sustainability

MDPI

Article

Identifying Key Barriers to Green Transition Development in China's Express Industry Based on the Fuzzy DEMATEL Method

Xuan Xu [1], Yifan Huang [1], Bo Hu [1,2], Chentao Li [3] and Kenan Gong [1,*]

[1] National Institute of Metrology, Beijing 100029, China; xuxuan@nim.ac.cn (X.X.); huangyf@nim.ac.cn (Y.H.); hubo@nim.ac.cn (B.H.)
[2] School of Law, Tsinghua University, Beijing 100084, China
[3] School of Economics and Management, North China Electric Power University, Beijing 100096, China; chentao1.li@outlook.com
* Correspondence: gongkn@nim.ac.cn

Abstract: The "green transformation of the express" delivery industry in this study primarily refers to the adoption of green energy and environmentally friendly technologies in express delivery packaging, transportation, and recycling systems. This transformation can significantly enhance energy efficiency and reduce emissions in the express system, promoting the sustainable development of the entire industry. However, the progress of green transformation in China's express delivery industry has been impeded by various barriers. To address this, we propose a barrier analysis framework based on the Fuzzy Decision Making Trial and Evaluation Laboratory (DEMATEL) methodology to explore key obstacles to green transformation in the express industry. Our research aims to answer three main questions: (1) What are the key barriers to green transformation in China's express delivery industry? (2) How do these barriers interact and influence each other? (3) What strategic measures can be implemented to overcome these barriers? We first compile a list of barriers, innovatively proposing two new ones: "inadequate green standards in the express industry" and "suboptimal green packaging technology". Considering the ambiguity in expert input and the complex interactions among barriers, we employ fuzzy DEMATEL within an Interval Type 2 Fuzzy Sets (IT2FSs) environment to investigate the significance and causality of these barriers. This approach distinguishes our study from previous research by providing a more nuanced understanding of barrier interactions in the specific context of China's express delivery industry. Based on our analysis, we identify eight critical barriers and propose corresponding strategic measures.

Keywords: green transition development; China's express industry; barriers analysis; fuzzy DEMATEL; interval type-2 fuzzy sets

Citation: Xu, X.; Huang, Y.; Hu, B.; Li, C.; Gong, K. Identifying Key Barriers to Green Transition Development in China's Express Industry Based on the Fuzzy DEMATEL Method. *Sustainability* **2024**, *16*, 5892. https://doi.org/10.3390/su16145892

Academic Editor: Darjan Karabašević

Received: 25 May 2024
Revised: 6 July 2024
Accepted: 9 July 2024
Published: 10 July 2024

1. Introduction

China's rapid economic development and rising consumer affluence have propelled online shopping to become a mainstream consumption method, driving the booming growth of the express delivery industry. From 2013 to 2023, China's express delivery volume led the world for ten consecutive years. In 2023, the cumulative express delivery volume reached 132.07 billion pieces [1], as illustrated in Figure 1. While the explosive growth has greatly enhanced consumer convenience, it has also exerted significant pressure on China's ecological environment. Factors such as excessive use of express packaging materials, vehicle exhaust emissions, and energy consumption at express delivery outlets have resulted in varying degrees of environmental pollution and degradation. The increasing carbon emissions from the express delivery industry starkly contradict China's current national strategies of "carbon peaking" and "carbon neutrality". This contradiction underscores the critical importance of promoting green transformation in the express delivery industry as an integral part of building a green, low-carbon, and circular consumption system.

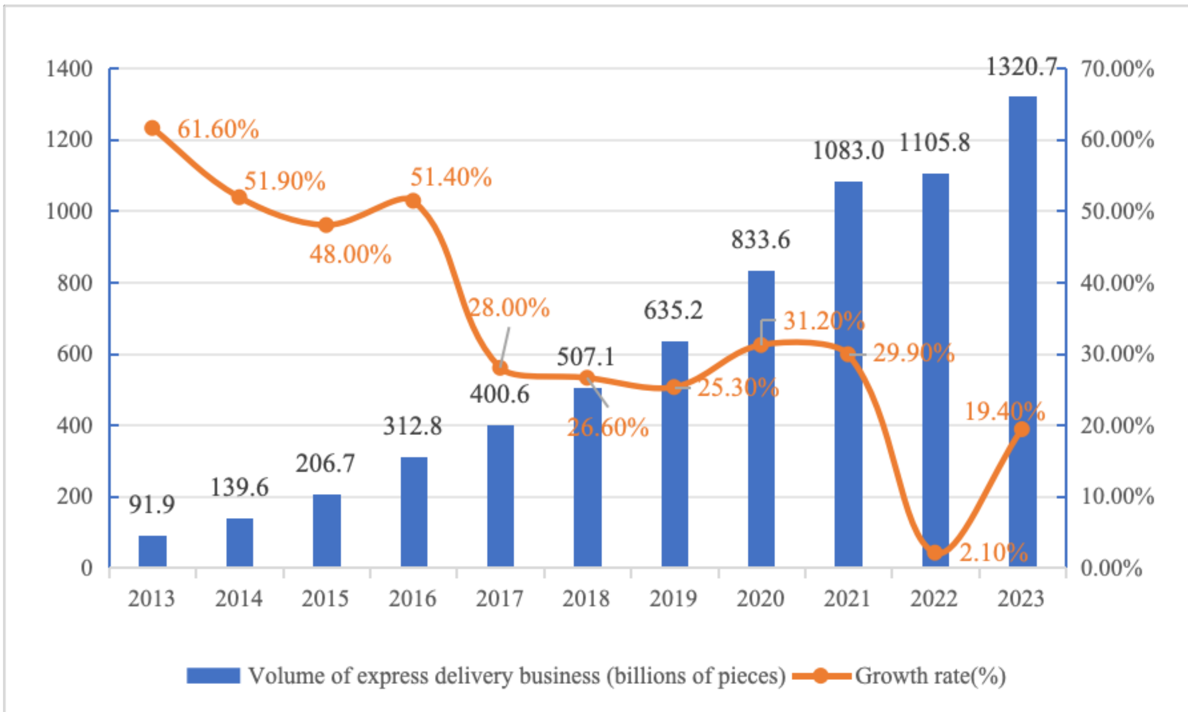

Figure 1. Annual business volume of China's express delivery industry, 2013–2023.

To address the environmental and social challenges arising from the express delivery industry's rapid development, China has successively issued a series of policy documents. In May 2018, the "Interim Regulations on Express Delivery," China's first administrative regulation for the express delivery industry, came into effect. This regulation introduced specific provisions for green express packaging, explicitly encouraging the use of degradable and reusable environmentally friendly packaging materials and the recycling of discarded express packaging waste. In the same year, the General Office of the State Council of the People's Republic of China issued the "Opinions on Promoting the Coordinated Development of E-commerce and Express Logistics," which proposed strengthening the green concept and promoting green packaging. In December 2020, the General Office of the State Council issued the "Opinions on Accelerating the Green Transformation of Express Packaging," proposing to further expand the application of recyclable express packaging.

Despite the government's issuance of numerous relevant policy documents in recent years, significant obstacles continue to hinder the practical implementation of green transformation in the express delivery industry. To achieve substantial progress, it is crucial to identify and overcome these obstacles. Academic research on the green transformation of the express industry has thus far primarily focused on specific areas such as factors influencing consumer recycling behavior of express packaging, recycling costs of express packaging, and costs of green express packaging [2–4]. However, there remains a lack of comprehensive analysis across the entire value chain, including research and development, industrial processes, and service delivery. Given this context, our study aims to explore the main barriers in the green transformation process of the express industry and their interactions, thereby laying a foundation for future pilot projects and broader implementation of green transformation in China's express industry.

To address these challenges, our research focuses on three key questions: What are the key barriers to green transformation in China's express delivery industry? How do these barriers interact and influence each other? And what strategic measures can be implemented to overcome these barriers? To answer these questions, we propose a novel barrier analysis framework based on an improved fuzzy DEMATEL approach within the IT2FSs environment.

Our study contributes to the existing literature by proposing a comprehensive barrier analysis framework specifically for the green transformation of China's express delivery industry. We identify and analyze a list of barriers, including two newly proposed ones: "inadequate green standards in the express industry" and "suboptimal green packaging technology". By applying the improved fuzzy DEMATEL method, we analyze the complex causality and significance of these barriers, accounting for uncertainties in expert evaluations and intricate interactions among barriers. Based on this analysis, we develop strategic measures, providing actionable recommendations for industry stakeholders and policymakers.

While similar studies have examined barriers in other industries' green transformations, our research is unique in its focus on China's express delivery industry and its use of the IT2FSs environment to handle uncertainty in expert evaluations. This approach allows for a more nuanced understanding of the barriers and their interactions in the specific context of China's express delivery industry.

The remainder of this paper is organized as follows: Section 2 presents a literature review; Section 3 details the barriers to green transformation in the express delivery industry; Section 4 describes the research methodology; Section 5 presents the barrier analysis framework and its application to the green transformation of the express delivery industry; and Section 6 concludes with strategic recommendations.

2. Literature Review

2.1. Express Industry Green Transformation

The rapid industrialization that has driven economic development has also brought about severe environmental pollution, a pressing social issue [5]. This problem is particularly acute in developing countries where industrialization began relatively late. In these regions, environmental management systems are often weak, leading to more prominent environmental degradation that poses significant threats to human health and ecosystems [6]. In response to these challenges, global attention has shifted towards the green transformation of industries, now widely regarded as a crucial pathway to address environmental problems and achieve sustainable development [7].

Industrial green transformation extends beyond traditional industrial transformation by incorporating environmental considerations. This approach not only focuses on rationalizing and upgrading industrial processes but also emphasizes the resource and environmental factors involved in the transformation, embodying the concept of green development [8]. The successful implementation of green transformation is inextricably linked to government macro-control and policy guidance. Governments provide institutional support for industrial green transformation through various means, including the formulation of laws, regulations, standards, and rules. Recent research has shed light on various aspects of green transformation. Zhai et al. argue that technological innovation and government actions positively impact the green transformation of the manufacturing industry [9]. Shen et al. highlight that government environmental subsidies strongly incentivize corporate green transformation. However, they note that in an imperfect market system, this incentive effect may be significantly diminished [10]. Blind and Gauch contend that government can guide consumption and investment behavior and promote green technology innovation by establishing mandatory standards, such as environmental and health standards [11]. Additionally, some scholars have proposed voluntary environmental regulation methods, including green certification initiatives by social institutions, industry associations, and enterprises. These methods, due to their flexibility and autonomy, can play a significant role in promoting green transformation [12,13].

In the context of the express logistics industry, which directly impacts resources and the environment, several key studies have shaped our understanding. Ei-Berishy et al. were pioneers in proposing the concept of sustainable development in express logistics, elucidating the relationship between sustainable development in express logistics and green development [14]. Tamulis et al. clarified the distinctions between green express logistics and traditional express logistics concepts, emphasizing the positive impact of the green logistics industry on global ecological development [15].

Current academic research on the green transformation of the express delivery industry has primarily focused on the packaging sector. Su et al. conducted a life cycle assessment to determine the environmental impact of express packaging materials. Their results indicate that the waste from express delivery packaging materials in China increased dramatically from 0.2 million metric tons (Mt) in 2007 to 9.2 ± 5% Mt in 2018 [16]. Bao suggests the secondary development of waste express packaging to promote circular ecology [17]. Song et al. propose developing new degradable packaging materials to improve resource utilization efficiency and reduce pollution [18].

Beyond packaging, researchers have identified other critical factors in the green transformation of the express delivery industry. Li argues that incomplete express recycling channels and high costs significantly hinder the efficiency of green transformation [19]. Zhang emphasizes the crucial roles of green storage and transportation in the industry's green transformation [20]. Some scholars have also focused on the service industry attributes of the express delivery industry, proposing improvements in network layout and delivery optimization to enhance green efficiency [21,22].

In summary, the green development of express logistics adheres to the principles of ecological economics and circular economy. The green transformation of express logistics should focus on innovating and developing green technologies and standards across various production links, including transportation, warehousing and distribution. Furthermore, the green transformation of the express logistics industry holistically rather than focusing on isolated improvements in individual areas.

2.2. Evaluation Method for Barriers Analysis

The potential barriers to the development of green transformation in the express delivery industry are interconnected. For example, the substantial investment required for the green transformation of the express industry may lead to longer payback periods and reduced financing opportunities. Similarly, the lack of green packaging standards for express delivery can result in increased initial investment, higher operation and maintenance costs, and public dissatisfaction. Therefore, identifying a method that can account for the complex relationships among these barriers is crucial for understanding the challenges in the green transformation of the express industry.

In the field of analyzing interrelationships among system factors, several multi-criteria decision-making (MCDM) methods are commonly employed, including the analytical hierarchy process (AHP), analytic network process (ANP), interpretive structural modeling (ISM), and decision-making trial and evaluation laboratory (DEMATEL) [23]. Among these methods, DEMATEL demonstrates superior performance in analyzing dependent factors [24]. This superiority stems from DEMATEL's ability to provide a broader discrimination of measures and quantify the overall degree of influence for each factor [25]. Additionally, DEMATEL can categorize factors into cause and effect groups while establishing causal relationships. Consequently, DEMATEL has gained widespread use in identifying and analyzing critical barriers in various fields.

Despite its advantages, the traditional DEMATEL method faces limitations in addressing the inherent fuzziness and imprecision in expert evaluations [26]. To overcome this challenge, researchers have proposed integrating fuzzy set theory with DEMATEL, resulting in fuzzy DEMATEL. Most studies employing DEMATEL have utilized type-1 fuzzy sets (T1FSs), including grey fuzzy sets, triangular fuzzy sets, and Z-numbers. Interval type-2 fuzzy sets (IT2FSs), an extension of T1FSs, offer enhanced capabilities in handling uncertainty [27].

IT2FSs are characterized by membership functions with additional parameters compared to T1FSs. In IT2FSs, the membership degrees themselves are described by fuzzy sets, in contrast to the crisp values used in T1FSs. This approach significantly enhances the system's capacity to handle uncertainties. While T1FSs typically rely on experience-based membership degree ranges, which can lead to inconsistencies due to varying interpretations of linguistic variables, IT2FSs address this issue by treating the membership degrees of T1FSs as fuzzy sets. This approach effectively encompasses the uncertainties inherent in fuzzy system designs by different individuals, thereby substantially improving the fuzzy system's ability to manage uncertainties and nonlinearities [28,29]. The advantages of IT2FSs include their ability to describe complex uncertainties with greater flexibility and accuracy, particularly in uncertain environments [30].

The application of IT2FSs has extended to various domains, including project selection, decision making, risk assessment and the identification and analysis of critical factors or barriers [31,32]. In the context of this study, which focuses on the green transformation of the express delivery industry, the application of IT2FSs is particularly relevant. The green transformation process in this sector involves multiple interacting factors. IT2FSs offer an effective means of handling the precision of decision-makers' linguistic variables while maintaining a relatively simple computational process compared to general type-2 fuzzy sets [33]. Moreover, the implementation of green transformation policies in China often begins with local or project-based pilot programs, aligning well with the scenarios where IT2FSs are typically applied. This approach can provide valuable assistance to policymakers in analyzing barriers during the transformation process.

Given these considerations, this study employs fuzzy DEMATEL based on IT2FSs to analyze the barriers to green transformation in the express delivery industry. This methodological approach allows for a comprehensive examination of the complex relationships among barriers while effectively addressing the uncertainties inherent in expert evaluations. By utilizing this advanced analytical framework, the study aims to provide insights that can inform policy development and strategic planning for the green transformation of China's express delivery sector.

3. Barriers to Green Transformation in the Express Delivery Industry

This section identifies and analyzes potential barriers to green transformation in China's express delivery industry. The identification process involved a comprehensive literature review followed by expert consultation. Initially, 16 potential barriers were identified through the literature survey. Subsequently, authoritative experts in green logistics-related fields were invited to evaluate and refine these potential barriers. As a result of this rigorous process, 13 potential barriers were retained, as shown in Table 1.

Table 1. Potential barriers to the green transformation of the express industry.

Criteria	Sub-Criteria
Economic barriers (A_1)	High initial capital investment requirements (A_{11})
	Elevated operation and maintenance (O&M) costs (A_{12})
	Extended investment recovery period (A_{13})
	Limited access to financing channels (A_{14})
Technological barriers (A_2)	Inadequate green standards in the express industry (A_{21})
	Shortage of specialized green logistics talent (A_{22})
	Suboptimal green packaging technologies (A_{23})
	Infrastructure incompatibility and inadequacy (A_{24})
	Insufficient recycling facilities and technologies(A_{25})
Social-political barriers (A_3)	Low public awareness and support (A_{31})
	Complex regulatory and administrative procedures (A_{32})
	Lack of comprehensive policy frameworks (A_{33})
	Ineffective subsidy mechanisms (A_{34})

3.1. Economic Barriers

High initial capital investment requirements (A_{11}): The green transformation of the courier industry requires substantial initial investments in green logistics service sites, eco-friendly packaging development, and recycling system implementation [34]. Additional costs such as land acquisition, engineering, and management further increase the total investment [35,36]. For instance, a study in Portugal indicated that establishing an efficient packaging recycling system requires a significant upfront investment, with a unit cost as high as EUR 204 per ton [37]. Consequently, the high initial capital requirement poses a significant barrier to the industry's green transformation.

Elevated operation and maintenance costs (A_{12}): The ongoing costs associated with the green transformation primarily involve maintaining the express packaging recycling system and operating green delivery service sites [38]. Regular maintenance of packaging, warehousing, and transportation systems is necessary to ensure timely and efficient green services, incurring high repair and maintenance costs [39]. For example, a smart locker system installed by SF Express, a prominent Chinese logistics company, incurs an average annual basic maintenance cost of about CNY 3500 per set, with an additional CNY 1000 for electricity, and typically has a lifespan of only 5 years. Moreover, the vast rural areas in China, being relatively remote, contribute to continuously increasing operation and maintenance costs [40]. Moreover, as China's express industry is in the early stages of green transformation, the lack of mature operational experience contributes to elevated maintenance costs.

Extended investment payback period (A_{13}): The extended duration required to recover the initial investment represents a considerable risk [41]. The substantial upfront costs coupled with uncertain returns make enterprises heavily reliant on government subsidies. Furthermore, intense market competition among express delivery companies exerts additional pressure on profitability [42]. In this competitive environment, the potential benefits of green transformation can be easily offset by factors such as price wars, further prolonging the payback period.

Limited access to financing channels (A_{14}): Adequate financial support is crucial for the success of green transformation projects [43]. However, China's express delivery faces significant challenges in securing funding for green initiatives. The nascent stage of green packaging materials development and the uncertainty surrounding the potential benefits deter financial institutions from providing necessary funds [44]. This reluctance from banks and other financial entities creates a substantial barrier to the industry's green transformation efforts.

3.2. Technological Barriers

Inadequate green standards in the express industry (A_{21}): Standardization plays a crucial role in modernizing industry practices and governance systems. Establishing comprehensive green technology standards can foster an environment conducive to innovation, reducing resource consumption, minimizing pollution, and promoting the industrialization of ecological technologies [45]. Globally, governments and multinational corporations increasingly prioritize suppliers adhering to social and environmental standards, and green logistics standards and certifications have garnered significant attention from various stakeholders, including enterprises, governments, and consumers [46,47]. However, China's express industry lacks robust green standards. The current focus in China is primarily on green packaging, with most standards being recommended or industry-specific rather than mandatory, resulting in weak enforcement [48].

Shortage of specialized green logistics talent (A_{22}): The scarcity of professionals with expertise in green logistics has become a significant bottleneck in the development of the modern green logistics industry [49]. Developing countries, including China, face challenges due to insufficient investment in specialized education and research. In China, for example, the logistics discipline in higher education is relatively new, having been established only about a decade ago when the Ministry of Education first allowed its introduction. Many Chinese universities are still in the early stages of developing their logistics programs, often emphasizing theoretical foundations over practical applications [50]. The rapid evolution of green logistics demands expertise in areas such as eco-friendly packaging technology, waste recycling, and new energy technologies. However, the current talent pool severely lacks professionals with these specialized skills [51]. Many graduates in environmental packaging material research are attracted to higher-paying positions in new energy or environmental protection companies. This mismatch between training and professional technical development needs hinders both the implementation of green logistics concepts and the overall transformation of the industry.

Suboptimal green packaging technologies (A_{23}): The environmental impact of logistics packaging has become increasingly concerning, promoting growing interest in recyclable and eco-friendly packaging solutions [52]. China's courier packaging industry, having started relatively late in adopting green technologies, still heavily relies on traditional materials such as paper, plastic, and tape, leading to significant resource waste of resources and environmental pollution [53]. While new biodegradable materials show promise for green packaging, their application faces challenges due to complex processing, high costs and limited production capacity that fails to meet market demand. The development of new, environmentally friendly package materials that meet current market requirements is still in its early stages, necessitating extensive research and testing before widespread application [54].

Infrastructure incompatibility and inadequacy (A_{24}): Many enterprises in the logistics sector prioritize product performance, development cycles, and costs over green infrastructure development [55]. The low level of mechanization and automation in key areas such as packaging, transportation, and loading/unloading, coupled with a lack of advanced supporting infrastructure compatible with green logistics principles, directly impacts the efficiency and environmental performance of the logistics system [56]. Furthermore, the inadequacy of modern, eco-friendly logistics facilities, including large-scale integrated freight hubs and logistics centers, and weak logistics informatization hampers improvements in operational efficiency and sustainable service quality.

Insufficient recycling facilities and technologies (A_{25}): Effective recycling and reuse of express packaging resources are vital for reducing waste and environmental pollution. However, the current domestic express delivery recovery model is inadequate, lacking appropriate technical equipment and advanced recycling technologies. According to from the State Post Bureau, the overall recovery rate of express packaging waste in China was less than 20% in 2021, with most packaging ending up as waste [57].

3.3. Social and Political Barriers

Low public awareness and support (A_{31}): As the logistics industry expands, the environmental pollution caused by express packaging has become increasingly severe [58]. Understanding and influencing public knowledge and willingness to support green logistics practices is crucial [59]. However, public acceptance of potential changes, such as tariff increases or new environmentally friendly service delivery methods, may be challenging due to limited awareness of environmental issues and concerns about increased costs.

Complex regulatory and administrative procedures (A_{32}): While green transition has become a key goal for the express delivery industry, China's large regional differences have hindered the formation of a cohesive policy framework [60]. Due to these regional disparities, policies promoting green transition in the express delivery industry have not yet effectively formed a synergy [61]. The complexity of regulatory and administrative procedures further slows the industry-wide green transformation process. For instance, in Vietnam, it takes approximately 17,263 administrative steps for an investor to start a PV energy green transition project. China's administrative procedures are reported to be no less complex than Vietnam's [62].

Lack of comprehensive policy frameworks (A_{33}): The express delivery industry lacks clear, comprehensive policy guidelines and appropriate frameworks to promote and standardize greening efforts. China's late start in developing green logistics policies has resulted in a preliminary understanding of green logistics and packaging among most domestic enterprises and consumers, with few having an in-depth comprehension of these concepts [63].

Ineffective subsidy mechanisms (A_{34}): Given the high upfront investment required for green transformation in the express delivery industry, well-designed government subsidy mechanisms play a crucial role [64]. However, the current subsidy system for the industry's green transformation is fraught with inconsistencies in subsidy standards, limited funding sources, and a lack of long-term sustainable support [65].

4. Research Methodology

In this section, we first introduce the basic concept and operations of IT2FSs, followed by the related concepts and operation steps of the fuzzy DEMATEL method.

4.1. Interval Type-2 Fuzzy Set

Definition 1. *An IT2FSs is defined as $\tilde{\tilde{A}}$ and represented by a type-2 membership function $\mu_{\tilde{\tilde{A}}(x,\mu)}$, shown as follows* [66]:

$$\tilde{\tilde{A}} = \left\{ ((x,u), \mu_{\tilde{\tilde{A}}}(x,u)) \middle| \forall x \in X, \forall u \in J_x \subseteq [0,1], 0 \leq \mu_{\tilde{\tilde{A}}}(x,u) \leq 1 \right\} \tag{1}$$

where J_x denotes an interval in [0, 1]. Moreover, the type-2 fuzzy set $\tilde{\tilde{A}}$ can also be represented as follows:

$$\tilde{\tilde{A}} = \int_{x \in X} \int_{u \in J_x} \mu_{\tilde{\tilde{A}}}(x,\mu)/(x,\mu) \tag{2}$$

Definition 2. *For IT2FSs, the uncertainty of $\tilde{\tilde{A}}$ can be characterized by a bounded region, which is the projection of the fuzzy set on the x and u plane. This region is called the Footprint of Uncertainty (FOU). The upper membership function ($\tilde{\tilde{A}}_i^U$) and the lower membership function ($\tilde{\tilde{A}}_i^L$) of an interval type-2 fuzzy set are type-1 fuzzy sets, and we have the following* [67]:

$$FOU(\tilde{\tilde{A}}) = \left[(\tilde{\tilde{A}}_i^U), (\tilde{\tilde{A}}_i^L) \right] \tag{3}$$

Figure 2 presents the upper value ($\tilde{\tilde{A}}_i^U$) and the lower value ($\tilde{\tilde{A}}_i^L$) of the IT2FS $\tilde{\tilde{A}}_i$.

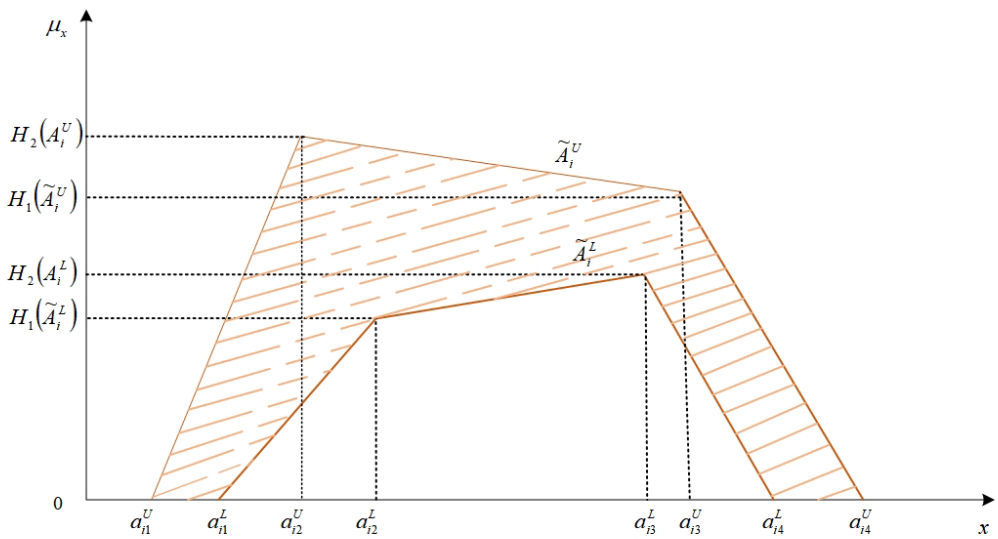

Figure 2. A trapezoidal type-2 fuzzy set.

A trapezoidal type-2 fuzzy set is a special case of an interval type-2 fuzzy set. When the upper and lower membership functions of an interval type-2 fuzzy set are trapezoidal fuzzy numbers, it is called an interval trapezoidal type-2 fuzzy number, denoted as $\tilde{\tilde{A}}_i$. In

Equation (4), $H_j\left(\overset{\approx U}{A}_i\right)$ and $H_j\left(\overset{\approx L}{A}_i\right)$ represent the membership degrees of the $(j+1)$th element $\alpha^U_{i,j+1}$, $\alpha^L_{i,j+1}$ (for $1 \le j \le 2$) in $(\widetilde{\widetilde{A}}{}^U_i)$ and $(\widetilde{\widetilde{A}}{}^L_i)$, respectively [68].

$$\widetilde{\widetilde{A}}_i = \left(\widetilde{\widetilde{A}}{}^U_i, \widetilde{\widetilde{A}}{}^L_i\right) = \left(\left(a^U_{i1}, a^U_{i2}, a^U_{i3}, a^U_{i4}; H_1\left(\widetilde{A}^U_i\right), H_2\left(\widetilde{A}^U_i\right)\right), \left(a^L_{i1}, a^L_{i2}, a^L_{i3}, a^L_{i4}; H_1\left(\widetilde{A}^L_i\right), H_2\left(\widetilde{A}^L_i\right)\right)\right) \tag{4}$$

Definition 3. *To facilitate subsequent operations, we introduce the arithmetic rules for interval type-2 fuzzy numbers that will be used later. Let* $\widetilde{\widetilde{A}}_1$ *and* $\widetilde{\widetilde{A}}_2$ *be two IT2FSs, and k be a positive real number. The arithmetic operations of the IT2FSs are presented in Equations (5)–(8)* [69].

$$\begin{aligned}\widetilde{\widetilde{A}}_1 \oplus \widetilde{\widetilde{A}}_2 &= \left(\widetilde{A}^U_1, \widetilde{A}^L_2\right) \oplus \left(\widetilde{A}^U_1, \widetilde{A}^L_2\right) \\ &= \begin{pmatrix} a^U_{11} + a^U_{21}, a^U_{12} + a^U_{22}, a^U_{13} + a^U_{23}, a^U_{14} + a^U_{24}; \min\left(H_1(\widetilde{A}^U_1), H_1(\widetilde{A}^U_2)\right), \min\left(H_2(\widetilde{A}^U_1), H_2(\widetilde{A}^U_2)\right) \\ a^L_{11} + a^L_{21}, a^L_{12} + a^L_{22}, a^L_{13} + a^L_{23}, a^L_{14} + a^L_{24}; \min\left(H_1(\widetilde{A}^L_1), H_1(\widetilde{A}^L_2)\right), \min\left(H_2(\widetilde{A}^L_1), H_2(\widetilde{A}^L_2)\right) \end{pmatrix}\end{aligned} \tag{5}$$

$$\begin{aligned}\widetilde{\widetilde{A}}_1 \otimes \widetilde{\widetilde{A}}_2 &= \left(\widetilde{A}^U_1, \widetilde{A}^L_2\right) \otimes \left(\widetilde{A}^U_1, \widetilde{A}^L_2\right) \\ &= \begin{pmatrix} a^U_{11} \times a^U_{21}, a^U_{12} \times a^U_{22}, a^U_{13} \times a^U_{23}, a^U_{14} \times a^U_{24}; \min\left(H_1(\widetilde{A}^U_1), H_1(\widetilde{A}^U_2)\right), \min\left(H_2(\widetilde{A}^U_1), H_2(\widetilde{A}^U_2)\right) \\ a^L_{11} \times a^L_{21}, a^L_{12} \times a^L_{22}, a^L_{13} \times a^L_{23}, a^L_{14} \times a^L_{24}; \min\left(H_1(\widetilde{A}^L_1), H_1(\widetilde{A}^L_2)\right), \min\left(H_2(\widetilde{A}^L_1), H_2(\widetilde{A}^L_2)\right) \end{pmatrix}\end{aligned} \tag{6}$$

$$\widetilde{\widetilde{A}} \times k = \begin{pmatrix} a^U_{11} \times k, a^U_{12} \times k, a^U_{13} \times k, a^U_{14} \times k; H_1(\widetilde{A}^U_1), H_2(\widetilde{A}^U_1) \\ a^L_{11} \times k, a^L_{12} \times k, a^L_{13} \times k, a^L_{14} \times k; H_1(\widetilde{A}^L_1), H_2(\widetilde{A}^L_1) \end{pmatrix} \tag{7}$$

$$\frac{\widetilde{\widetilde{A}}}{k} = \begin{pmatrix} a^U_{11} \times \frac{1}{k}, a^U_{12} \times \frac{1}{k}, a^U_{13} \times \frac{1}{k}, a^U_{14} \times \frac{1}{k}; H_1(\widetilde{A}^U_1), H_2(\widetilde{A}^U_1) \\ a^L_{11} \times \frac{1}{k}, a^L_{12} \times \frac{1}{k}, a^L_{13} \times \frac{1}{k}, a^L_{14} \times \frac{1}{k}; H_1(\widetilde{A}^L_1), H_2(\widetilde{A}^L_1) \end{pmatrix} \tag{8}$$

For example, consider the addition operation rule for interval trapezoidal fuzzy numbers. Given two interval trapezoidal type-2 fuzzy numbers $\widetilde{\widetilde{A}}_1$ and $\widetilde{\widetilde{A}}_2$, respectively:
$\overset{\approx}{A}_1 = ((5,7,8,9;1,0.9),(6,7,7,8;0.8,0.8))$; $\overset{\approx}{A}_2 = ((1,3,5,6;0.8,0.9),(2,3,4,5;0.7,0.6))$
Then,
$\overset{\approx}{A}_1 \oplus \overset{\approx}{A}_2 = ((6,10,13,15;0.8,0.9),(8,10,11,13;0.7,0.6))$ [70].

Definition 4 *The interval type-2 fuzzy numbers can be defuzzified for comparison as follows:*

$$\begin{aligned} Defuzzified\left(\overset{\approx}{a}_i\right) = \frac{1}{2}\Bigg\{ &\frac{1}{4}\left[\left(a^U_{i4} - a^U_{i1}\right) + \left(H_1\left(\overset{\sim U}{A}_i\right) \times a^U_{i2} - a^U_{i1}\right) + \left(H_2\left(\overset{\sim U}{A}_i\right) \times a^U_{i3}\right) - a^U_{i1}\right\} + a^U_{i1} \\ &\frac{1}{4}\left[\left(a^L_{i4} - a^L_{i1}\right) + \left(H_1\left(\overset{\sim L}{A}_i\right) \times a^L_{i2} - a^L_{i1}\right) + \left(H_2\left(\overset{\sim L}{A}_i\right) \times a^L_{i3}\right) - a^L_{i1}\right] + a^L_{i1}\Bigg\} \end{aligned} \tag{9}$$

4.2. Fuzzy DEMATEL Method

The DEMATEL method is a powerful tool for analyzing complex causal relationships among factors in a system. It synthesizes collective knowledge to create a structural model, representing intricate interrelationships through a directed graph [71]. This capability has led to its widespread application across various fields for identifying and analyzing influential factors and barriers. In this study, to address the inherent uncertainty in expert evaluations, we employ a fuzzy DEMATEL approach based on Interval Type-2 Fuzzy Sets. This enhanced methodology allows for a more nuanced handling of imprecise information. The key steps of our fuzzy DEMATEL procedure, adapted from [72,73], are outlined below.

Step 1: Defining the fuzzy linguistic measurement scale.

In many decision-making and evaluation processes, uncertainty is a common phenomenon. Typically, input data for questionnaires is collected using linguistic variables such as "high," "medium," or "low" to gather expert judgments. However, due to the inherent fuzziness and hesitancy in human thinking, these qualitative judgments cannot be directly transformed into precise numbers. Therefore, fuzzy numbers are widely applied due to their unique advantages in expressing uncertainty.

Fuzzy numbers allow membership functions to fluctuate within an interval rather than being confined to a single specific value, thereby more accurately capturing the complexities of the real world. Furthermore, fuzzy numbers provide a flexible tool to capture the deeper meanings of linguistic terms, enabling decision-makers to more comprehensively consider various factors, including those that are not easily measured by precise values [74,75].

For example, in a multi-criteria decision-making problem with linguistic fuzziness, assume there are m alternatives $A = (A_1, A_2, \ldots, A_m)$ and n decision criteria $C = (C_1, C_2, \ldots, C_n)$, with each criterion being independently related. When decision-makers provide evaluation information in the form of hesitant linguistic values, we can convert these into interval trapezoidal fuzzy numbers to obtain an evaluation matrix $H = \left(\approx{h}_{ij}\right)_{mn}$, where $\approx{h}_{ij}$ represents the criterion value given by the decision-maker for alternative i under criterion j, which can also be expressed as an interval trapezoidal type-2 fuzzy number.

In this study, we adopted a 7-level linguistic evaluation set to capture expert opinions more precisely. We invited three authoritative experts with extensive experience in the field to provide their assessments. The use of hesitant linguistic values allows experts to express their evaluations more intuitively and comprehensively. These linguistic terms and corresponding IT2FSs are shown in Table 2.

Table 2. The linguistic terms and corresponding IT2FSs [76,77].

Linguistic Terms	IT2FSs
Very low (VL)	((0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9))
Low (L)	((0, 0.1, 0.1, 0.3; 1, 1), (0.05, 0.1, 0.1, 0.2; 0.9, 0.9))
Medium low (ML)	((0.1, 0.3, 0.3, 0.5; 1, 1), (0.2, 0.3, 0.3, 0.4; 0.9, 0.9))
Medium (M)	((0.5, 0.7, 0.7, 0.9; 1, 1), (0.4, 0.5, 0.5, 0.6; 0.9, 0.9))
Medium High (MH)	((0.5, 0.7, 0.7, 0.9;1, 1), (0.6, 0.7, 0.7, 0.8; 0.9, 0.9))
High (H)	((0.7, 0.9, 0.9, 1; 1, 1), (0.8, 0.9, 0.9, 0.95; 0.9, 0.9))
Very High (VH)	((0.9, 1, 1, 1; 1, 1), (0.95, 1, 1, 1; 0.9, 0.9))

Step 2: Forming the fuzzy direct-influenced matrices of different experts.

Assuming K participate in the barrier evaluation and n barriers are identified. Each expert assesses the direct influence of one barrier on others using the linguistic scale defined in Step 1. This process yields K linguistic direct-influenced matrices based on the judgments of the experts. Finally, we have K fuzzy direct-influenced matrices based on expert judgments. These matrices are then translated into fuzzy direct-influenced matrices using the IT2FSs correspondences shown in Table 2, as represented in Equation (10).

$$\widetilde{A}^k = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n1} & \cdots & a_{nn} \end{bmatrix} \quad (10)$$

Step 3: Integrating all the fuzzy direct-influenced matrices into a matrix.

While the overall averaged matrix is typically derived from individual expert weightings, the diverse backgrounds of experts make weight determination challenging. To address this, we employ the order-weighted averaging (OWA) operator, proposed by Yager [78]. This method focuses on the order weight of evaluation values, eliminating the need for individual expert weighting. The OWA operator has found wide application across various fields, including neural networks, database systems, market research, image compression, mathematical programming, expert systems, and multi-criteria decision-making problems [79].

The OWA operator applied in IT2FNs is defined as follows:

$$OWA\left(a_{ij}^{E_1}, a_{ij}^{E_2}, \cdots, a_{ij}^{E_k}\right) = \sum_{j=1}^{m} w_j a_j \tag{11}$$

Here, a_j is the $j-$th largest value among $a_{ij}^1, a_{ij}^1, \cdots, a_{ij}^K$, w_j is the weight of a_j, $w_j \in [0,1]$, and $\sum_{j=1}^{m} w_j b_j = 1$. The value of w_j is calculated as follows [80]:

$$w_j = Q\left(\frac{j}{m}\right) - Q\left(\frac{j-1}{m}\right) \tag{12}$$

where $Q(\beta) = \beta^{\alpha}, \alpha \geq 0, 1 \leq j \leq m$. Typically, parameter α is set to 2.

The resulting comprehensive matrix $\otimes A$ is represented as follows:

$$\otimes A = \left[\otimes a_{11} \otimes a_{12} \cdots \otimes a_{1n} \otimes a_{21} \otimes a_{22} \cdots \otimes a_{2n} \vdots \vdots \vdots \otimes a_{n1} \otimes a_{n2} \cdots \otimes a_{nn}\right] \tag{13}$$

Step 4: Normalizing the directed-influenced matrix

The normalized direct-influenced matrix is derived from the initial fuzzy comprehensive matrix $\otimes A$ as follows:

$$s = \max\left(\max_{1 \leq i \leq n} \sum_{j=1}^{n} a_{ij}, \max_{1 \leq j \leq n} \sum_{i=1}^{n} a_{ij}\right) \tag{14}$$

$$M = \frac{\otimes A}{s} \tag{15}$$

Step 5: Determining the total-relation matrix

The fuzzy total-relation matrix is calculated through Equations (16) and (17):

$$T = M + M^2 + M^3 + \cdots = \sum_{i=1}^{\infty} M^i = M(I - M)^{-1} \tag{16}$$

$$T = \left[t_{ij}\right]_{n \times n} i, j \in \{1, 2, 3 \cdots, n\} \tag{17}$$

Step 6: Determining barrier prominence and net effect

The prominence P_i and the net effect of each potential barrier are calculated using Equations (18)–(21). P_i represents the overall significance of the i-th barrier, considering both its influence on other barriers and the influence it receives from them. A higher P_i value indicates greater overall prominence of the barrier. The net effect E_i reflects the barrier's relative influence: a positive E_i suggests the barrier has a stronger influence on others, while a negative E_i indicates that it is more influenced by other barriers.

$$D_i = \sum_{j=1}^{n} t_{ij}, \forall_i \tag{18}$$

$$R_j = \sum_{i=1}^{n} t_{ij}, \forall_j \tag{19}$$

$$P_i = \{D_i + R_j | i = j\} \tag{20}$$

$$E_i = \{D_i - R_j | i = j\} \tag{21}$$

where D_i represents the sum of direct and indirect effects that barrier i has on other barriers. R_i represents the sum of direct and indirect effects that barrier i receives from other barriers.

Step 7: Plotting the cause-and-effect diagram

The cause-and-effect diagram plots P_i on the horizontal axis and E_i on the vertical axis, visually representing the relationships between barriers.

For data processing and analysis in this study, we utilized Microsoft Excel (Version 2019, Microsoft Corporation, Redmond, WA, USA). The visualizations and diagrams were created using Microsoft Visio (Version 2019, Microsoft Corporation, Redmond, WA, USA).

5. The Proposal and Application of the Research Framework

Based on the fuzzy DEMATEL method, we propose and apply a four-stage research framework to identify and analyze the potential barriers to green transformation in the express industry, as illustrated in Figure 3.

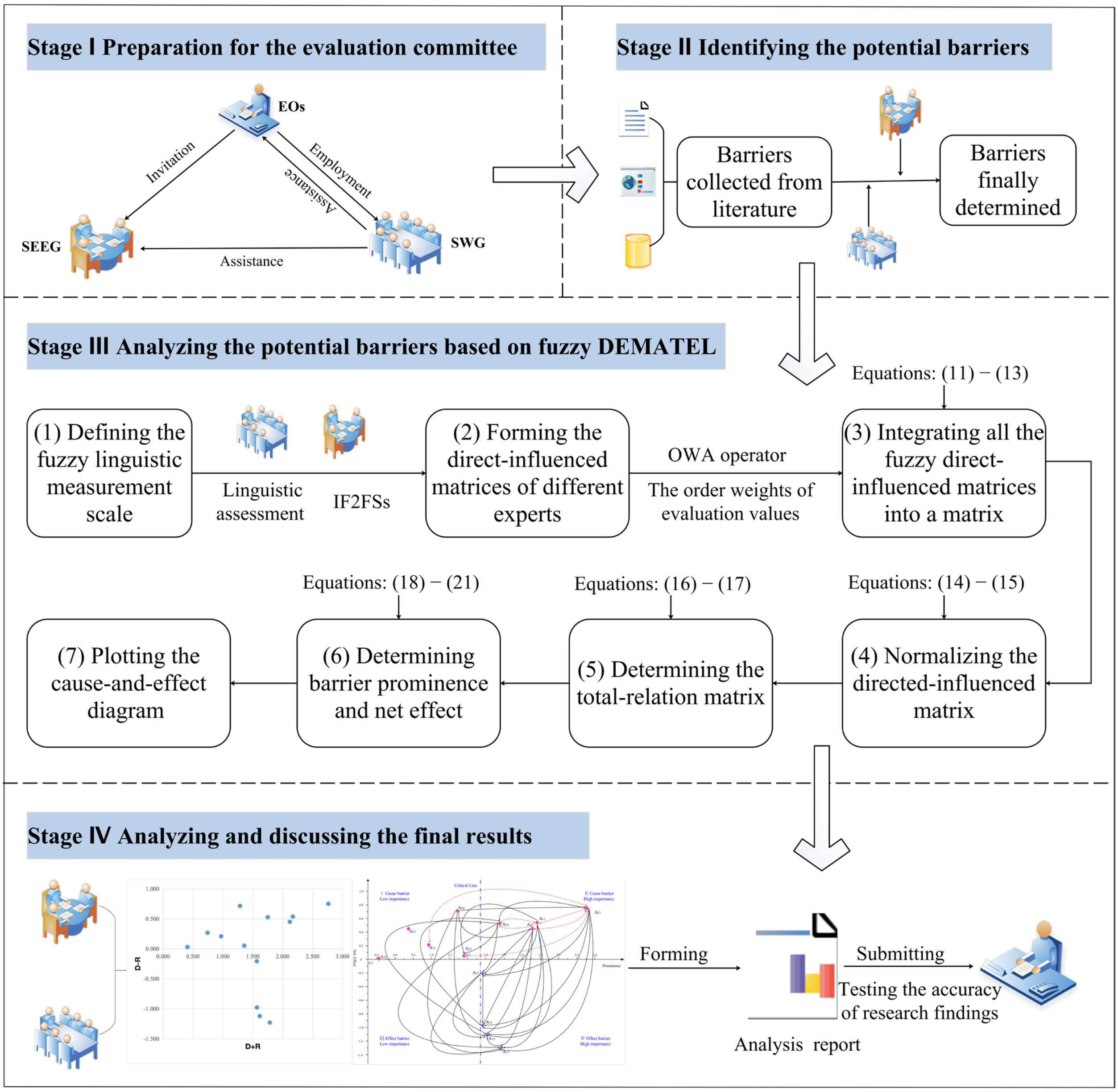

Figure 3. The barriers-analysis research framework for green transformation in the express industry.

5.1. Stage I: Preparation for the Evaluation Committee

The research framework begins with the establishment of an evaluation committee, which forms the foundation for the barrier analysis. The committee comprises three key roles:

Evaluation Organizers (EOs): Primarily composed of project management personnel, EOs conduct field research and initial professional consultations to set the goals for barrier analysis.

Senior Expert Evaluation Group (SEEG): Three authoritative experts from China's State Post Bureau (responsible for licensing and regulation of the express industry), China's State Administration for Market Supervision and Administration (responsible for green standards and regulation of products/services), and from a major Chinese express company (implementing green transformation practices) were invited to represent key stakeholders in the green transformation of China's express industry. These experts have extensive experience in government policy, industry regulation, and senior management in the field of green transformation in the express industry.

Supporting Working Group (SWG): Comprising doctoral students in related research fields, this group assists with data processing, collection, and analysis.

The detailed responsibilities of each role are outlined in Table 3.

Table 3. The detailed responsibilities of different roles in the evaluation committee.

Roles	Specific Duties
EOs	✣ Set the goal of barriers analysis ✣ Arrange and organize the procedures of the barriers' analysis
SEEG	✣ Search and determine the final barriers list ✣ Assess the influence degree among the barriers
SWG	✣ Assist the works of EOs and SEEG ✣ Calculate the final results of barriers' analysis

5.2. Stage II: Identifying the Potential Barriers

In this stage, the SWG initially identifies sixteen potential barriers to the green transformation of China's express delivery industry through a comprehensive literature survey, analysis of newspaper articles, and government reports. The SEEG then analyzes and refines these potential barriers. As a result of this rigorous process, thirteen critical barriers are retained, as previously presented in Table 1.

5.3. Stage III: Analyzing the Potential Barriers Based on the Fuzzy DEMATEL

Using the final barriers list from stage II, this stage involves a comprehensive analysis of the potential barriers. The SEEG assesses the degree of mutual influence between the barriers, expressing the relationships using the linguistic terms defined earlier. Each expert in the SEEG establishes a fuzzy direct-influence matrix. The SWG then computes the overall prominence and net effect of each barrier using the fuzzy DEMATEL method.

The linguistic direct-influence matrices provided by experts 1, 2, and 3 are presented in Tables A1–A3 of Appendix A. These are then converted into interval type-2 fuzzy direct-influence matrices according to Table 2. Based on Equations (11)–(13), the aggregated fuzzy direct-influenced matrix is calculated and shown in Table A6 of Appendix B.

The normalized direct-influenced matrix is then calculated using Equations (14) and (15). Subsequently, the total-relation matrix is derived through Equations (16) and (17), as shown in Table A7 of Appendix B. Finally, the defuzzification values P_i and E_i are computed according to Equations (18)–(21). These results are presented in Table 4 and visualized in Figure 4.

To facilitate the interpretation of relationships between barriers, we establish a threshold (θ) for the cause–effect diagram. This threshold is calculated as $\theta = \mu + \delta$, where μ and δ represents the mean and standard deviation of the total-relation matrix, respectively. In this study, the threshold value is $\theta = 0.0594 + 0.0584 = 0.118$. Figure 5 depicts the relationships between barriers where the values exceed this threshold.

Table 4. Values of D, R, P_i, and E_i of the barriers.

Barriers	D_i	R_i	P_i	E_i
A_{11}	1.352	0.816	2.168	0.537
A_{12}	0.295	1.273	1.568	−0.978
A_{13}	0.277	1.506	1.783	−1.229
A_{14}	0.247	1.367	1.614	−1.121
A_{21}	1.756	1.006	2.762	0.750
A_{22}	0.704	0.652	1.356	0.052
A_{23}	0.679	0.887	1.566	−0.208
A_{24}	1.138	0.611	1.749	0.526
A_{25}	1.284	0.834	2.118	0.451
A_{31}	0.589	0.381	0.970	0.209
A_{32}	0.218	0.188	0.407	0.030
A_{33}	0.505	0.238	0.743	0.267
A_{34}	1.000	0.285	1.285	0.715

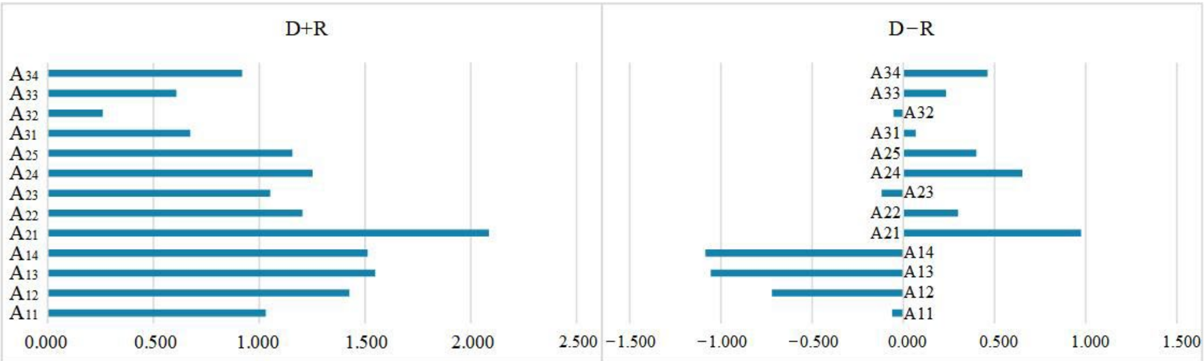

Figure 4. The values of P_i and E_i.

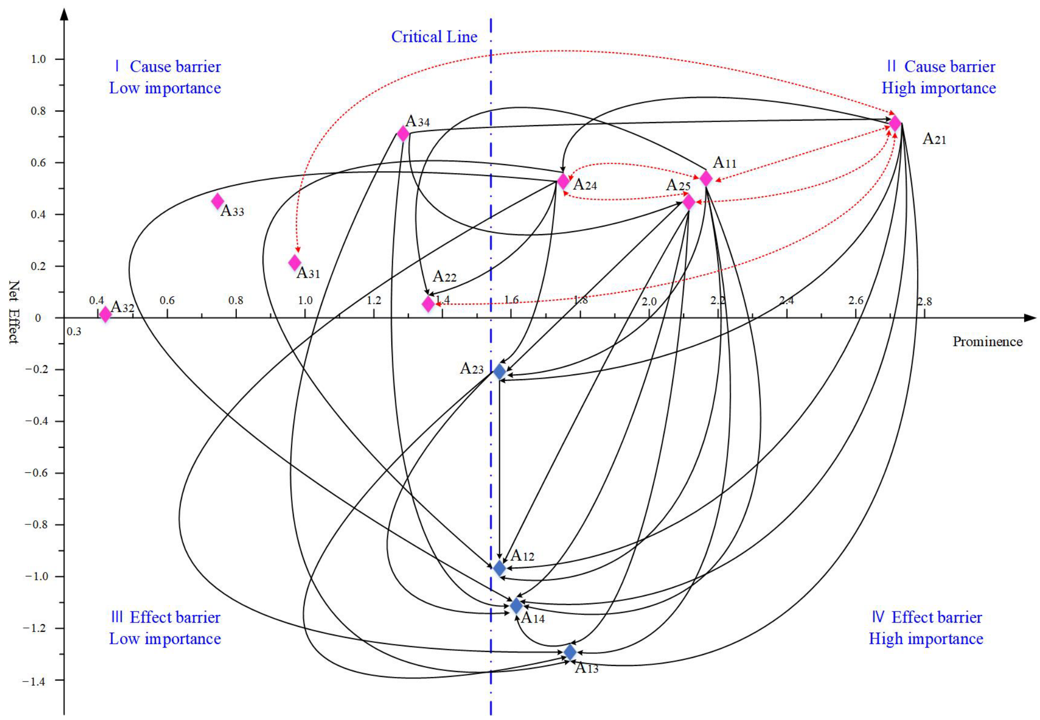

Figure 5. The DEMATEL cause–effect diagram. (Note: The black solid lines represent one-way relationships, while the red dashed arrows indicate two-way relationships. The blue critical line is determined by the mean of the P_i values).

5.4. Stage IV: Analyzing and Discussing the Final Results

From Figure 5, we can observe that four barriers (A_{22}, A_{31}, A_{33} and A_{34}) are located in area I, indicating that they are cause barriers with relatively low importance. Among these, A_{22} has a significant influence on A_{21}. This relationship highlights how the scarcity of specialized talent directly impedes the formation of technical standards related to green logistics. Barrier A_{34} directly influences barriers A_{13}, A_{14}, and A_{21}, with E_i values of 0.178, 0.160, and 0.146, respectively. This influence is particularly noteworthy as the green transformation of China's express industry is in its initial stages, characterized by high initial investment and operational costs, necessitating substantial reliance on government subsidies. Consequently, A_{22} and A_{34} emerge as important barriers despite their location in area I. It is also crucial to note that A_{31}, A_{32}, and A_{33}, while not classified as critical barriers, reflect regional variations in government policies, public support, and administrative procedures. These variations significantly impact the implementation of green transformation in the express industry and should not be overlooked.

The barriers A_{11}, A_{21}, A_{22}, A_{24}, and A_{25} are situated in area II of Figure 5, categorizing them as high-importance cause barriers. Figure 4 reveals that A_{21} has the highest P_i value (2.086) among all barriers exerting considerable influence on A_{11}, A_{12}, A_{13}, A_{14}, A_{23}, A_{24}, A_{25}, and A_{31}. The underscores the critical role of a unified standard system in the sustainable development of the green courier industry. The lack of standards will bring many serious challenges to the industry. First, the initial investment cost is high. Due to the lack of technical standards and facility standards, each enterprise needs to research and development, resulting in duplication of capital investment, aggravating the pressure of the initial investment. The second challenge is high operation and maintenance costs. The lack of standardization leads to equipment and facilities that cannot be common, high maintenance and replacement costs, and heavy operating costs. Furthermore, the payback period is long. The lack of standardization hinders the application and promotion of green express delivery on a wider scale and slows down the investment recovery process. In addition, green packaging technology cannot be realized in a wide range of applications, warehousing and transportation infrastructure display a lack of compatibility, and recycling link efficiency and quality are affected: these effects are from the lack of uniform norms and guiding standards. To sum up, A_{21} is a critical barrier. Besides, the barriers of A_{11}, A_{24}, and A_{25} also have high P_i values, which are 2.168, 1.749, and 2.118, respectively, and they are also critical barriers.

Area IV in Figure 5 contains four barriers: A_{12}, A_{13}, A_{14}, and A_{23}. These are classified as effect barriers with high importance, having P_i values of 1.568, 1.783, 1.614, and 1.566, respectively. All four are directly influenced by barriers A_{11}, A_{21}, A_{24}, and A_{25}. For instance, the lack of standards leads to increased O&M costs, prolonged investment payback periods, and reduced financing opportunities. Additionally, barriers A_{12}, A_{13}, and A_{14} are simultaneously affected by A_{23} and A_{34}, with E_i values of 0.138, 0.128, and 0.153, respectively. Barriers A_{13} and A_{14} are particularly influenced by A_{34}, with E_i values of 0.178 and 0.161.

In conclusion, our analysis identifies A_{11}, A_{12}, A_{13}, A_{14}, A_{21}, A_{23}, A_{24}, and A_{25} as the critical barriers to the green transformation of China's express delivery industry. Addressing these barriers should be prioritized to promote industry-wide green transformation. However, it is important to note that while barriers such as A_{22} and A_{34} are not classified as critical, they still play significant roles in hindering the green transformation process and should not be disregarded in policy and strategic planning.

5.5. Stage V: Testing the Accuracy of Research Findings

While this paper has already enlisted the expertise of three senior government, regulatory, and industry professionals who have been deeply involved in the green transformation of the express delivery sector for many years to assess the factors hindering the green transformation of China's express delivery industry, further steps have been taken to ensure the reliability of the research findings. To this end, this section will delve into how the variation in the number of experts might influence the analytical outcomes, aiming to maximize the precision of the study's conclusions. Consequently, our research team has extended an invitation to two additional experts, Expert 4 and Expert 5. Hailing from academic institutions, Expert 4 and Expert 5 specialize in low-carbon transformation and logistics economics, respectively, and have been engaged in scholarly research on the low-carbon transition in logistics for an extended period. They will re-analyze the interrelationships and the extent of mutual influence among these potential barriers.

At this stage, the direct influences linguistically provided by Experts 4 and 5 are depicted in Tables A4 and A5 of Appendix A. Following Equations (11)–(17), the principles are consistent with the previous text and thus will not be described in further detail. Utilizing these equations, we have derived the total-relation matrix based on the input of five experts, which is displayed in Table A8 of Appendix B. Similarly, the defuzzification values, based on the perspectives of the five experts, can be calculated according to Equations (18)–(21), as presented in Table 5.

Table 5. Values of D, R, P_i, and E_i of the barriers. (Based on the assessment results of five experts).

Barriers	D_i	R_i	P_i	E_i
A_{11}	1.530	0.804	2.334	0.726
A_{12}	0.293	1.256	1.549	−0.963
A_{13}	0.263	1.522	1.786	−1.259
A_{14}	0.247	1.441	1.688	−1.194
A_{21}	1.747	1.006	2.753	0.740
A_{22}	0.678	0.620	1.298	0.057
A_{23}	0.654	0.891	1.545	−0.237
A_{24}	1.150	0.651	1.801	0.499
A_{25}	1.265	0.781	2.046	0.484
A_{31}	0.536	0.320	0.855	0.216
A_{32}	0.221	0.172	0.393	0.049
A_{33}	0.448	0.242	0.689	0.206
A_{34}	0.941	0.265	1.206	0.676

From Table 5, we can discern that the assessment by five experts indicates that the obstacle indicators with high P_i values still remain A_{11}, A_{12}, A_{13}, A_{14}, A_{21}, A_{23}, A_{24}, and A_{25}, both of which have surpassed the mean value of P_i. This result is consistent with the analysis presented earlier, thereby confirming the representativeness of the previous analysis.

6. Conclusions and Recommendations

6.1. Conclusions

This study set out to explore the green transformation of China's express delivery industry, focusing on identifying key barriers, analyzing their interactions, and proposing strategic measures to overcome them. Accelerating the green and low-carbon development of the express delivery industry is crucial for implementing China's national economic development strategy and achieving its carbon-neutral goals. This transformation is essential for promoting high-quality industry development. However, the presence of key barriers has hindered the express industry's green transformation from achieving its expected outcomes. To address these challenges, we proposed a research framework for barrier analysis using a fuzzy DEMATAL approach in the context of Interval Type-2 Fuzzy Sets (IT2FSs). Our analysis revealed eight critical barriers: A_{11}, A_{12}, A_{13}, A_{14}, A_{21}, A_{23}, A_{24}, and A_{25}.

6.2. Recommendations

According to the results obtained in Section 5, eight barriers are identified as key obstacles that need to be urgently addressed. In this section, we propose corresponding measures to overcome these barriers.

6.2.1. Accelerate the Promotion of Green Low-Carbon Standard System Construction in the Express Industry

Standards are crucial for the industry's green and low-carbon development. Industry associations, research institutions, and leading enterprises in the express delivery field should accelerate the development of standards for key energy-using facilities and equipment, energy efficiency, and carbon reduction technologies. These standards will guide industry enterprises in the comprehensive implementation of green development strategies, strengthen energy conservation, and enhance energy use efficiency. This will, in turn, accelerate the adoption of advanced technologies, green products, and equipment.

We should continuously optimize national standards and improve the structure of national, industry, and association standards, expanding the coverage of green and low-carbon practices. Accelerating the establishment of a more scientific, applicable, and internationally compatible green low-carbon standard system is essential. This system should integrate the entire industry chain, from R&D and production to operations and services, thereby enhancing the green competitiveness of express delivery enterprises.

6.2.2. Encourage Capital Investment to Boost Green Transformation in the Express Delivery Industry

The cost pressure of green transformation poses a significant challenge in the express delivery industry. Sufficient capital investment is required, particularly for green packaging transformation. We propose the following measures:

1. The government should adopt policies such as tax incentives and fiscal appropriations to enable express companies to innovate in environmental protection, thereby improving green services and promoting industrial transformation.
2. Secondly, the financial sector should be fully engaged to increase support for the green transformation of express delivery enterprises. This include introducing green insurance and credit mechanisms, raising awareness among commercial banks about supporting the industry's green development, and guiding funds towards environmentally friendly enterprises.
3. Efforts should be made to increase publicity for green packaging and other eco-friendly products. By attracting idle funds from the market and demonstrating the dual economic and environmental benefits of green express delivery, we can strengthen awareness of green investment opportunities.

6.2.3. Accelerate R&D of Related Technologies

Accelerating the development of relevant technologies is crucial for implementing widespread green transformation in the express delivery industry. The complexities and uncertainties in green express packaging and key facilities upgrades pose significant challenges. To address these, we recommend the following:

1. Enhance research on green express packaging technologies: Encourage collaboration among express packaging manufacturers, recycling companies, universities, and research institutions to develop biodegradable and environmentally friendly packaging materials. Promote the use of innovative solutions such as solar-powered photovoltaic recyclable green packaging to enable efficient folding, recycling, and reused of packaging materials.
2. Advance research on intelligent warehousing and transportation technologies: As digital technologies like big data and the Internet of Things become increasingly prevalent, focus on developing communication and sensing technologies for intelligent warehousing and transportation. This can enable automation in sorting, loading/unloading, and scheduling, thereby increasing transportation efficiency and reducing waste. Simultaneously, utilize big data analytics and artificial intelligence to optimize route planning and vehicle scheduling, reducing energy consumption and carbon emissions.

3. Establish a digitalized recycling system: Develop intelligent recycling lockers compatible with smart packaging boxes and create an integrated online–offline digitalized recycling system. This will optimize the express packaging recycling process and transform traditional recycling methods.

6.2.4. Improve Project Management Standards and Efficiency

Enhancing project management standards and efficiency is an effective way to reduce initial investment costs, improve green express services, and promote the industry's sustainable development. We suggest the following:

1. In the early stages of projects, conduct comprehensive planning that considers factors such as the location of express service stations and integration with existing facilities. Utilize geographic information technology combined with multi-criteria decision-making methods to select efficient equipment, technologies, and risk control measures during construction and operation phases. This approach will ensure efficient project implementation and sustainable benefits.
2. At the service level, implement measures to optimize green packaging recycling process, promote the use of recyclable and environmentally friendly packaging, strengthen energy-saving and emission reduction controls for transportation vehicles, and enhance environmental protection education and training for employees. These actions will improve the quality of green express services and contribute to sustainable development.
3. Proactively strengthen exchanges and cooperation with leading countries in express delivery green transformation, such as Germany and Japan. By actively learning from advanced foreign technologies and management experiences, we can accelerate the green transformation of the domestic express delivery industry.

6.3. Limitations

This study provides valuable insights for analyzing the barriers in the green transformation process of China's express delivery industry, aiming to promote sustainable development in the logistics system. However, it is important to acknowledge its limitations. Firstly, some minor barriers are not fully reflected in this study, such as the high consumption in green logistics packaging and the lack of coordination among related sectors. These seemingly small barriers should not be overlooked, as their cumulative effect can significantly impact the green transformation process. Secondly, the assessment is primarily based on expert judgments, which, while valuable, may introduce some bias due to personal opinions and experiences. For future research, we suggest conducting a more detailed and comprehensive analysis of barriers, including those considered minor in this study. Additionally, exploring the operational model, risk control mechanisms, and assessment methodologies specific to the green transition in the express delivery industry would be valuable areas for further investigation.

Author Contributions: Conception, X.X. and K.G.; methods and writing, X.X. and C.L.; data organization and resources, Y.H. and B.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by China's National Key R&D Program "Research on Green and Intelligent Standardized Key Technologies and Application of Testing and Certification in Express Industry" (Project No. 2022YFF0608100).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. Linguistic direct-influenced matrix of Expert 1.

	A_{11}	A_{12}	A_{13}	A_{14}	A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	A_{31}	A_{32}	A_{33}	A_{34}
A_{11}	—	H	VH	VH	L	VL	VL	L	ML	VL	VL	L	VL
A_{12}	L	—	VH	H	VL	L	L	L	ML	VL	VL	L	VL
A_{13}	VL	ML	—	VH	VL	L	VL	VL	VL	M	VL	L	L
A_{14}	L	L	MH	—	VL	VL	VL	VL	ML	VL	VL	VL	VL
A_{21}	VH	VH	H	VL	—	VH	H	VH	VH	VH	M	H	H
A_{22}	M	VH	L	MH	H	—	M	VL	VL	ML	VL	VL	VL
A_{23}	VL	H	H	H	VL	VL	—	VL	VL	VL	VL	L	VL
A_{24}	H	H	MH	MH	VL	H	H	—	H	VL	VL	VL	VL
A_{25}	M	VH	H	VH	VL	H	VH	L	—	VL	VL	VL	VL
A_{31}	L	M	M	VL	VH	VL	VL	VL	VL	—	VL	VL	L
A_{32}	M	M	VL	VL	VL	VL	L	VL	L	VL	—	VL	VL
A_{33}	M	L	M	VL	H	VL	VL	VL	VL	VL	ML	—	M
A_{34}	M	L	H	VH	H	VL	VL	VL	L	VL	VL	VL	—

Table A2. Linguistic direct-influenced matrix of Expert 2.

	A_{11}	A_{12}	A_{13}	A_{14}	A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	A_{31}	A_{32}	A_{33}	A_{34}
A_{11}	—	M	VH	H	L	VL	VL	ML	VL	VL	VL	VL	VL
A_{12}	VL	—	H	H	VL	VL	VL	VL	L	VL	VL	VL	VL
A_{13}	L	VL	—	VH	VL	VL	VL	VL	VL	L	VL	VL	VL
A_{14}	VL	VL	H	—	VL	VL	L	ML	M	L	VL	VL	VL
A_{21}	VH	H	H	ML	—	VH	VH	MH	H	MH	M	M	M
A_{22}	ML	H	L	M	H	—	VH	VL	VL	VL	VL	L	VL
A_{23}	L	H	H	H	L	VL	—	VL	L	M	VL	VL	VL
A_{24}	MH	H	H	M	VL	H	MH	—	VH	VL	VL	L	VL
A_{25}	ML	VH	H	VH	VL	M	H	ML	—	VL	VL	VL	VL
A_{31}	VL	M	L	VL	H	VL	VL	VL	VL	—	VL	VL	VL
A_{32}	L	L	VL	VL	VL	VL	VL	VL	VL	VL	—	VL	VL
A_{33}	ML	ML	M	VL	MH	VL	VL	VL	VL	VL	M	—	ML
A_{34}	MH	M	H	H	VH	VL	VL	VL	VL	VL	L	M	—

Table A3. Linguistic direct-influenced matrix of Expert 3.

	A_{11}	A_{12}	A_{13}	A_{14}	A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	A_{31}	A_{32}	A_{33}	A_{34}
A_{11}	—	MH	VH	VH	VL	VL	VL	M	L	VL	VL	VL	VL
A_{12}	VL	—	VH	VH	VL	L	VL	L	L	VL	VL	VL	VL
A_{13}	VL	L	—	VH	VL	VL	VL	VL	L	M	VL	VL	VL
A_{14}	VL	L	M	—	ML	VL	VL	ML	VL	VL	L	VL	VL
A_{21}	H	H	MH	L	—	VH	VH	H	M	VH	L	MH	H
A_{22}	M	VH	M	H	H	—	H	M	L	VL	VL	VL	VL
A_{23}	M	VH	M	VH	ML	VL	—	VL	VL	ML	VL	VL	VL
A_{24}	MH	H	H	M	VL	H	MH	—	MH	VL	VL	VL	VL
A_{25}	L	VH	MH	H	L	M	H	L	—	VL	L	VL	L
A_{31}	ML	ML	VL	VL	MH	VL	L	L	VL	—	VL	VL	L
A_{32}	VL	L	ML	L	VL	VL	VL	VL	L	L	—	VL	L
A_{33}	L	VL	VL	VL	M	VL	L	VL	VL	VL	M	—	M
A_{34}	ML	M	VH	MH	H	VL	VL	VL	VL	VL	L	ML	—

Table A4. Linguistic direct-influenced matrix of Expert 4.

	A_{11}	A_{12}	A_{13}	A_{14}	A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	A_{31}	A_{32}	A_{33}	A_{34}
A_{11}	—	H	MH	MH	L	VL	VL	M	L	L	VL	VL	ML
A_{12}	L	—	VH	VH	VL	L	L	L	M	VL	VL	L	VL

Table A4. *Cont.*

	A_{11}	A_{12}	A_{13}	A_{14}	A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	A_{31}	A_{32}	A_{33}	A_{34}
A_{13}	VL	L	—	VH	VL	VL	VL	VL	VL	ML	VL	VL	VL
A_{14}	L	L	M	—	ML	VL	ML	ML	VL	VL	L	L	VL
A_{21}	VH	H	MH	VH	—	VH	VH	VH	VH	VH	VH	VH	VH
A_{22}	M	MH	M	H	H	—	H	M	VL	VL	VL	VL	VL
A_{23}	MH	MH	MH	VH	ML	VL	—	VL	VL	L	L	VL	VL
A_{24}	M	H	H	M	VL	H	ML	—	MH	VL	L	VL	VL
A_{25}	M	VH	MH	VH	VL	M	ML	VL	—	L	ML	VL	L
A_{31}	L	ML	VL	VL	MH	ML	L	ML	VL	—	VL	VL	VL
A_{32}	VL	M	L	L	VL	L	VL	VL	L	ML	—	VL	VL
A_{33}	ML	ML	L	VL	VL	VL	L	VL	VL	L	ML	—	ML
A_{34}	ML	M	MH	MH	L	VL	VL	VL	VL	L	M	ML	—

Table A5. Linguistic direct-influenced matrix of Expert 5.

	A_{11}	A_{12}	A_{13}	A_{14}	A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	A_{31}	A_{32}	A_{33}	A_{34}
A_{11}	—	MH	VH	MH	VL	VL	VL	M	L	L	VL	VL	ML
A_{12}	ML	—	H	VH	VL	L	VL	L	M	VL	VL	ML	VL
A_{13}	ML	L	—	VH	VL	VL	L	VL	L	ML	VL	VL	L
A_{14}	L	L	H	—	ML	VL	VL	ML	VL	VL	L	ML	VL
A_{21}	VH	H	H	VH	—	VH	VH	VH	VH	VH	VH	VH	VH
A_{22}	M	MH	L	H	H	—	H	M	L	VL	VL	L	VL
A_{23}	MH	MH	H	VH	VL	VL	—	VL	VL	ML	L	L	L
A_{24}	M	H	H	M	VL	H	ML	—	MH	VL	L	VL	VL
A_{25}	MH	VH	MH	H	L	M	ML	L	—	L	ML	L	L
A_{31}	L	ML	L	VL	MH	ML	VL	L	VL	—	VL	VL	VL
A_{32}	L	M	VL	L	VL	L	L	VL	L	ML	—	L	M
A_{33}	ML	ML	L	VL	M	VL	VL	VL	VL	L	ML	—	ML
A_{34}	ML	M	MH	M	MH	L	L	M	M	ML	M	M	—

Appendix B

Table A6. Aggregated fuzzy direct-influenced matrix.

	A_{11}	A_{12}	A_{13}
A_{11}	(0, 0, 0, 0; 1, 1), (0, 0, 0, 0; 0.9, 0.9)	(0.411, 0.611, 0.611, 0.8; 1, 1), (0.511, 0.611, 0.611, 0.706; 0.9, 0.9)	(0.411, 0.611, 0.611, 0.8; 1, 1), (0.511, 0.611, 0.611, 0.706; 0.9, 0.10)
A_{12}	(0, 0.044, 0.044, 0.189; 1, 1), (0.022, 0.044, 0.044, 0.117; 0.9, 0.9)	(0, 0, 0, 0; 1, 1), (0, 0, 0, 0; 0.9, 0.9)	(0.478, 0.678, 0.678, 0.833; 1, 1); (0.578, 0.678, 0.678, 0.756; 0.9, 0.9)
A_{13}	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)	(0.011, 0.067, 0.067, 0.211; 1, 1), (0.039, 0.067, 0.067, 0.139; 0.9, 0.9)	(0.011, 0.067, 0.067, 0.211; 1, 1), (0.039, 0.067, 0.067, 0.139; 0.9, 0.10)
A_{14}	(0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)	(0, 0.044, 0.044, 0.189; 1, 1), (0.022, 0.044, 0.044, 0.117; 0.9, 0.9)	(0, 0.044, 0.044, 0.189; 1, 1), (0.022, 0.044, 0.044, 0.117; 0.9, 0.10)
A_{21}	(0.789, 0.944, 0.944, 1; 1, 1), (0.867, 0.944, 0.944, 0.972; 1, 1)	(0.722, 0.911, 0.911, 1; 1, 1), (0.817, 0.911, 0.911, 0.956; 0.9, 0.9)	(0.722, 0.911, 0.911, 1; 1, 1), (0.817, 0.911, 0.911, 0.956; 0.9, 0.10)
A_{22}	(0.189, 0.389, 0.389, 0.589; 1, 1), (0.289, 0.389, 0.389, 0.489; 0.9, 0.9)	(0.322, 0.522, 0.522, 0.722; 1, 1), (0.422, 0.522, 0.522, 0.622; 0.9, 0.9)	(0.789, 0.944, 0.944, 1; 1, 1), (0.867, 0.944, 0.944, 0.972; 0.9, 0.10)
A_{23}	(0.478, 0.678, 0.678, 0.833; 1, 1); (0.578, 0.678, 0.678, 0.756; 0.9, 0.9)	(0.789, 0.944, 0.944, 1; 1, 1), (0.867, 0.944, 0.944, 0.972; 1, 1)	(0.478, 0.678, 0.678, 0.833; 1, 1); (0.578, 0.678, 0.678, 0.756; 0.9, 0.9)
A_{24}	(0.522, 0.722, 0.722, 0.911; 1, 1), (0.622, 0.722, 0.722, 0.817; 0.9, 0.9)	(0.7, 0.9, 0.9, 1; 1, 1), (0.8, 0.9, 0.9, 0.95; 0.9, 0.9)	(0.7, 0.9, 0.9, 1; 1, 1), (0.8, 0.9, 0.9, 0.95; 0.9, 0.10)
A_{25}	(0.067, 0.211, 0.211, 0.411; 1, 1), (0.139, 0.211, 0.211, 0.311; 0.9, 0.9)	(0.9, 1, 1, 1; 1, 1), (0.95, 1, 1, 1; 1, 1)	(0.9, 1, 1, 1; 1, 1), (0.95, 1, 1, 1; 1, 2)
A_{31}	(0.011, 0.067, 0.067, 0.211; 1, 1), (0.039, 0.067, 0.067, 0.139; 0.9, 0.9)	(0.189, 0.389, 0.389, 0.589; 1, 1), (0.289, 0.389, 0.389, 0.489; 0.9, 0.9)	(0.189, 0.389, 0.389, 0.589; 1, 1), (0.289, 0.389, 0.389, 0.489; 0.9, 0.10)
A_{32}	(0.033, 0.089, 0.089, 0.233; 1, 1), (0.061, 0.089, 0.089, 0.161; 0.9, 0.9)	(0.033, 0.144, 0.144, 0.344; 1, 1), (0.089, 0.144, 0.144, 0.244; 0.9, 0.9)	(0.033, 0.144, 0.144, 0.344; 1, 1), (0.089, 0.144, 0.144, 0.244; 0.9, 0.10)

Table A6. *Cont.*

	A_{11}	A_{12}	A_{13}
A_{33}	(0.067, 0.211, 0.211, 0.411; 1, 1), (0.139, 0.211, 0.211, 0.311; 0.9, 0.9)	(0.011, 0.067, 0.067, 0.211; 1, 1), (0.039, 0.067, 0.067, 0.139; 0.9, 0.9)	(0.011, 0.067, 0.067, 0.211; 1, 1), (0.039, 0.067, 0.067, 0.139; 0.9, 0.10)
A_{34}	(0.211, 0.411, 0.411, 0.611; 1, 1), (0.311, 0.411, 0.411, 0.511; 0.9, 0.9)	(0.133, 0.278, 0.278, 0.478; 1, 1), (0.206, 0.278, 0.278, 0.378; 0.9, 0.9)	(0.722, 0.911, 0.911, 1; 1, 1), (0.817, 0.911, 0.911, 0.956; 0.9, 0.9)
	A_{14}	A_{21}	A_{22}
A_{11}	(0.789, 0.944, 0.944, 1; 1, 1), (0.867, 0.944, 0.944, 0.972; 0.9, 0.9)	(0.722, 0.911, 0.911, 1; 1, 1), (0.817, 0.911, 0.911, 0.956; 0.9, 0.9)	(0.5, 0.7, 0.7, 0.9; 1, 1), (0.6, 0.7, 0.7, 0.8; 0.9, 0.9)
A_{12}	(0.322, 0.522, 0.522, 0.722; 1, 1), (0.422, 0.522, 0.522, 0.622; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0.044, 0.044, 0.189; 1, 1), (0.022, 0.044, 0.044, 0.167; 0.9, 0.9)
A_{13}	(0.9, 1, 1, 1; 1, 1), (0.95, 1, 1, 1; 1, 1)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.0, 0.9)
A_{14}	(0, 0, 0, 0; 1, 1), (0, 0, 0, 0; 0.9, 0.9)	(0.011, 0.033, 0.033, 0.144; 1, 1), (0.022, 0.033, 0.033, 0.089; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{21}	(0.011, 0.067, 0.067, 0.211; 1, 1), (0.039, 0.067, 0.067, 0.139; 0.9, 0.9)	(0, 0, 0, 0; 1, 1), (0, 0, 0, 0; 0.9, 0.9)	(0, 0.044, 0.044, 0.189; 1, 1), (0.022, 0.044, 0.044, 0.117; 0.9, 0.10)
A_{22}	(0.111, 0.122, 0.122, 0.322; 1, 1), (0.067, 0.122, 0.122, 0.222; 0.9, 0.9)	(0.7, 0.9, 0.9, 1; 1, 1), (0.8, 0.9, 0.9, 0.95; 0.9, 0.9)	(0, 0, 0, 0; 1, 1), (0, 0, 0, 0; 0.9, 0.9)
A_{23}	(0.722, 0.911, 0.911, 1; 1, 1), (0.817, 0.911, 0.911, 0.956; 0.9, 0.9)	(0.011, 0.067, 0.067, 0.211; 1, 1), (0.039, 0.067, 0.067, 0.139; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{24}	(0.322, 0.522, 0.522, 0.722; 1, 1), (0.422, 0.522, 0.522, 0.622; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0.7, 0.9, 0.9, 1; 1, 1), (0.8, 0.9, 0.9, 0.95; 0.9, 0.9)
A_{25}	(0.789, 0.944, 0.944, 1; 1, 1), (0.867, 0.944, 0.944, 0.972; 0.9, 0.9)	(0.722, 0.911, 0.911, 1; 1, 1), (0.817, 0.911, 0.911, 0.956; 0.9, 0.9)	(0.322, 0.522, 0.522, 0.722; 1, 1), (0.422, 0.522, 0.522, 0.622; 0.9, 0.9)
A_{31}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0.611, 0.8, 0.8, 0.944; 1, 1), (0.706, 0.8, 0.8, 0.872; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{32}	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{33}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0.411, 0.611, 0.611, 0.8; 1, 1), (0.511, 0.611, 0.611, 0.706, 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{34}	(0.611, 0.8, 0.8, 0.944; 1, 1), (0.706, 0.8, 0.8, 0.872; 0.9, 0.9)	(0.722, 0.911, 0.911, 1; 1, 1), (0.817, 0.911, 0.911, 0.956; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
	A_{23}	A_{24}	A_{25}
A_{11}	(0.789, 0.944, 0.944, 1; 1, 1), (0.867, 0.944, 0.944, 0.972; 0.9, 0.9)	(0.722, 0.911, 0.911, 1; 1, 1), (0.817, 0.911, 0.911, 0.956; 0.9, 0.9)	(0.5, 0.7, 0.7, 0.9; 1, 1), (0.6, 0.7, 0.7, 0.8; 0.9, 0.9)
A_{12}	(0.322, 0.522, 0.522, 0.722; 1, 1), (0.422, 0.522, 0.522, 0.622; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0.044, 0.044, 0.189; 1, 1), (0.022, 0.044, 0.044, 0.167; 0.9, 0.9)
A_{13}	(0.9, 1, 1, 1; 1, 1), (0.95, 1, 1, 1; 1, 1)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.0, 0.9)
A_{14}	(0, 0, 0, 0; 1, 1), (0, 0, 0, 0; 0.9, 0.9)	(0.011, 0.033, 0.033, 0.144; 1, 1), (0.022, 0.033, 0.033, 0.089; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{21}	(0.011, 0.067, 0.067, 0.211; 1, 1), (0.039, 0.067, 0.067, 0.139; 0.9, 0.9)	(0, 0, 0, 0; 1, 1), (0, 0, 0, 0; 0.9, 0.9)	(0, 0.044, 0.044, 0.189; 1, 1), (0.022, 0.044, 0.044, 0.117; 0.9, 0.10)
A_{22}	(0.111, 0.122, 0.122, 0.322; 1, 1), (0.067, 0.122, 0.122, 0.222; 0.9, 0.9)	(0.7, 0.9, 0.9, 1; 1, 1), (0.8, 0.9, 0.9, 0.95; 0.9, 0.9)	(0, 0, 0, 0; 1, 1), (0, 0, 0, 0; 0.9, 0.9)
A_{23}	(0.722, 0.911, 0.911, 1; 1, 1), (0.817, 0.911, 0.911, 0.956; 0.9, 0.9)	(0.011, 0.067, 0.067, 0.211; 1, 1), (0.039, 0.067, 0.067, 0.139; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{24}	(0.322, 0.522, 0.522, 0.722; 1, 1), (0.422, 0.522, 0.522, 0.622; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0.7, 0.9, 0.9, 1; 1, 1), (0.8, 0.9, 0.9, 0.95; 0.9, 0.9)
A_{25}	(0.789, 0.944, 0.944, 1; 1, 1), (0.867, 0.944, 0.944, 0.972; 0.9, 0.9)	(0.722, 0.911, 0.911, 1; 1, 1), (0.817, 0.911, 0.911, 0.956; 0.9, 0.9)	(0.322, 0.522, 0.522, 0.722; 1, 1), (0.422, 0.522, 0.522, 0.622; 0.9, 0.9)
A_{31}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0.611, 0.8, 0.8, 0.944; 1, 1), (0.706, 0.8, 0.8, 0.872; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{32}	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{33}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0.411, 0.611, 0.611, 0.8; 1, 1), (0.511, 0.611, 0.611, 0.706, 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{34}	(0.611, 0.8, 0.8, 0.944; 1, 1), (0.706, 0.8, 0.8, 0.872; 0.9, 0.9)	(0.722, 0.911, 0.911, 1; 1, 1), (0.817, 0.911, 0.911, 0.956; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)

Table A6. *Cont.*

	A_{31}	A_{32}
A_{11}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{12}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)
A_{13}	(0.133, 0.278, 0.278, 0.478; 1, 1), (0.206, 0.278, 0.278, 0.378; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{14}	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)
A_{21}	(0.678, 0.833, 0.833, 0.944; 1, 1), (0.756, 0.833, 0.833, 0.889; 0.9, 0.9)	(0.133, 0.278, 0.278, 0.478; 1, 1), (0.206, 0.278, 0.278, 0.378; 0.9, 0.9)
A_{22}	(0.011, 0.033, 0.033, 0.144; 1, 1), (0.022, 0.033, 0.033, 0.089; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{23}	(0.067, 0.211, 0.211, 0.411; 1, 1), (0.139, 0.211, 0.211, 0.311; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{24}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{25}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)
A_{31}	(0, 0, 0, 0; 1, 1), (0, 0, 0, 0; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{32}	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)	(0, 0, 0, 0; 1, 1), (0, 0, 0, 0; 0.9, 0.9)
A_{33}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0.189, 0.389, 0.389, 0.589; 1, 1), (0.289, 0.389, 0.389, 0.489; 0.9, 0.9)
A_{34}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0.044, 0.044, 0.189; 1, 1), (0.022, 0.044, 0.044, 0.117; 0.9, 0.9)

	A_{33}	A_{34}
A_{11}	(0, 0.044, 0.044, 0.189; 1, 1), (0.022, 0.044, 0.044, 0.117; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{12}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{13}	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)
A_{14}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{21}	(0.411, 0.611, 0.611, 0.8; 1, 1), (0.511, 0.611, 0.611, 0.706, 0.9, 0.9)	(0.478, 0.678, 0.678, 0.833; 1, 1); (0.578, 0.678, 0.678, 0.756; 0.9, 0.9)
A_{22}	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{23}	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{24}	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)
A_{25}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)
A_{31}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0.044, 0.044, 0.189; 1, 1), (0.022, 0.044, 0.044, 0.117; 0.9, 0.9)
A_{32}	(0, 0, 0, 0.1; 1, 1), (0, 0, 0, 0.05; 0.9, 0.9)	(0, 0.011, 0.011, 0.122; 1, 1), (0.006, 0.011, 0.011, 0.067; 0.9, 0.9)
A_{33}	(0, 0, 0, 0; 1, 1), (0, 0, 0, 0; 0.9, 0.9)	(0.189, 0.389, 0.389, 0.589; 1, 1), (0.289, 0.389, 0.389, 0.489; 0.9, 0.9)
A_{34}	(0.067, 0.156, 0.156, 0.3; 1, 1), (0.111, 0.156, 0.156, 0.228; 0.9, 0.9)	(0, 0, 0, 0; 1, 1), (0, 0, 0, 0; 0.9, 0.9)

Table A7. The total-relation matrix. (Based on the assessment results of three experts).

	A_{11}	A_{12}	A_{13}	A_{14}	A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	A_{31}	A_{32}	A_{33}	A_{34}
A_{11}	0.054	0.154	0.210	0.198	0.152	0.126	0.145	0.125	0.106	0.031	0.012	0.020	0.019
A_{12}	0.010	0.011	0.098	0.084	0.010	0.013	0.011	0.014	0.024	0.008	0.004	0.005	0.004
A_{13}	0.009	0.020	0.018	0.130	0.011	0.008	0.008	0.008	0.013	0.038	0.004	0.005	0.006
A_{14}	0.011	0.020	0.088	0.020	0.014	0.009	0.012	0.023	0.027	0.009	0.005	0.004	0.004
A_{21}	0.173	0.209	0.213	0.128	0.083	0.125	0.179	0.141	0.145	0.125	0.048	0.089	0.099
A_{22}	0.079	0.108	0.073	0.062	0.131	0.024	0.096	0.034	0.031	0.025	0.009	0.016	0.016
A_{23}	0.094	0.138	0.128	0.153	0.032	0.019	0.019	0.020	0.024	0.030	0.006	0.008	0.007
A_{24}	0.122	0.171	0.172	0.146	0.052	0.138	0.133	0.032	0.124	0.019	0.008	0.011	0.010
A_{25}	0.077	0.191	0.184	0.193	0.145	0.101	0.157	0.114	0.042	0.029	0.013	0.017	0.020
A_{31}	0.036	0.088	0.058	0.040	0.121	0.025	0.037	0.029	0.097	0.016	0.009	0.013	0.020
A_{32}	0.020	0.034	0.023	0.020	0.014	0.010	0.015	0.011	0.054	0.007	0.001	0.004	0.006
A_{33}	0.048	0.039	0.064	0.033	0.095	0.019	0.026	0.020	0.026	0.016	0.053	0.009	0.058
A_{34}	0.084	0.091	0.178	0.161	0.146	0.035	0.049	0.040	0.121	0.026	0.017	0.034	0.016

Table A8. The total-relation matrix. (Based on the assessment results of five experts).

	A_{11}	A_{12}	A_{13}	A_{14}	A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	A_{31}	A_{32}	A_{33}	A_{34}
A_{11}	0.065	0.185	0.203	0.220	0.124	0.268	0.159	0.165	0.064	0.011	0.011	0.035	0.019
A_{12}	0.006	0.018	0.074	0.091	0.017	0.014	0.010	0.010	0.036	0.006	0.003	0.005	0.004
A_{13}	0.008	0.015	0.019	0.128	0.012	0.002	0.008	0.009	0.012	0.036	0.003	0.005	0.005
A_{14}	0.010	0.015	0.099	0.020	0.013	0.007	0.013	0.022	0.026	0.008	0.005	0.004	0.004
A_{21}	0.185	0.218	0.225	0.137	0.093	0.074	0.187	0.155	0.151	0.103	0.045	0.085	0.089
A_{22}	0.066	0.094	0.068	0.083	0.147	0.017	0.084	0.033	0.029	0.023	0.008	0.013	0.013
A_{23}	0.089	0.129	0.128	0.135	0.042	0.012	0.020	0.023	0.027	0.029	0.005	0.009	0.006
A_{24}	0.144	0.182	0.184	0.153	0.059	0.082	0.129	0.032	0.137	0.019	0.008	0.011	0.010
A_{25}	0.077	0.179	0.185	0.206	0.157	0.071	0.154	0.122	0.040	0.024	0.012	0.018	0.019
A_{31}	0.040	0.073	0.058	0.033	0.118	0.031	0.035	0.021	0.070	0.015	0.007	0.014	0.019
A_{32}	0.014	0.038	0.028	0.013	0.015	0.008	0.015	0.008	0.064	0.007	0.001	0.005	0.005
A_{33}	0.030	0.027	0.070	0.033	0.086	0.013	0.025	0.017	0.021	0.015	0.048	0.007	0.056
A_{34}	0.072	0.082	0.182	0.188	0.125	0.020	0.051	0.033	0.105	0.023	0.015	0.030	0.015

References

1. State Post Bureau of The People's Republic of China. National Postal Administration Announces Postal Industry Operations for 2023. 2024. Available online: https://www.spb.gov.cn/gjyzj/c100015/c100016/202401/59eeb6e8b0e7404f8127aa2c7aebded6.shtml (accessed on 22 January 2024).
2. Li, P.; Ru, Y.; Wu, J. Influential Factors Affecting Recycling Behavior toward Cardboard Boxes in the Logistics Sector: An Empirical Analysis from China. *Sustainability* **2023**, *15*, 13343. [CrossRef]
3. Ketkale, H.; Simske, S. A LifeCycle Analysis and Economic Cost Analysis of Corrugated Cardboard Box Reuse and Recycling in the United States. *Resources* **2023**, *12*, 22. [CrossRef]
4. Wandosell, G.; Parra-Meroño, M.C.; Alcayde, A.; Baños, R. Green Packaging from Consumer and Business Perspectives. *Sustainability* **2021**, *13*, 1356. [CrossRef]
5. Nazeer, M.; Tabassum, U.; Alam, S. Environmental pollution and sustainable development in developing countries. *Pak. Dev. Rev.* **2016**, *55*, 589–604. [CrossRef]
6. Nahar, N.; Mahiuddin, S.; Hossain, Z. The severity of environmental pollution in the developing countries and its remedial measures. *Earth* **2021**, *2*, 124–139. [CrossRef]
7. Du, K.; Cheng, Y.; Yao, X. Environmental regulation, green technology innovation, and industrial structure upgrading: The road to the green transformation of Chinese cities. *Energy Econ.* **2021**, *98*, 105247. [CrossRef]
8. Mao, W.; Wang, W.; Sun, H. Driving patterns of industrial green transformation: A multiple regions case learning from China. *Sci. Total Environ.* **2019**, *697*, 134134. [CrossRef]
9. Zhai, X.; An, Y. Analyzing influencing factors of green transformation in China's manufacturing industry under environmental regulation: A structural equation model. *J. Clean. Prod.* **2020**, *251*, 119760. [CrossRef]
10. Shen, C.; Li, S.; Wang, X.; Liao, Z. The effect of environmental policy tools on regional green innovation: Evidence from China. *J. Clean. Prod.* **2020**, *254*, 120122. [CrossRef]
11. Blind, K.; Gauch, S. Research and Standardisation in Nanotechnology: Evidence from Germany. *J. Technol. Transf.* **2009**, *34*, 320–342. [CrossRef]

12. Jiang, Z.; Wang, Z.; Zeng, Y. Can voluntary environmental regulation promote corporate technological innovation? *Bus. Strategy Environ.* **2020**, *29*, 390–406. [CrossRef]
13. *ISO 14001:2015*; Environmental Management Systems—Requirements with Guidance for Use. ISO: Geneva, Switzerland, 2015.
14. El-Berishy, N.; Rügge, I.; Scholz-Reiter, B. The interrelation between sustainability and green logistics. *IFAC Proc. Vol.* **2013**, *46*, 527–531. [CrossRef]
15. Tamulis, V.; Guzaviius, A.; Algiryt, L. Factors Influencing the Use of Green Logistics: Theoretical Implications. *Econ. Manag.* **2012**, *17*, 706–711. [CrossRef]
16. Su, Y.; Duan, H.; Wang, Z.; Song, G.; Kang, P.; Chen, D. Characterizing the environmental impact of packaging materials for express delivery via life cycle assessment. *J. Clean. Prod.* **2020**, *274*, 122961. [CrossRef]
17. Bao, X. Management Optimization on Used Express Packages—From the Perspective of Energy and Emission Reduction. In Proceedings of the 2014 International Conference on Management Science and Management Innovation (MSMI 2014), Changsha, China, 14–15 June 2014; Atlantis Press: Beijing, China, 2014; pp. 518–521.
18. Song, Z.; Xiu, F.R.; Qi, Y. Degradation and partial oxidation of waste plastic express packaging bags in supercritical water: Resources transformation and pollutants removal. *J. Hazard. Mater.* **2022**, *423*, 127018. [CrossRef]
19. Li, J.; Xu, Y.; Jiao, J.; Yang, R.; Zha, J. Do recycling channels affect young consumers' choices for formal power battery recycling? *J. Clean. Prod.* **2023**, *425*, 138766. [CrossRef]
20. Zhang, G.; Gu, N.; Lv, X.; Wang, X. The study of operation mode of green logistics. In Proceedings of the 2010 Second International Conference on Intelligent Human-Machine Systems and Cybernetics, Nanjing, China, 26–28 August 2010; IEEE: New York, NY, USA, 2010; Volume 1, pp. 65–68.
21. Armacost, A.P.; Ware, B. Composite Variable Formulations for Express Shipment Service Network Design. *Transp. Sci.* **2002**, *36*, 1–20. [CrossRef]
22. Martin, F.; Hemmelmayr, V.C.; Wakolbinger, T. Integrated express shipment service network design with customer choice and endogenous delivery time restrictions. *Eur. J. Oper. Res.* **2021**, *294*, 590–603. [CrossRef]
23. Xu, C.; Wu, Y.; Dai, S. What are the critical barriers to the development of hydrogen refueling stations in China? A modified fuzzy DEMATEL approach. *Energy Policy* **2020**, *142*, 111495. [CrossRef]
24. Venkatesh, V.G.; Zhang, A.; Luthra, S.; Dubey, R.; Subramanian, N.; Mangla, S. Barriers to coastal shipping development: An Indian perspective. *Transp. Res. Part D Transp. Environ.* **2017**, *52*, 362–378. [CrossRef]
25. Wei, D.; Liu, H.; Shi, K. What are the key barriers for the further development of shale gas in China? A grey-DEMATEL approach. *Energy Rep.* **2019**, *5*, 298–304. [CrossRef]
26. Wu, Y.; Hu, Y.; Lin, X.; Li, L.; Ke, Y. Identifying and analyzing barriers to offshore wind power development in China using the grey decision-making trial and evaluation laboratory approach. *J. Clean. Prod.* **2018**, *189*, 853–863. [CrossRef]
27. Mendel, J.M.; Rajati, M.R.; Sussner, P. On clarifying some definitions and notations used for type-2 fuzzy sets as well as some recommended changes. *Inf. Sci.* **2016**, *340–341*, 337–345. [CrossRef]
28. Wang, T.; Li, H.; Qian, Y.; Huang, B.; Zhou, X. A Regret-Based Three-Way Decision Model Under Interval Type-2 Fuzzy Environment. *IEEE Trans. Fuzzy Syst.* **2022**, *30*, 175–189. [CrossRef]
29. Deveci, M.; Simic, V.; Karagoz, S.; Antucheviciene, J. An Interval Type-2 Fuzzy Sets Based Delphi Approach to Evaluate Site Selection Indicators of Sustainable Vehicle Shredding Facilities. *Appl. Soft Comput.* **2022**, *118*, 108465. [CrossRef]
30. Mendel, J.M. Advances in type-2 fuzzy sets and systems. *Inf. Sci.* **2007**, *177*, 84–110. [CrossRef]
31. Hong, Y.; Pasman, H.J.; Quddus, N.; Mannan, M.S. Supporting risk management decision making by converting linguistic graded qualitative risk matrices through interval type-2 fuzzy sets. *Process Saf. Environ. Prot.* **2020**, *134*, 308–322. [CrossRef]
32. Sayyadi Tooranloo, H.; Azadi, M.H.; Sayyahpoor, A. Analyzing factors affecting implementation success of sustainable human resource management (SHRM) using a hybrid approach of FAHP and Type-2 fuzzy DEMATEL. *J. Clean. Prod.* **2017**, *162*, 1252–1265. [CrossRef]
33. da Cruz, N.F.; Simões, P.; Marques, R.C. Economic Cost Recovery in the Recycling of Packaging Waste: The Case of Portugal. *J. Clean. Prod.* **2012**, *37*, 8–18. [CrossRef]
34. Torra, V. Hesitant Fuzzy Sets. *Int. J. Intell. Syst.* **2010**, *25*, 529–539. [CrossRef]
35. Liu, C.; Huo, L. Problems and Solutions for Express Logistic Packaging. In *Advanced Graphic Communications and Media Technologies*; Springer: Singapore, 2017; pp. 705–710.
36. Jiang, R. Cost-Benefit Analysis of Rural Express Delivery in County D by SF Express. Master's Thesis, Shandong University, Jinan, China, 2023.
37. Lyu, R.; Zhang, C.; Li, Z. Optimal strategies of green express packaging recycling and sales mode in an online platform. *J. Clean. Prod.* **2023**, *390*, 136090. [CrossRef]
38. Da Cruz, N.F.; Simões, P.; Marques, R.C. Costs and benefits of packaging waste recycling systems. *Resour. Conserv. Recycl.* **2014**, *85*, 1–4. [CrossRef]
39. Pham-Thuy, A.; Le-Anh, T. Green Logistics Practice in Vietnam. In Proceedings of the 2023 Asia Meeting on Environment and Electrical Engineering (EEE-AM), Hanoi, Vietnam, 13–15 November 2023; IEEE: New York, NY, USA, 2023; pp. 1–6.
40. Rose, L.A.; Chew, B.C.; Hamid MS RB, A. Green logistics implementation in Malaysian logistics industry. *Adv. Sci. Lett.* **2018**, *24*, 4214–4217. [CrossRef]

41. Debnath, P.; Dinda, S. Risk–return spectrum of investment for going green: Evidence from Indian equity market. *Bus. Strategy Dev.* **2023**, *6*, 817–827. [CrossRef]
42. Li, Y.; Cao, J.; Xiong, D.; Xu, X.; Cai, Y.; Li, M. Analysis of Multinational Courier Company's Expansion in China Market—Base on Multi-player Oligopoly Model. In *Information and Business Intelligence: Proceedings of the International Conference, IBI 2011, Chongqing, China, 23–25 December 2011*; Proceedings, Part II; Springer: Berlin/Heidelberg, Germany, 2011; pp. 423–429.
43. Peng, W.; Xiong, L. Managing financing costs and fostering green transition: The role of green financial policy in China. *Econ. Anal. Policy* **2022**, *76*, 820–836. [CrossRef]
44. Liu, C.; Yang, Y.; Chen, S. How does transition finance influence green innovation of high-polluting and high-energy-consuming enterprises? Evidence from China. *Environ. Sci. Pollut. Res.* **2024**, *31*, 8026–8045. [CrossRef] [PubMed]
45. Zhang, X.; Li, Y.; Shi, K.; Feng, Y. How Do Environmental Technology Standards Affect the Green Transformation? New Evidence from China. *Int. J. Environ. Res. Public Health* **2022**, *19*, 5883. [CrossRef]
46. Kao, C.-K.; Sun, M.; Tang, Z.-B.; Luo, Y.-P.; Zeng, F. Green Manufacturing Strategy of E-Commerce Express Packaging in China. *Int. Technol. Innov. Manag. Rev.* **2020**, *9*, 11–26. [CrossRef]
47. Villena, V.H.; Gioia, D.A. A more sustainable supply chain. *Harv. Bus. Rev.* **2020**, *98*, 84–93.
48. Yunlin, C. Awareness of green logistics technology, certification, and standards by logistics practitioners at Chinese e-commerce company, Jing Dong. *Asian J. Shipp. Logist.* **2023**, *39*, 37–46. [CrossRef]
49. Liu, Y.; Wang, S.H. The Research of the Green Buffer Packaging Materials for the Small Pieces of Express Items. *Appl. Mech. Mater.* **2013**, *275*, 2346–2349. [CrossRef]
50. Wang, Z.; Li, M.; Qian, Y. A Study on the Talent Development Model for Low-Carbon Logistics in Response to Cross-border E-commerce Supply Chains. *J. Hum. Resour. Dev.* **2023**, *5*, 26–34.
51. Qu, Q.; Wang, W.; Tang, M.; Lu, Y.; Tsai, S.-B.; Wang, J.; Li, G.; Yu, C.-L. A performance evaluation study of human resources in low-carbon logistics enterprises. *Sustainability* **2017**, *9*, 632. [CrossRef]
52. Sun, H.; Li, J. Behavioural choice of governments, enterprises and consumers on recyclable green logistics packaging. *Sustain. Prod. Consum.* **2021**, *28*, 459–471. [CrossRef]
53. Li, H.; Wang, B. Green packaging materials design and efficient packaging with Internet of Things. *Sustain. Energy Technol. Assess.* **2023**, *58*, 103186. [CrossRef]
54. Zhou, F.F. The theory of green packaging design and its application. *Appl. Mech. Mater.* **2014**, *635*, 248–252. [CrossRef]
55. Nguyen, C.D.T.; Luong, B.T.; Hoang, H.L.T. The impact of logistics and infrastructure on economic growth: Empirical evidence from Vietnam. *J. Asian Financ. Econ. Bus.* **2021**, *8*, 21–28.
56. Harris, I.; Naim, M.; Mumford, C. *A Review of Infrastructure Modelling for Green Logistics*; Cardiff University: Cardiff, UK, 2007.
57. Jun, K.; Xinyu, L. The Researches on Optimization Strategies of Recycling and Reusing Path of Express Packaging. *Logist. Res.* **2024**, 1–13. Available online: http://kns.cnki.net/kcms/detail/10.1700.F2.20240412.1358.002.html (accessed on 3 May 2024).
58. Wu, S.; Gong, X.; Wang, Y.; Cao, J. Consumer cognition and management perspective on express packaging pollution. *Int. J. Environ. Res. Public Health* **2022**, *19*, 4895. [CrossRef]
59. Huang, H.; Long, R.; Chen, H.; Sun, K.; Sun, Q.; Li, Q. Why don't more people engage in green practices in China? A policy-oriented approach to promoting green transformation in five consumption areas. *Environ. Impact Assess. Rev.* **2023**, *101*, 107099. [CrossRef]
60. Guo, Y.; Yuan, Y. Assessing the energy resources policy agenda: Evidence from China's green express policy. *Resour. Policy* **2022**, *79*, 103037. [CrossRef]
61. Acevedo Rueda, R.A.; Vásquez Stanescu, C.L.; Torres, E. Complex thinking principles in sustainable energy policy-making. *Suma Neg.* **2020**, *11*, 73–83. [CrossRef]
62. World Bank. World Bank: Developing Sustainable Rooftop PV in Vietnam HCMC and Danang. 2019. Available online: https://documents.worldbank.org (accessed on 21 October 2020).
63. Zhang, M.; Yang, L.; Deng, P. Sustainable development mode of express packaging based on green concept. In *Applied Sciences in Graphic Communication and Packaging: Proceedings of 2017 49th Conference of the International Circle of Educational Institutes for Graphic Arts Technology and Management & 8th China Academic Conference on Printing and Packaging, Xi'an, China, 14–17 November 2018*; Springer: Singapore, 2018; pp. 451–458.
64. Benkhodja, M.T.; Fromentin, V.; Ma, X. Macroeconomic effects of green subsidies. *J. Clean. Prod.* **2023**, *410*, 137166. [CrossRef]
65. Zhang, S.; Wu, Z.; Dou, W.; Wang, Y. Do government subsidies promote enterprise green innovation? Evidence from listed companies in China. *Appl. Econ.* **2024**, 1–21. [CrossRef]
66. Dinçer, H.; Yüksel, S.; Martínez, L. Interval type 2-based hybrid fuzzy evaluation of financial services in E7 economies with DEMATEL-ANP and MOORA methods. *Appl. Soft Comput. J.* **2019**, *79*, 186–202. [CrossRef]
67. Mendel, J.M.; John, R.I.; Liu, F. Interval Type-2 Fuzzy Logic Systems Made Simple. *IEEE Trans. Fuzzy Syst.* **2006**, *14*, 808–821.
68. Chen, S.-M.; Lee, L.-W. Fuzzy Multiple Attributes Group Decision-Making Based on the Ranking Values and the Arithmetic Operations of Interval Type-2 Fuzzy Sets. *Expert Syst. Appl.* **2010**, *37*, 824–833.
69. Mousakhani, S.; Nazari-Shirkouhi, S.; Bozorgi-Amiri, A. A novel interval type-2 fuzzy evaluation model based group decision analysis for green supplier selection problems: A case study of battery industry. *J. Clean. Prod.* **2017**, *168*, 205–218. [CrossRef]
70. Wang, B.; Zhang, C.; Li, D.; Ma, J.; Wang, Y. Energy Consumption Decision-Making in the Steel Industry Based on Interval Type-2 Fuzzy Multi-Granularity Evidence Fusion Method. *J. Nanjing Univ. Nat. Sci.* **2023**, *59*, 600–609.

71. Qi, R.; Li, S.; Qu, L.; Sun, L.; Gong, C. Critical factors to green mining construction in China: A two-step fuzzy DEMATEL analysis of state-owned coal mining enterprises. *J. Clean. Prod.* **2020**, *273*, 122852. [CrossRef]
72. Quiñones, R.S.; Caladcad, J.A.A.; Himang, C.M.; Quiñones, H.G.; Castro, C.J.; Caballes, S.A.A.; Abellana, D.P.M.; Jabilles, E.M.Y.; Ocampo, L.A. Using Delphi and fuzzy DEMATEL for analyzing the intertwined relationships of the barriers of university technology transfer: Evidence from a developing economy. *Int. J. Innov. Stud.* **2020**, *4*, 85–104. [CrossRef]
73. Shao, J.; Taisch, M.; Ortega-Mier, M. A grey-DEcision-MAking Trial and Evaluation Laboratory (DEMATEL) analysis on the barriers between environmentally friendly products and consumers: Practitioners' viewpoints on the European automobile industry. *J. Clean. Prod.* **2016**, *112*, 3185–3194. [CrossRef]
74. Zadeh, L.A. Fuzzy Sets. *Inf. Control.* **1965**, *8*, 338–353. [CrossRef]
75. Zadeh, L.A. The Concept of a Linguistic Variable and Its Application to Approximate Reasoning—I. *Inf. Sci.* **1975**, *8*, 199–249. [CrossRef]
76. Kiracı, K.; Akan, E. Aircraft selection by applying AHP and TOPSIS in interval type-2 fuzzy sets. *J. Air Transp. Manag.* **2020**, *89*, 101924. [CrossRef] [PubMed]
77. Keshavarz Ghorabaee, M.; Zavadskas, E.K.; Amiri, M.; Esmaeili, A. Multi-criteria evaluation of green suppliers using an extended WASPAS method with interval type-2 fuzzy sets. *J. Clean. Prod.* **2016**, *137*, 213–229. [CrossRef]
78. Yager, R.R. On Ordered Weighted Averaging Aggregation Operators in Multicriteria Decisionmaking. *IEEE Trans. Syst. Man Cybern.* **1988**, *18*, 183–190. [CrossRef]
79. Zarghami, M.; Szidarovszky, F. Revising the OWA operator for multi criteria decision making problems under uncertainty. *Eur. J. Oper. Res.* **2009**, *198*, 259–265. [CrossRef]
80. Peláez, J.I.; Doña, J.M.; Gómez-Ruiz, J.A. Analysis of OWA operators in decision making for modelling the majority concept. *Appl. Math. Comput.* **2007**, *186*, 1263–1275. [CrossRef]