burgeoning carbon emissions on the global scale. Within the overarching vista of eco-conscious economic progress, the onus rests squarely on logistics enterprises to persistently traverse the trajectory of industrial elevation and embrace the tenets of green logistics to align with the nation's indomitable pursuit of sustainable development.

In 2014, the State Council of China delineated a road map for the logistics sector. This road map spans medium- and long-term horizons, prominently spotlighting the cultivation of green logistics as a cardinal facet amid the council's seven strategic imperatives. The delineated road map underscores the importance of advancing "transport energy conservation" within the logistical domain. At the enterprise level, the cultivation of green logistics involves augmenting infrastructure, refining logistics equipment, and implementing cutting-edge technological paradigm. As the doctrine of energy frugality and emissions abatement increases, a plethora of logistics enterprises have embraced the mantle of green workplace practices. Concurrently, the discerning consumer base has exhibited a preoccupation with the environmental standing of enterprises, thus elevating the primacy of service sustainability. Notably, the advocacy of a green ethos has crystallized into an industrywide movement for logistics enterprises. In anticipation of the future, the tenets of green packaging, eco-friendly transportation, and sustainable terminals are poised to transmute into shared aspirations across enterprises. Thus, the triumvirate of environmental conservation, low-carbon footprint, and heightened efficiency may burgeon into the seminal forces that will propel the growth of logistics enterprises.

Smart Logistics

Smart logistics encompasses the adept use of scientific advancements, technological capabilities, and state-of-the-art methodologies to elevate acumen underpinning analyses, decision-making, and the intricate orchestration within the logistics realm. Through automation augmentation and intelligence infusion across the gamut of logistical processes, the overarching ambition of smart logistics to improve holistic efficiency can be realized. As the economy changes within the ambit of national imperatives, technological leaps, and the dynamic currents of the market, the logistics sector will experience continuous transformation and evolution. Accordingly, globalization will coalesce with the gradual maturation of the intelligent metamorphosis within the logistics vista.

Numerous logistics enterprises that are cognizant of the propulsive potential of science and technology have steered their strategic evolution. Vigorously delving into cutting-edge arenas, including, but not limited to, big data, the IoT, cloud computing, and artificial intelligence, such enterprises stand committed to augmenting their capacity for innovation and self-directed inquiry. This renewed focus can be seen in increased investment in research and development (R&D), which may culminate in the augmentation of innovative and self-propelled research competencies. From

their point of origin to consumers, logistics entities are embracing intelligent solutions that accord with the industry's requirements. Autonomous frameworks for item tracking and coding have been developed, thereby reducing labor-related expenditures while amplifying efficiency. In the realm of transportation, intelligent sorting and conveyance mechanisms can ensure the seamless integration of timeliness and stability for material transit. In terms of delivery, unmanned aerial apparatuses and intelligent express repositories can cater to the logistical demand of diverse geographical spheres and situations.

In summary, the advancement of smart logistics conveys a transformative augmentation in the ambit of logistical efficiency, thus fostering the reduction of social costs while optimizing the judicious deployment of resources and solidifying the cardinal fulcrum underpinning the maturation trajectory of logistics enterprises. However, smart logistics requires substantial fiscal outlay. In 2013, the smart logistics market traversed the threshold of 145.2 billion yuan. Investment in smart logistics increased because of its trajectory in the past five years, which surpassed 400 billion yuan in 2018. In concurrence with forecasts by pertinent institutions and the sagacity of experts, market investment in smart logistics is expected to increase further to 1 trillion yuan by 2025.

Logistics Talents

With its gradual confluence with the "Internet+" paradigm, Internet intelligence has engendered novel vistas and burgeoning prospects in the logistics domain. The advent of smart logistics induced changes in occupational roles and responsibilities within logistics conglomerates, characterized by demand for resourceful and versatile professionals, to integrate technological and management capabilities. The cultivation of specialists stands as a pivot within the ambit of logistics pedagogy and erudition, emphasizing the establishment of congruous academic disciplines to cater to the burgeoning demand. By the end of 2018, a total of 2,279 higher education institutions in China proffered a bonanza of logistics-centric courses, and approximately 156,000 individuals graduated from the logistics and related domains, including 655 logistics majors across the nation.

Recognizing the foundational import of logistics acumen, the China Federation of Logistics and Purchasing, in accordance with the directives of the Ministry of Education and commensurate with the national stratagem, orchestrated a medley of initiatives and training endeavors. The federation has held the esteemed "Masteel Cup" National College Students Logistics Design Competition and organized various logistical skills competitions and domestic training initiatives since 2018 that have drawn participation from more than 8,000 individuals.

Holistically, China has augmented the importance of logistics-oriented education, albeit with a conspicuous tilt toward vocational institutions. Regrettably, higher education undergraduate programs are marred by a relative paucity of professional offerings. To ensure the development of relevant knowledge and capabilities at the higher education level, the quantity and quality of graduates should be combined. Despite the importance of quantity, focus remains on quality. Thus, commitment is necessary to augment the quantitative and qualitative logistics disciplines offered by colleges and universities across the nation.

Performance Evaluation

Analytic Hierarchy Process (AHP) and TOPSIS

This study's meticulous scrutiny of the contemporary landscape of the logistics domain and its constituent enterprises reveals an incontrovertible truth: Performance evaluation is a cornerstone of paramount importance. As the logistics milieu expands, the accrued costs of social logistics increase as well as demand for logistics services. Simultaneously, logistics enterprises confront the crucible of competition in which their mettle is tested in an arena of thriving industry dynamics. Despite the trajectory of prosperity, the logistics domain grapples with challenges ranging from resource depletion to antiquated technological paradigms and from inflated costs to unrelenting competitive pressure, culminating in dwindling market shares. Such predicaments collectively coalesce into a matrix of

obstructions that may imperil the trajectory of sustainable maturation of logistics enterprises. Hence, the scientific and effective evaluation of the operational performance of logistics enterprises has become essential, and this evaluation can propel the enterprises' advancement.

This study provides an overview of the developmental performance of logistics enterprises, which is channeled through a multitude of perspectives to illuminate the multifaceted terrain of enterprise performance dynamics.

Drawing on previous research, we conducted this study to identify a compendium of performance evaluation methodologies germane to logistics enterprises, such as the AHP, fuzzy comprehensive evaluation, data envelopment analysis, the balanced scorecard, grey relational analysis, and TOPSIS. The AHP and fuzzy comprehensive evaluation are suitable for expert scoring, but despite their utility, the subjectivity of such methods, which may diminish the accuracy of results, should be acknowledged. Meanwhile, data envelopment analysis can integrate panel data based on the assumption of uniform structural congruity between the objects to be evaluated. The balanced scorecard paradigm can seamlessly integrate fiscal and nonfiscal indicators, including customer satisfaction, operational efficacy, and learning and development. Although this framework can offer comprehensive insights, its instantiation is costly and requires considerable effort.

In summary, the delineation of the logistics landscape underscores the importance of performance evaluation for enterprise augmentation. Performance evaluation methodologies, though diverse and effective, remain encumbered by their own unique set of attributes and constraints that underscore the need for careful selection that is congruent with an enterprise's exigencies and strategic orientation.

TOPSIS involves the statistical analysis of data based on limited information that may effectively reflect the closeness of alternative and ideal plans, but may not well reflect the changes in various factors and the difference between positive and negative ideal plans. Grey relational analysis can explain changes in the factors of alternative project plans and the relationship between positive and negative ideal plans in the case of little information; however, defects exist in its overall evaluation of a system. The combination of grey relational analysis and TOPSIS can overcome the shortcomings of the two methods, reflect the geometric and situation changes in the data, accurately evaluate the quality of schemes, and explain the changes in the factors of each scheme.

Evaluation of the performance of logistics enterprises necessitates the comprehension of the industry's actualities. Previous research predominantly focused on financial facets, encapsulating dimensions such as profitability, cash flow, debt-servicing capabilities, asset architecture, and financial jeopardy. However, juxtaposed with fiscal concepts, myriad pivotal dimensions demand equal contemplation, from operational outcomes and investment yields to strategic orchestration. The prevailing corpus of research can attest to the definitive transformation, emancipating the performance evaluation of logistics enterprises from the shackles of an exclusive fiscal purview. With the escalating emphasis on supply chain governance, the logistics domain witnessed a paradigmatic shift, engendering the realization of the intricate interdependencies of enterprises within a supply chain. In performance evaluation, the orbit of consideration should transcend individual enterprise's interests and assimilate stakeholders' perspectives. Mutuality and the attainment of a "win-win" situation may be adopted as cardinal imperatives.

Moreover, the benchmark indicators governing enterprise performance should be inextricably aligned with sustainable development. Reflecting the sustainable evolution, technology, the environment, and society should be seamlessly integrated with the evaluative criteria underpinning enterprise performance. This integration may yield a comprehensive vista encompassing the repercussions and viability of stratagems for commercial operations.

In summary, the ethos underpinning the performance evaluation of logistics enterprises encompasses parameters ranging from financial contours to operational efficacies and from stakeholders' perspectives to sustainable vistas. As the logistics domain transcends the epoch of conventional paradigms, the evaluation schema must evolve and align with the imperatives of sustainable and multifaceted enterprise development.

Designation of Evaluation Indicators

This study's in-depth perusal of the relevant literature reveals a conspicuous truth: Diverse assessment metrics coalesce within the ambit of logistics enterprises, and scholars adroitly develop performance evaluation frameworks from various perspectives. However, amid the fierce competition in the industry, desire for immediate economic gratification motivates the pursuits of many logistics enterprises. A considerable cohort of scholars fixated on fiscal performance while forging evaluation indices, veering toward the myopic realm of short-term gains during indicator selection. The heedless pursuit of fiscal benefits is an injudicious course. To flourish and succeed, logistics enterprises should have a competitive advantage; that is, they should distinguish themselves from other similar enterprises. Management tenets and service benchmarks can augment the upward trajectory of enterprises and culminate in a favorable public corporate image. A company's strategic objectives should be considered in the formulation of enterprise performance evaluation indices, underscoring the pivot toward sustainable growth beyond the confines of economic gain and multidimensional progress.

In a sweeping vista, the trajectory of performance evaluation within logistics enterprises encapsulates the unfolding evolutionary narrative. The landscape traverses the spectrum from rudimentary simplicity to comprehensiveness, and the evaluation unfurls under the aegis of the integration of methodologies. The evaluative gaze also transcends a singular realm and embraces various entities, ranging from enterprise operators, shareholders, and employees to consumers, government agencies, and others, synthesizing perspectives that reflect the facets composing the logistics landscape. In conclusion, performance evaluation indices should be meticulously tailored to individual business milieus and scopes.

CONSTRUCTION OF LOGISTICS ENTERPRISE PERFORMANCE EVALUATION SYSTEM

Index Selection Method

For this study, we constructed a performance evaluation system for logistics enterprises, focusing on financial and nonfinancial aspects while emphasizing sustainable development. Financial indicators that may impact enterprise performance encompass debt repayment ability, profitability, operating capacity, and growth potential, with numerous other indicators falling within these four domains. The indicators exhibit a certain degree of correlation; thus, we employed an objective mathematical statistical method to screen the financial indicators.

By contrast, the nonfinancial indicators that can influence the performance evaluation of logistics enterprises are limited. The selection of such indicators must be aligned with the sustainable development principles and unique characteristics of the logistics industry. Therefore, the application of mathematical statistical methods in the selection of nonfinancial indicators is not feasible. Drawing on previous research findings and an examination of the relevant literature, we primarily considered paper-based data as a guiding principle for selection of nonfinancial indicators.

Principal Component Analysis

Step 1: Assume that the original data matrix of the sample enterprise is the formula shown in equation (1):

$$X = \begin{pmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ \vdots & \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{np} \end{pmatrix} \tag{1}$$

Step 2: Standardize the original data, as shown in equations (2), (3), and (4):

$$x_{ij}^{*} = \frac{x_{ij} - \overline{x}_{j}}{\sqrt{\mathrm{var}\left(x_{j}\right)}} \ (i = 1,2,\cdots,n; j = 1,2,\cdots,p) \tag{2}$$

$$\overline{x}_{j} = \frac{1}{n}\sum_{i=1}^{n} x_{ij} \tag{3}$$

$$\mathrm{var}\left(x_{j}\right) = \frac{1}{n-1}\sum_{i=1}^{n}\left(x_{ij} - \overline{x}_{j}\right)^{2} \ (j = 1,2,\cdots,p) \tag{4}$$

Step 3: Calculate the correlation coefficient matrix using the formula shown in equation (5):

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1p} \\ r_{21} & r_{22} & \cdots & r_{2p} \\ \vdots & \vdots & \cdots & \vdots \\ r_{p1} & r_{p2} & \cdots & r_{pp} \end{bmatrix} \tag{5}$$

Step 4: Calculate the correlation coefficient of the standardized data using the formula shown in equation (6):

$$r_{ij} = \frac{1}{n-1}\sum_{t=1}^{n} x_{ti}x_{tj} \ (i, j = 1,2,\cdots,p) \tag{6}$$

Step 5: Obtain the eigenvalue of the correlation coefficient matrix R, with its eigenvector ai, which can determine the cardinality of the principal components. Principal components are considered to be effective when their total contribution rate exceeds the threshold of 80%. This threshold indicates that the principal components of the dataset include considerable information. As the total contribution rate increases, the effectivity of the principal components, with relevant information, also increases.

Step 6: Combine the principal components and weights assigned to their eigenvalue to obtain the principal component score using the formula in equation (7). This principal component score is an effective metric for sample differentiation, embracing the spectral continuum of the samples within its fold:

$$F = \sum_{i=1}^{P} \frac{\lambda_{1}}{\lambda_{1} + \lambda_{2} + \ldots + \lambda_{p}} F_{i} (i = 1,2 \ldots p) \tag{7}$$

Stepwise Regression Analysis

For this study we conducted principal component analysis to derive the F score of the dependent variable during the stepwise regression analysis. The independent variables for the regression are selected from the original standardized data.

Underpinning the stepwise regression is a cardinal precept; that is, the variables should have statistical and pragmatic significance, based on the partial regression square. F tests and T tests are conducted for each independent variable. If the significance of the existing variables diminishes with the addition of new variables, then the existing variables are excluded, guaranteeing the statistical

potency of the independent variables. This process will continue until no new variables are included and no existing variables are omitted.

This method yields a final regression result of statistically significant independent variables in relation to the dependent variable. The efficacy of the stepwise regression extends to the multicollinearity issue of independent variables. Despite the robust correlations, the independent variables in the regression equation will have a substantial impact on the dependent variable.

Indicator Screening

Financial and nonfinancial performance is essential in logistics enterprise evaluation. A logistics enterprise's financial performance can underpin its fiscal health and operational stability, and a logistics enterprise's nonfinancial performance can showcase its ethical values, social impact, and long-term sustainability. Together, the two facets can provide a comprehensive assessment that can guide stakeholders' decisions, foster meaningful growth, and position logistics enterprises as dynamic contributors to economic progress and societal well-being. Recognizing the symbiotic relationship between the two aspects is vital for achieving a balanced and holistic understanding of a logistics company's overall value and potential.

Financial Indicators

The assessment of enterprise performance using financial metrics is an effective approach. Financial indicators include four important dimensions: profitability, operational efficiency, debt repayment ability, and development potential. Debt repayment ability can guarantee the enterprise dynamics; profitability, as the zenith of operational objectives, delineates the ultimate objective; operational capacity can augment economic efficacy; and development potential can ensure continuous sustainable operations. Thus, financial indicators, with unique nuances, are important to the performance evaluation of logistics enterprises.

In the regression, the model equations and coefficients culminate in statistical significance. The matrix of indicators to determine the solvency of a logistics enterprise includes the current ratio, asset-liability ratio, and long-term debt-equity ratio. Profitability can be determined by the net profit margin on total assets, return on equity, and net operating profit margin. In terms of operational efficiency, the indicators include the ratio of accounts receivable turnover to the total asset turnover, growth rate of total assets, sustainable growth rate, and growth rate of net assets per share. In summary, an enterprise's performance can be determined by its profitability, operational efficiency, debt management capability, and potential growth. The intricacies of this narrative are meticulously interspersed through a symphony of financial indicators, each resonating harmoniously within its evaluative precinct.

Nonfinancial Indicators

The performance evaluation index system for logistics enterprises developed in this study comprises financial and nonfinancial indicators. Financial indicators can provide insights into an enterprise's operating performance and asset management. Meanwhile, nonfinancial indicators can primarily reflect an enterprise's sustainability—specifically, its innovation capacity, environmental protection capability, and social responsibility. Such nonfinancial indicators can also collectively showcase an enterprise's ability for sustainable development.

Regarding the evaluation of environmental protection capability, we considered whether an enterprise has obtained environmental management certification and whether it discloses information related to the environment and sustainable development. Environmental management certification and transparent disclosure may suggest that an enterprise possesses strong environmental protection capabilities and a high degree of sustainability.

The selection of specific performance evaluation indices is a crucial step in the alignment of the research objectives with industry standards. Thus, in the next section, we rationalize the chosen indicators for assessing enterprises' innovation ability and social responsibility.

Innovation Ability Evaluation

Ratio of R&D investment to income: This indicator aligns with the research objective to assess the innovation ability of enterprises by quantifying the extent of their investment in R&D relative to their operating revenue. Industry standards recognize that a high ratio signifies a considerable commitment to innovation because increased R&D investment will typically lead to the development of new products, technologies and processes, thereby enhancing an enterprise's competitiveness.

Ratio of R&D personnel to total number of employees: This indicator aligns with the research objectives because it measures the concentration of R&D expertise within the workforce. A high ratio suggests a strong focus on innovation because it indicates the existence of a dedicated team of experts working to drive the R&D initiatives. According to industry standards, a specialized R&D team will contribute significantly to a company's innovation capabilities.

Ratio of employees with a bachelor's degree or higher to total number of employees: This indicator aligns with the research objective to evaluate knowledge-intensive innovation. Higher education qualifications are typically associated with advanced skills and knowledge, both of which are essential for driving innovation. Industry standards recognize the importance of a well-educated workforce in fostering a culture of continuous improvement and creative thinking.

Social Responsibility Evaluation

- **Employee return rate:** This indicator is in line with the research objective to assess enterprises' social responsibility by considering their fair treatment of and adequate compensation for employees. This indicator adheres to industry standards that emphasize the significance of a balanced employee–employer relationship in which employees receive a reasonable proportion of remuneration relative to the company's operating income.
- **Tax contribution rate:** This indicator accords with the research objectives because it demonstrates an enterprise's fiscal responsibility toward the government. Industry standards acknowledge the importance of contributing to public funds through tax payments, reflecting ethical business practices, and supporting the overall well-being of the society where the enterprise operates.
- **Donation rate:** This indicator aligns with the research objective to evaluate enterprises' commitment to making social contributions. Donations can reflect a company's willingness to give back to the community and address societal needs beyond its core business operations; they are in line with industry standards that encourage corporate social responsibility.
- **Rate of women in senior management:** This indicator is in line with the research objectives because it promotes gender equality and women's development rights. Industry standards emphasize diversity and inclusion in senior leadership positions and recognize that a diverse management team can enhance decision-making and overall organizational performance.

By carefully selecting the specific performance evaluation indices, we effectively attained our research objectives of assessing enterprises' innovation ability and social responsibility. Moreover, the indicators accord with established industry standards and thus can guarantee that the evaluation process is robust, comprehensive, and reflective of the long-term development potential of logistics enterprises.

Data Collection

For this study, we conducted an exhaustive exploration of the Flush Financial network and IHexun Financial network using the search term "logistics." A total of 43 logistics-focused A-share listed companies common in both platforms were obtained and meticulously screened. The initial assemblage of 43 logistics-affiliated A-share companies underwent a pruning process, and entities were designated as "special treatment" (i.e., ST) and "double special treatment" (i.e., *ST). Those with an incomplete dataset were omitted.

We screened the enterprises' financial analytical data and disclosure of pertinent R&D initiatives and social responsibility comprehensively. Through the application of the judicious selection criteria, we obtained 17 A-share logistics companies listed in the Shanghai and Shenzhen Stock Exchanges from 2016 to 2018; namely, Chuanhua Zhilian, Yunda Express, Aoyang Shunchang, SF Express, Shentong Express, Hengki Daxin, Longzhou Holdings, Xining Express, Feilida, Huapeng Fei, Xiamen Xiangyu, C&D Holdings, Ruimotong, Yuantong Express, Huaihe Energy, C&T, and China Reserve Holdings.

LOGISTICS ENTERPRISE PERFORMANCE EVALUATION BASED ON TOPSIS–GREY RELATIONAL ANALYSIS

TOPSIS–Grey Relational Analysis

Through a thorough review of the relevant literature, we determined that traditional TOPSIS focuses solely on ranking evaluation objects without effectively differentiating the strengths and weaknesses of the decision objectives. In addition, the method overlooks the dynamic trends of changes over time. Meanwhile, grey relational analysis can calculate the similarity of data series curves and effectively reflect the dynamic changes in the data.

The limitations of grey relational analysis and TOPSIS can be addressed by combining the two methods. This hybrid approach allows for the assessment of geometric changes and situational variations in the data and accurate evaluation of the quality of different schemes. This method can also provide insights into the factors that drive the changes in each scheme and highlight the differences between positive and negative ideal schemes. The results derived by this combined approach are highly credible and can provide a comprehensive understanding of the evaluated factors.

Entropy Weight Method

The entropy weight method calculates the entropy value of each criterion based on the distribution of its values. A criterion with a high entropy value indicates the uniform distribution of its values, thus implying considerable uncertainty and a low degree of distinctiveness between the options being evaluated. Conversely, a criterion with a low entropy value signifies a highly concentrated distribution, suggesting a high degree of distinctiveness.

The advantages of the entropy weight method include its ability to handle subjective and uncertain data effectively and thus accommodate a wide range of criteria and provide a quantitative basis for assigning weights. By capturing the inherent uncertainty of logistics operations, the entropy weight method allows decision-makers to make informed and robust evaluations. However, the method has certain limitations. For example, it will initially assume that all the criteria are equally important, which may not consistently reflect the true preferences of decision-makers. In addition, the method is sensitive to small changes in the data distribution, possibly leading to unstable weight assignments. To address such limitations, researchers and practitioners typically combine the entropy weight method with other techniques, such as expert judgment or sensitivity analysis.

For this study we used the entropy weight method to determine the weight of the performance evaluation index. The calculation procedure is described below.

If we assume that n companies and m indicators are selected, X_{ij} represents the value of the j indicator of company i ($i = 1,2..., n$; $j = 1,2..., m$).

Step 1: Conduct dimensionless data quantitative processing. The dimensionless quantification formula of the forward index is shown in equation (8):

$$Y_{ij} = \frac{X_{ij} - \min\left(X_{1j}, X_{2j}, \ldots, X_{nj}\right)}{\max\left(X_{1j}, X_{2j}, \ldots, X_{nj}\right) - \min\left(X_{1j}, X_{2j}, \ldots, X_{nj}\right)} \tag{8}$$

Meanwhile, the dimensionless quantification formula of the negative index can be calculated using the formula in equation (9):

$$Y_{ij} = \frac{\max\left(X_{1j}, X_{2j}, \ldots, X_{nj}\right) - X_{ij}}{\max\left(X_{1j}, X_{2j}, \ldots, X_{nj}\right) - \min\left(X_{1j}, X_{2j}, \ldots, X_{nj}\right)} \tag{9}$$

The optimal value range of the interval index should be set to $[a_{1j}, a_{2j}]$, and the standardized formula is as shown in equation (10):

$$Y_{ij} = \begin{cases} \dfrac{a_{1j} - X_{ij}}{\max\left[a_{1j} - \min\left(X_{1j}, X_{2j}, \ldots, X_{nj}\right), \max\left(X_{1j}, X_{2j}, \ldots, X_{nj}\right) - a_{2j}\right]}, X_{ij} < a_{1j} \\ 1 \\ 1 - \dfrac{X_{ij} - a_{2j}}{\max\left[a_{1j} - \min\left(X_{1j}, X_{2j}, \ldots, X_{nj}\right), \max\left(X_{1j}, X_{2j}, \ldots, X_{nj}\right) - a_{2j}\right]}, X_{ij} > a_{2j} \end{cases} \tag{10}$$

Step 2: Calculate the proportion of the index. The proportion of company i in the j index is as shown in equation (11):

$$P_{ij} = \frac{Y_{ij}}{\sum_{i=1}^{n} Y_{ij}}, (i = 1,2,\ldots,n; j = 1,2,\ldots,m) \tag{11}$$

Step 3: Calculate the entropy value of index e_j. An index with a low entropy value will have a high utility, whereas an index with a high entropy value will have a low utility. The calculation formula is as shown in equation (12):

$$e_j = -k \sum_{i=1}^{n} p_{ij} \ln\left(p_{ij}\right), K = 1 / \ln(n), k, e_j \geq 0 \tag{12}$$

Step 4: Calculate the difference coefficient g_j of the index. The difference coefficient and final evaluation result will change in the positive direction, and the calculation formula is as shown in equation (13):

$$g_j = 1 - e_j, (j = 1,2,\ldots,m) \tag{13}$$

Step 5: Calculate the entropy weight W_j of the index. The greater the entropy weight, the more important the index, and the greater the influence on the evaluation object will be. The calculation formula for the entropy weight is shown in equation (14):

$$w_j = \frac{g_j}{\sum_{j=1}^{m} g_j}, (j = 1,2,\ldots,m) \tag{14}$$

TOPSIS–Grey Relational Analysis

TOPSIS is a decision-making method that ranks alternatives based on their distances to an ideal solution and proximity to a negative-ideal solution. This technique is well suited for multicriteria decision-making and widely used in various fields, including logistics. Meanwhile, grey relational analysis can assess the degree of relationship between sequences of data; thus, it is suitable for analyzing complex and uncertain systems. However, the TOPSIS–grey relational analysis method may require the careful consideration of the parameter settings and choice of the reference sequences in the grey relational analysis. In addition, the method may involve a certain level of subjectivity, particularly when determining the reference sequences or assigning the grey relational coefficients. Nonetheless, when used thoughtfully and appropriately, the TOPSIS–grey relational analysis method can offer valuable insights into the performance of logistics enterprises.

For this study, we combined grey relational analysis and TOPSIS to construct a novel proximity degree calculation method. The specific steps are described below.

Step 1: Multiply the weight w_j of each index with the dimensionless quantization matrix y_{ij} to form the weighted decision matrix z_{ij}, as shown in equation (15):

$$z_{ij} = w_j \times y_{ij} \tag{15}$$

Step 2: Determine the optimal solution $Z^+ = \max(z_{ij})$ and worst solution $Z^- = \min(z_{ij})$ of the matrix.

Step 3: Determine the distance of each scheme to the optimal solution and worst solution by using the formula shown in equation (16):

$$s_i^+ = \sqrt{\sum_{j=1}^{n} \left(z_{ij} - z_j^+\right)^2} \quad s_i^- = \sqrt{\sum_{j=1}^{n} \left(z_{ij} - z_j^-\right)^2} \tag{16}$$

Step 4: Calculate the grey correlation coefficient matrix of each evaluation unit using the formula shown in equation (17):

$$r_{ij}^{+} = \frac{\min\left|z_j^{+} - z_{ij}\right| + \rho\max\left|z_j^{+} - z_{ij}\right|}{\left|z_j^{+} - z_{ij}\right| + \rho\max\left|z_j^{+} - z_{ij}\right|} \; r_{ij}^{-} = \frac{\min\left|z_j^{-} - z_{ij}\right| + \rho\max\left|z_j^{-} - z_{ij}\right|}{\left|z_j^{-} - z_{ij}\right| + \rho\max\left|z_j^{-} - z_{ij}\right|} \tag{17}$$

In this equation, ρ is the discrimination coefficient, with a value of 0,1, and the smaller the discrimination coefficient, the stronger the discrimination ability of the data. In general, this value is 0.5.

Step 5: Calculate the grey correlation degree between each evaluation unit and positive and negative ideal solutions using the formula shown in equation (18):

$$r_i^{+} = \frac{1}{n}\sum_{j=1}^{n} r_{ij}^{+} \; r_i^{-} = \frac{1}{n}\sum_{j=1}^{n} r_{ij}^{-} \tag{18}$$

Step 6: Use the formula shown in equation (19) to perform dimensionless quantization on Euclidean distances s_i^{+} and s_i^{-} and correlation degrees r_i^{+} and r_i^{-}:

$$S_i^{+} = \frac{s_i^{+}}{\max s_i^{+}}, S_i^{-} = \frac{s_i^{-}}{\max s_i^{-}}, \; R_i^{+} = \frac{r_i^{+}}{\max r_i^{+}}, R_i^{-} = \frac{r_i^{-}}{\max r_i^{-}} \tag{19}$$

Step 7: Merge the Euclidean distance and correlation as shown in the formula in equation (20):

$$V_i^{+} = \alpha R_i^{+} + \beta S_i^{+} \; V_i^{-} = \alpha R_i^{-} + \beta S_i^{-} \tag{20}$$

In equation (20), α and β are the preference degree of the decision-maker, $\alpha+\beta = 1$, and the larger the V^{+} and V^{-} value, the closer to the ideal solution the results will be.

Step 8: Calculate the proximity of the scheme, as shown in equation (21):

$$C_i^{+} = \frac{V_i^{+}}{V_i^{+} + V_i^{-}} \tag{21}$$

The degree of proximity serves as a measure of the performance or quality of an evaluation unit. A high degree of proximity indicates a superior evaluation unit, whereas a low degree of proximity suggests an inferior evaluation unit. In other words, the proximity measure is inversely related to the performance or quality of the evaluated units.

RESULTS AND ANALYSIS

Comprehensive Evaluation

After the meticulous calculation, logistics enterprise performance is assessed using the proximities in the financial index evaluation system. This process, underscored by the financial indicators, embodies

the conventional paradigm. For a comparative analysis, the enterprise performance is juxtaposed with the traditional financial evaluation indices and sustainable development evaluation indices. A meticulous calculation is conducted to ascertain the proximity of the logistics enterprises' nonfinancial and all-encompassing indicators in 2018. This calculation uses the methodology underlying the logistics enterprise performance proximity in the financial index evaluation system. The calculation yields proximity values that indicate the hierarchy of the logistics enterprises. A high ranking signifies superior performance and a close proximity.

The results, which were obtained from the meticulous calculation and evaluative juxtaposition, are presented in Table 1.

An insightful examination of Table 1 yields several noteworthy conclusions. The assessment of the financial indicators shows that SF Express is the frontrunner among the sampled logistics enterprises, boasting the highest proximity value of 0.5470. By contrast, Hua Pengfei trails behind, with the lowest financial indicator proximity at 0.4700. This disparity underscores SF Express's robust financial performance, while highlighting Hua Pengfei's comparatively weak standing.

The financial indicator proximity of the surveyed logistics enterprises falls predominantly within the range of 0.4 to 0.6, indicating a consistent pattern of fiscal competence. The majority of the sampled logistics companies surpasses the 0.5 proximity threshold, which is an indicator of their commendable financial health and favorable economic stability.

A cluster of top-performing entities (SF Express, C&D Holdings, Yunda Express, Xiamen Xiangyu, and Yuantong Express), secured a spot in the top five financial index proximity rankings. This achievement underscores the companies' robust financial standing and reinforces their reputation for sound fiscal management. On the other end of the spectrum, Huapeng Fei, C&T, and Xinning

Table 1. Comprehensive performance evaluation of logistics enterprises

Logistics Enterprise	Proximity of Financial Indicators	Rank	Proximity of Nonfinancial Indicators	Rank	Comprehensive Proximity	Comprehensive Rank
Chuanhua Zhilian	0.5177	10	0.5530	7	0.5389	8
Yunda Express	0.5368	3	0.5743	2	0.5507	2
Aoyang Shunchang	0.5154	13	0.4924	14	0.5016	13
Shentong Express	0.5277	6	0.5406	9	0.5407	7
SF Express	0.5459	1	0.5811	1	0.5670	1
Hengki Daxin	0.5199	9	0.5708	3	0.5505	4
Xinning Express	0.5118	15	0.5553	6	0.5379	9
Longzhou Holdings	0.5157	12	0.5647	5	0.5451	5
Feilida	0.5162	11	0.4584	17	0.4815	16
Huapeng Fei	0.4700	17	0.4755	16	0.4733	17
C&D Holdings	0.5447	2	0.5686	4	0.5500	3
Xiamen Xiangyu	0.5303	4	0.5520	8	0.5433	6
Ruimotong	0.5121	14	0.4914	15	0.4997	14
China Reserve Holdings	0.5201	8	0.5132	12	0.5163	12
Huaihe Energy	0.5247	7	0.5241	11	0.5243	11
C&T	0.5081	16	0.4930	13	0.4990	15
Yuantong Express	0.5283	5	0.5246	10	0.5261	10

Express are on the bottom rungs of the financial indicator proximity rankings ladder, signaling their relatively weak financial performance.

In summary, the analysis sheds light on the financial landscape of the examined logistics enterprises, highlighting their exemplary or subpar performances. This comprehensive understanding of financial indicators can serve as a foundation of the overall economic capabilities and stability of the companies in the dynamic logistics sector.

Table 1 provides a comprehensive overview of the close interconnectedness of the various facets of the logistics enterprises and sheds light on the disparity between the financial, nonfinancial, and sustainable development dimensions of the surveyed companies. This observation underscores the promising trajectory of the logistics sector and indicates a positive shift to a certain extent. The holistic performance indicators align closely with the financial and nonfinancial metrics, thereby underscoring the imperative for logistics entities to accord equal importance to their economic viability as well as to their broad contributions to society and the environment for the sake of progress.

The trajectory of sustainable development is distinctly influenced by the intricate interplay of the nonfinancial metrics. Consequently, the companies with poor financial performances can elevate their positions by deliberately enhancing their nonfinancial indicators. Thus, the evolution of logistics enterprises must transcend the mere pursuit of fiscal achievement to encompass a balanced focus on holistic prosperity, incorporating financial gain and the intangible, yet pivotal dimensions of corporate responsibility and sustainable practices. This multifaceted approach is pivotal in not only ensuring the prolonged success of individual enterprises but also fostering the holistic advancement of the logistics industry as a whole, in harmony with the broad socioeconomic and ecological landscape.

Dynamic Performance Evaluation

To assess the performance of the logistics enterprises under sustainable development over the years, we calculated their comprehensive proximity for the period of 2016–2018. Based on the comprehensive proximity values of the logistics enterprises during the research period, their rankings for each year under sustainable development is presented in Table 2.

In the general context, the overall proximity of the logistics enterprises reveals a lack of significant divergence. The majority of the examined sample companies showcased an upward trajectory in their comprehensive proximity from 2016 to 2018. This encouraging trend of progress can be seen in Yunda Stock, SF Express, Shentong Express, Hengki Daxin, Xiamen Xiangyu, and Huaihe Energy. This trend reflects the discernible enhancement of their operational efficiency.

However, a subset of enterprises demonstrated a degree of variability in their comprehensive proximity values. Notable among such enterprises are Aoyang Shunchang, Longzhou, Xinning Express, and Huapeng Fei, whose comprehensive proximity metrics fluctuated during the specified period. Furthermore, some of the enterprises, such as Fei Lida, experienced a reduction in their comprehensive proximity, signifying a certain degree of performance deterioration.

Nevertheless, the comprehensive proximity of the majority of the sampled logistics enterprises in 2018 was better than it was in 2016. This prevailing pattern suggests a constructive trajectory of advancement within the logistics domain, albeit to a limited extent. The enterprises' concerted efforts to bolster their comprehensive performances indicate their collective commitment to multifaceted growth and development, thus underlining the industry's evolving stance toward holistic progress.

Discussion

The research findings can present significant practical implications that have substantial value for logistics enterprises and offer insightful guidance for effective decision-making and strategic planning. A balanced focus on financial and nonfinancial performance is crucial; this focus entails recognizing the intricate interplay between various aspects and prioritizing their alignment. By

Table 2. Performance ranking of logistics enterprises from 2016 to 2018

Logistics Enterprise	2016	2017	2018	Average Rank
Chuanhua Zhilian	2	7	8	4
Yunda Express	3	5	2	2
Aoyang Shunchang	12	13	13	13
Shentong Express	7	8	7	8
SF Express	1	1	1	1
Hengki Daxin	4	2	4	3
Xinning Express	8	15	9	10
Longzhou Holdings	9	4	5	6
Feilida	11	17	16	16
Huapeng Fei	16	14	17	17
C&D Holdings	15	6	3	7
Xiamen Xiangyu	5	3	6	5
Ruimotong	17	10	14	14
China Reserve Holdings	13	12	12	12
Huaihe Energy	1	11	11	11
C&T	10	16	15	15
Yuantong Express	6	9	10	9

incorporating environmental and social considerations in financial goals, logistics companies can ensure that their activities resonate with societal values and stakeholders' expectations. To achieve a comprehensive evaluation of the impacts and sustainability, the development of holistic metrics is essential. Such metrics should extend beyond conventional financial indicators to encompass nonfinancial key performance indicators related to environmental impact, employee satisfaction, community engagement, and ethical practices. This comprehensive evaluation can serve as a foundation for informed decision-making that accords with companies' long-term vision and strategic goals.

Moreover, insights garnered from financial and nonfinancial performance assessments should actively inform strategic decisions. This strategic alignment can drive growth while upholding ethical and sustainable practices. Commitment to continuous improvement is paramount; it involves regular assessments and benchmarking against industry peers and best practices. By identifying areas for enhancement, logistics enterprises can deploy strategies to bolster performance in both dimensions to ensure competitiveness and relevance.

Financial performance indicators can be instrumental for identifying avenues for cost reduction, process optimization, and revenue generation. Such opportunities can be strategically allocated to initiatives that can foster innovation, operational efficiency, and the achievement of financial and nonfinancial objectives. Recognizing the importance of stakeholder engagement, logistics companies should actively interact with customers, employees, investors, and communities. Such interactions can provide insights into expectations and concerns and shape strategies for demonstrating commitment to responsible and sustainable practices. Transparency plays a critical role in maintaining trust and reputation. Comprehensive reporting that highlights achievements in financial and nonfinancial domains can also bolster stakeholders' confidence. Recognizing the impact of nonfinancial performance on their operational efficiency and customer service quality, enterprises should prioritize

employee development, training, and well-being. Furthermore, a motivated and skilled workforce can directly contribute to an enterprise's overall success.

Risk management encompasses financial and nonfinancial aspects. Specifically, contingency plans can address economic fluctuations, regulatory changes, and environmental impact and thus effectively mitigate risks through adaptable strategies. Understanding that sustained success transcends short-term financial gain is vital. By investing in sustainable practices and engaging in responsible corporate behavior, logistics companies can strengthen their resilience and contribute value to society and the environment. The incorporation of such practical implications into decision-making and strategic planning can foster the development of holistic and responsible approaches for growth. Such approaches can not only contribute to the success of individual enterprises but also support the well-being of stakeholders and the broad community.

However, this study's reliance on the TOPSIS–grey relational analysis method, though innovative, may introduce subjectivity in the weighting of the indicators. The assignment of weights to financial and nonfinancial indicators may be influenced by our judgment or stakeholders' perspectives, which may impact the final proximity calculations and rankings.

Furthermore, the selection of the sample enterprises may be biased. The criteria used to choose the enterprises may inadvertently favor certain types of companies over others, which can lead to a skewed representation of the logistics industry. The exclusion of specific companies can also affect the generalizability of the findings to the entire industry. Another limitation pertains to the data used in the analysis. The accuracy and completeness of financial and nonfinancial data sources can impact the reliability of results. Data inconsistencies or gaps may lead to misinterpretations or inaccuracies in the calculated proximity values and subsequent rankings.

In addition, this study's temporal scope—that is, from 2016 to 2018—may not have captured recent changes in the logistics industry or external factors that could have influenced the performance of the enterprises. Economic fluctuations, policy changes, or technological advancements that occurred after 2018 may potentially impact the research conclusions. The potential for multicollinearity of the indicators is another consideration. Some of the financial and nonfinancial indicators may be correlated, possibly affecting the robustness of the calculated proximity values and subsequent rankings.

CONCLUSION

In conclusion, we employed an innovative TOPSIS–grey relational analysis method to assess the proximity of the financial, nonfinancial, and comprehensive indicators of a diverse range of enterprises. The outcomes of this study may have valuable implications for academics, practitioners, and policymakers.

For academics, this study contributes to the literature by demonstrating the significance of integrating financial and nonfinancial performance metrics in the evaluation of sustainable development. The finding of the comprehensive index proximity falling between the financial and nonfinancial indicators underscores the need to develop a holistic approach for performance assessment to shed light on the intricate interplay between the dimensions. Practitioners in the logistics industry can glean actionable insights from this research. The emphasis on the substantial impact of nonfinancial performance on overall enterprise performance can provide a strategic perspective for enhancing operational efficiency and decision-making. The upward trend in the comprehensive proximity of most of the sample enterprises from 2016 to 2018 suggests a positive momentum in the logistics industry. However, the fluctuations and declines in some cases—particularly for Chuanhua Zhilian, Longzhou Holdings, Feilida, Yuantong Express, and C&T—emphasize the need to pay proactive attention to operational processes to ensure sustained success.

Policymakers can also benefit from the empirical evidence presented in this study. This evidence underscores the effectiveness of grey relational analysis combined with TOPSIS in evaluating and

comparing logistics enterprises. This methodology can aid policymakers in crafting informed policies that can promote sustainable development in the industry. In essence, this research underscores the importance of considering financial and nonfinancial aspects in assessing the performance of logistics enterprises through the lens of sustainable development. By employing the TOPSIS–grey relational analysis method, we provide a robust framework that can advance our understanding of enterprise evaluation and offer a road map for improved decision-making, performance, and resilient logistics practices.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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