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Understanding Employee Environmental Performance in China's Logistics Industry: The Role of Environmental Knowledge, Attitude, Practice, and Pro-Environmental Behaviour

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Abstract. Global carbon emissions drive climate change, causing extreme weather and social problems. The logistics industry is a key part of the modern service sector. Its rapid growth has also raised carbon emissions. Previous logistics sustainability studies have predominantly focused on operational optimisation, green technologies, and supply-chain systems, while employee-level behavioural mechanisms remain underexplored (Centobelli et al., 2017). They pay little attention to employees' behaviours. This study investigates logistics employees in Shandong Province, China. It uses structural equation modelling to examine how environmental knowledge, attitudes, and job-related practices affect environmental performance. It also tests the mediating role of pro-environmental behaviour. Data were collected through a questionnaire and analysed with SPSS and AMOS. The results show that employee environmental knowledge and attitudes, both directly and indirectly, improve environmental performance by encouraging pro-environmental behaviour. Although job-mandated environmental practices can directly enhance environmental performance, they do not necessarily translate into proactive employee behaviours. The study shows that improving employees' knowledge, attitudes, practices, and pro-environmental behaviour can boost low-carbon performance. It provides evidence to support green transformation and low-carbon management in logistics companies.

Keywords: Employee Environmental Performance; Employee Environmental Knowledge; Employee Environmental Attitude; Employee Environmental Practice; Pro-environmental Behaviour; logistics service; Carbon Reduction

1. Introduction

In recent years, global ecological and environmental problems have become increasingly severe, and climate change has emerged as a major challenge facing human society. Carbon emissions are considered a key driver of climate change, placing urgent demands on enterprises to achieve sustainable development and low-carbon transformation (Lee, 2012). According to the International Energy Agency (IEA, 2024), global energy-related CO_2 emissions reached 37.4 billion tonnes in 2023, with China accounting for approximately 34%, ranking first for several consecutive years. Under the national carbon peaking and carbon neutrality strategies, Chinese industries are accelerating their transition to green, low-carbon development.

As a critical component of modern logistics, the logistics industry has rapidly expanded alongside e-commerce's growth. While supporting economic development, it has also generated significant carbon emissions (Buldeo Rai et al., 2023). In Shandong Province, for example, logistics deliveries reached 9.52 billion items in 2024, a year-on-year increase of 24.74%, with total carbon emissions of approximately 3.2 million tons of CO_2 equivalent, representing an annual growth rate of 6.5%, higher than the national average. This indicates that, although the logistics industry contributes to economic growth, effective strategies are urgently needed to achieve carbon reduction and green transformation.

Although prior studies have examined enterprises' efforts in technological innovation (Li et al., 2021), green logistics (Tetteh et al., 2025), and operational optimisation (Li et al., 2025), the role of employees—who are key agents in implementing corporate strategies—has received limited attention. In particular, in labour-intensive logistics operations, the differences between formalised environmental practices and employees' voluntary pro-environmental behaviours, as well as their effects on organisational environmental performance at the micro level, remain largely unexplored. Recent evidence from JLISS suggests that green logistics practices significantly contribute to sustainability performance in logistics service systems. However, most existing studies focus on organisational capabilities and operational systems, while employee behavioural mechanisms remain insufficiently explored (Moh'd et al., 2026).

To address this gap, this study systematically investigates employees' carbon-reduction behaviours in the logistics industry in Shandong Province and their underlying mechanisms. Specifically, it examines three core employee variables—environmental knowledge, attitude, and practice—and evaluates their direct effects on environmental performance, while further analysing the mediating role of proactive pro-environmental behaviour. Using structural equation modelling (SEM), this study tests the relationships and path effects among these variables, providing empirical evidence on behaviour-driven sustainability at the micro level.

The main contributions of this study are threefold. Theoretically, it integrates the Knowledge-Attitude-Practice (KAP) model with the Theory of Planned Behaviour (TPB) in a labour-intensive logistics context, thereby extending the applicability of the KAP model to micro-level research on employees' low-carbon behaviours. In terms of behavioural insights, it highlights differences between formalised environmental practices and employees' proactive behaviours, offering an empirical understanding of the shift from compliance-driven to voluntary action. In practice, the study provides direct evidence of employee-level carbon reduction. It informs the design of training, incentive, and participation strategies, thereby facilitating the development of low-carbon behaviours among employees and supporting green transformation and regional sustainable development.

The remainder of this paper is organised as follows. Section 2 reviews relevant theories and concepts; Section 3 presents the theoretical framework, definitions, research hypotheses, and measurement methods; Section 4 describes data collection, sample characteristics, and SEM analyses, including measurement and structural models as well as the mediation effect of proactive pro-environmental behaviour; Section 5 discusses the theoretical and practical implications of the findings and proposes management strategies for employee low-carbon behaviour in logistics

enterprises; and Section 6 concludes the study, identifies limitations, and suggests directions for future research.

2. Literature Review

Recent research has demonstrated that logistics efficiency has become an important driver of sustainable economic growth and operational optimisation. The growing attention to sustainable logistics highlights the need to examine not only technological and system-level factors but also employee-level behavioural mechanisms that contribute to environmental sustainability (Centobelli et al., 2017). However, studies rarely examine employees at the micro level. Most research emphasises organisational investments in green technologies and the impact of policies or industry regulations. Limited attention has been given to employees, who are the main actors implementing carbon-reduction initiatives. This study uses the Knowledge–Attitude–Practice (KAP) model and the Theory of Planned Behaviour (TPB) to examine employees' environmental performance in the logistics industry. It explores the key factors that influence employee behaviour and aims to support low-carbon development in the sector.

2.1 KAP model

The Knowledge–Attitude–Practice (KAP) model explains behaviour as a process in which knowledge influences attitudes, and attitudes, in turn, shape practice (Launiala, 2009). It has been widely applied in environmental research, where knowledge is seen as the cognitive basis of pro-environmental action and attitudes as an important motivational mechanism (Kollmuss & Agyeman, 2002). However, the model's traditional linear logic is less applicable in organisational contexts, where formal rules and institutional arrangements often constrain behaviour.

This issue is particularly salient in logistics service companies, where many environmental activities are embedded in standard operating procedures and job requirements rather than left to individual discretion (Norton et al., 2015). Actions such as packaging reduction, recycling, and route optimisation are frequently performed as in-role duties (Ones & Dilchert, 2012). Accordingly, this study reconceptualises environmental knowledge, environmental attitude, and environmental practice as parallel antecedents of employee environmental performance. In this way, the KAP model provides the cognitive and institutional foundation for explaining how employee environmental performance is formed in a highly structured organisational setting.

2.2 The Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) explains behaviour through the combined effects of attitude, subjective norm, and perceived behavioural control (Beck & Ajzen, 1991). It has been widely used in environmental research to explain why individuals engage in pro-environmental actions under different social and situational conditions (Bamberg & Möser, 2007). In organisational settings, TPB is particularly useful for understanding voluntary environmental actions that extend beyond formal job requirements.

This perspective is relevant to the logistics industry, where organisational procedures prescribe many environmental activities, while additional pro-environmental actions remain discretionary. Employees are more likely to engage in such extra-role behaviour when they hold favourable evaluations of environmental action, perceive social support, and believe they are capable of acting (Greaves et al., 2013; Norton et al., 2015). Prior studies have also shown that organisational green practices and green psychological climate significantly encourage employees' voluntary workplace green behaviour (Dumont et al., 2017). Accordingly, this study uses TPB as a complementary behavioural perspective to explain the emergence of voluntary pro-environmental behaviour in a highly structured workplace context.

2.3 Integration of KAP and TPB

This study integrates the Knowledge–Attitude–Practice (KAP) model and the Theory of Planned Behaviour (TPB) to explain employee environmental performance in logistics service companies. KAP captures the cognitive and institutional foundations of environmental performance through environmental knowledge, attitudes, and in-role environmental practices. In contrast, TPB explains the emergence of voluntary pro-environmental behaviour beyond formal job requirements. In this way, pro-environmental behaviour serves as a behavioural pathway through which KAP-based antecedents contribute to employee environmental performance. This integrated framework provides a more contextually appropriate explanation of environmental performance in the highly structured logistics industry.

3. Materials and Methods

3.1. Hypotheses and Research Framework

Based on previous studies, the conceptual framework constructed in this study is as follows

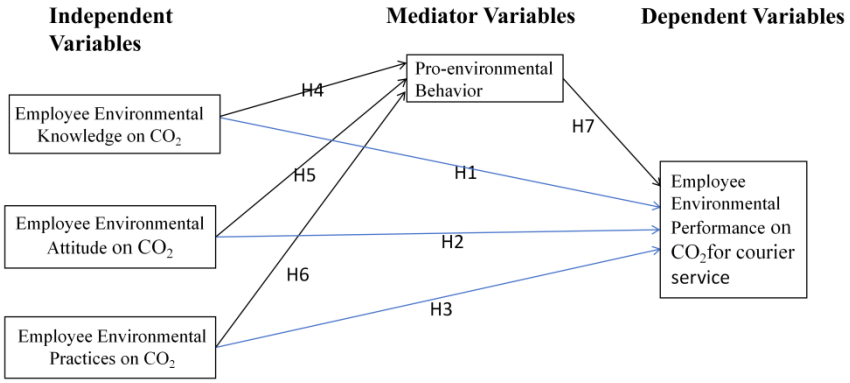

Fig.1: Conceptual Framework

Based on the conceptual framework presented above, the key constructs in this study are defined, and the corresponding hypotheses are developed as follows.

Employee Environmental Knowledge (EEK) includes both general and specific knowledge. General knowledge covers awareness of eco-friendly products, recycling, and carbon offset programs (Schahn & Holzer, 1990). Specific knowledge focuses on key sources of carbon emissions in the logistics industry. Some research reports that carbon emissions from logistics services primarily arise from fuel use, electricity, and packaging (Chen et al., 2024). In this study, EEK refers to knowledge of these three areas. Research shows that environmental knowledge helps reduce carbon footprints and supports sustainable development (Pham et al., 2020). Knowledge of green logistics also improves green logistics performance and supports sustainable practices (Van Vo & Nguyen, 2023).

Employee Environmental Attitude (EEA) reflects employees' evaluative judgments about operational stages. This study uses the Paradigms in Pollution Prevention framework to measure attitude (Jindal, 2017). It is often assessed by agreement with statements such as "I support establishing curbside recycling programs" (Eagly, 1993). Positive environmental attitudes can promote better environmental performance (Rubel et al., 2023).

Employees Environmental Practices (EEP) refer to the in-role low-carbon work behaviours undertaken by logistics employees within the framework of company regulations and operational guidelines; they are required, formal, compliance-based, and task-prescribed. These include eco-driving, proper waste management, and energy conservation practices. Such actions contribute to achieving greener and more sustainable operations (Janowski, 2021). Engaging employees in environmental practices helps organisations meet environmental goals, improve productivity, and

increase employee retention (Amrutha & Geetha, 2020).

Employee Environmental Performance (EEPE) is the extent to which employees contribute to environmental sustainability through skills, knowledge, and responsible practices (Widarko & Anwarodin, 2022). Green HR practices, such as green training, incentives, and leadership, can enhance employees' environmental performance (Aulia & Nawangsari, 2023). Recent studies further suggest that green organisational support and green work engagement can significantly strengthen employees' environmentally responsible behaviour and sustainability performance (Aboramadan, 2022). Psychological factors, such as green commitment, also influence work values and behavioural intentions, affecting environmental performance (Ahsan et al., 2024). Hypothesis 1 (H1) There is a significant impact of EEK on EEPE in mitigating carbon emissions among logistics service companies.

Hypothesis 2 (H2) There is a significant impact of EEA on EEPE in mitigating carbon emissions among logistics service companies.

Hypothesis 3 (H3) There is a significant impact of EEP on EEPE in mitigating carbon emissions among logistics service companies.

Pro-environmental Behaviour (PEB) refers to the extra-role, low-carbon behaviours voluntarily undertaken by logistics employees; they are discretionary, extra-role, and beyond formal requirements. These behaviours include actively participating in environmental initiatives and promoting environmentally friendly delivery options to customers (Jovanovic et al., 2024). Such discretionary and self-initiated environmental actions are considered to have a significant positive impact on long-term environmental performance (Boiral, 2009). Previous studies have suggested that organisational environmental support can encourage employees to engage in discretionary environmental citizenship behaviour beyond formal role requirements (Paillé et al., 2013). Studies also find a positive link between employees' green behaviour and environmental performance, suggesting that managers should promote these behaviours to achieve better environmental outcomes (Al-Swidi et al., 2021).

Hypothesis 4 (H4) There is a significant impact of EEK on PEB to mitigate carbon emission among logistics service companies.

Hypothesis 5 (H5) There is a significant impact of EEA on PEB in mitigating carbon emissions among logistics service companies.

Hypothesis 6 (H6) There is a significant impact of EEP on PEB in mitigating carbon emissions among logistics service companies.

Hypothesis 7 (H7) There is a significant impact of employee PEB towards EEPE on mitigating carbon emission among logistics service companies.

Based on research on the relationships among the variables above, this study assumes that EPB plays an intermediary role between the influencing factors and EEPE. Specifically, the following sub-assumptions apply.

Hypothesis 8a (H8a): PEB mediates the relationship between employees' environmental knowledge and EEPE in mitigating carbon emissions among logistics service companies.

Hypothesis 8b (H8b): PEB mediates the relationship between EEA and EEPE in mitigating carbon emissions among logistics service companies.

Hypothesis 8c (H8c) PEB mediates the relationship between EEP and EEPE in mitigating carbon emission among logistics service companies.

3.2. Methodology

This study adopts a quantitative research design to examine the factors influencing employees' environmental performance in the express delivery industry. Specifically, the study investigates the roles of environmental knowledge, environmental attitude, and environmental practice, and tests the mediating role of pro-environmental behaviour. The proposed hypotheses are tested using structural

equation modelling (SEM), which allows the simultaneous examination of multiple relationships among latent variables and the assessment of both direct and indirect effects. SEM is appropriate for this study because the conceptual model involves complex behavioural relationships between antecedents, mediating behaviour, and performance outcomes.

A multi-stage non-probability sampling approach was adopted. At the regional level, five representative cities in Shandong Province—Jinan, Qingdao, Weifang, Linyi, and Heze—were purposively selected to reflect variations in economic development and logistics market structures. At the organisational level, eight major express delivery companies were included: SF Express, JD Logistics, EMS, ZTO, YTO, STO, Yunda, and J&T Express. These companies hold substantial market shares and operate standardised management systems, which help improve the generalisability of the findings. At the individual level, respondents were recruited through company channels and industry networks using convenience and snowball sampling. Given the operational difficulty of accessing logistics employees, non-probability sampling was considered appropriate.

The questionnaire consisted of two sections. The first section collected demographic information, while the second measured the key constructs in the study. Measurement items were adapted from established scales for employee environmental knowledge (7 items), environmental attitude (6 items), environmental practice (8 items), pro-environmental behaviour (7 items), and employee environmental performance (6 items). All items were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). To ensure linguistic accuracy, the questionnaire was translated and back-translated by two bilingual researchers with management backgrounds, and discrepancies were resolved through discussion. Content validity was further assessed through expert review by two academic researchers and four industry practitioners.

Data were collected through an online questionnaire using the Questionnaire Star platform. The survey link was distributed to employees of the selected express delivery companies through company communication channels and industry networks. Participation was voluntary and anonymous, and all respondents provided informed consent before completing the questionnaire. A total of 1,128 questionnaires were distributed, of which 640 were returned, resulting in a response rate of 56.7%. Invalid responses were removed due to missing data, straight-line answering, and incomplete questionnaires.After data screening, 464 valid responses were retained for analysis. According to the sample size guideline proposed by Krejcie and Morgan (1970), a minimum of 384 responses is required for large populations. The final sample exceeds this threshold and is therefore adequate for SEM analysis. The demographic characteristics of the respondents are presented in Table 1.

Table 1: Demographic Characteristics of Respondents (N = 464)

Variable	Category	N	%
Gender	male	253	54.5%
	female	188	40.5%
	Prefer not to disclose	23	5.0%
Age	18-25years	211	45.5%
	26-35years	54	11.6%
	36-45years	55	11.9%
	46-55years	90	19.4%
	56 years and above	24	5.2%
	Prefer not to disclose	30	6.5%
Work Experience	One year or less	235	50.7%
	1-3 years (inclusive)	75	16.2%
	3 to 5 years (inclusive)	59	12.7%
	5 to 10 years (inclusive)	49	10.6%
	More than 10 years	46	9.9%
Educational Background	Primary school or below	40	8.6%
	Junior high school	44	9.5%
	High school / Secondary	58	12.5%

Variable	Category	N	%
	specialised school /Vocational high school		
	Associate degree	184	39.7%
	Bachelor's degree	92	19.8%
	Master's degree or above	46	9.9%

This study adapted and refined measurement instruments from multiple existing studies to ensure both validity and reliability. The final questionnaire was developed by integrating and revising items from previous research and surveys. The questionnaire was structured into two main sections: the first collected respondents' demographic information, while the second included measurement items corresponding to the constructs in the research model.

Following the procedure proposed by Armstrong and Overton (1977), the sample was divided into early- and late-response groups, and independent-samples t-tests were conducted to compare the key variables. The results indicated no significant differences between the two groups ($p > 0.05$), suggesting that non-response bias is unlikely to be a serious concern.

Given that all data were collected using a single questionnaire, Harman's single-factor test was employed to assess common method bias. The results showed that the first unrotated factor accounted for less than 50% of the total variance, indicating that common method bias does not pose a serious threat to the findings. Although Harman's single-factor test was conducted, future studies may adopt more rigorous approaches to further address common method variance.

4. Results

The study first used SPSS 26.0 to perform data cleaning, descriptive statistics, reliability analyses, and exploratory factor analysis to preliminarily assess the measurement instruments' reliability. Subsequently, AMOS 26.0 was used to conduct structural equation modelling (SEM) for both the measurement and structural models to test the research hypotheses.

4.1 Descriptive Statistics

When estimating descriptive statistics, the mean of each dimension should be considered. Accordingly, the means and standard deviations for the five dimensions of the research model are presented in Table 2. As a 5-point Likert subscale was used as the response format, the mean scores for each construct are expected to range from 1 to 5, with the neutral midpoint set at 3.

Overall, the sample exhibited slightly above-average performance across EEK, EEA, EEP, PEB, and EEPE, with EEPE scoring the highest (Mean = 3.38) and environmental practice scoring the lowest (Mean = 3.07, SD = 1.29), indicating substantial individual variation in this dimension. The skewness ($|Skew| < 0.5$) and kurtosis ($|Kurt| < 1.3$) of all constructs met normality criteria, suggesting that the data are suitable for subsequent structural equation modelling analysis.

Table 2: Descriptive Statistics of the construct

Numeric	Item	N	Min	Max	Mean	S.D.
1	EEK	464	1	5	3.3349	1.2542
2	EEA	464	1	5	3.2992	1.2239
3	EEP	464	1	5	3.0678	1.2921
4	PEB	464	1	5	3.2937	1.2534
5	EEPE	464	1	5	3.3681	1.2545

4.2 Measurement Model

The reliability of the measurement model was assessed by examining the factor loadings of individual items. An item is considered reliable if its factor loading is between 0.5 and 0.8 and significant at the 0.05 level (Cheung et al., 2024). Higher loadings indicate that the item more closely represents the

underlying construct, thereby improving measurement reliability.

Confirmatory factor analysis (CFA) was used to assess model fit. The chi-square to degrees of freedom ratio (χ^2/df) should be below 5.0. Goodness-of-fit indices, including GFI, CFI, AGFI, NFI, and TLI, should exceed 0.90. RMSEA and RMR values below 0.08 also indicate good fit (Byrne, 2016).

Internal consistency was measured using Cronbach's α (CA). Values above 0.7 are acceptable, with higher values indicating stronger consistency (Cronbach, 1971). Convergent validity was assessed using Average Variance Extracted (AVE). An AVE ≥ 0.5 indicates that the construct accounts for a substantial portion of the variance in its indicators (Fornell & Larcker, 1981). Composite reliability (CR) above 0.7 also indicates good internal consistency.

Discriminant validity checks whether constructs are distinct. According to the Fornell–Larcker criterion, the square root of each construct's AVE should be greater than its correlations with other constructs.

Table 3 shows the rotated factor loading matrix, which clearly reflects a five-factor structure. Standardised loadings for all 34 items range from 0.636 to 0.816, all above the 0.5 threshold, with no major cross-loadings. These results indicate high reliability of the measurement items.

Table 3: Rotated Component Matrix

Items	Component					Communalities
	1	2	3	4	5	
EEK1			0.745			0.581
EEK2			0.726			0.603
EEK3			0.735			0.630
EEK4			0.727			0.622
EEK5			0.696			0.606
EEK6			0.726			0.656
EEK7			0.726			0.647
EEA1					0.816	0.688
EEA2					0.699	0.622
EEA3					0.731	0.660
EEA4					0.737	0.631
EEA5					0.753	0.666
EEA6					0.713	0.627
EEP1	0.761					0.589
EEP2	0.735					0.563
EEP3	0.763					0.606
EEP4	0.766					0.604
EEP5	0.744					0.593
EEP6	0.738					0.561
EEP7	0.749					0.581
EEP8	0.753					0.587
PEB1		0.781				0.642
PEB2		0.756				0.680
PEB3		0.710				0.583
PEB4		0.745				0.644
PEB5		0.636				0.569
PEB6		0.722				0.622
PEB7		0.749				0.652
EEPE1				0.806		0.701
EEPE2				0.681		0.593
EEPE3				0.741		0.646
EEPE4				0.771		0.669
EEPE5				0.701		0.629
EEPE6				0.727		0.649

The overall reliability and validity of the questionnaire were evaluated, and Figure 2 shows that

all fit indices meet or approach the recommended thresholds in the literature. This indicates that the measurement model demonstrates good overall fit and is suitable for subsequent structural model analysis.

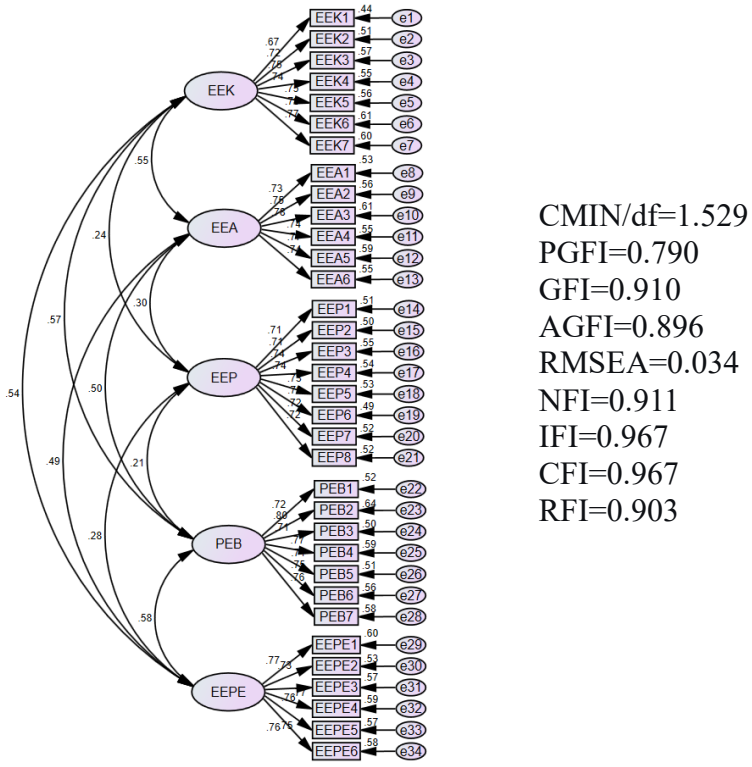

Fig.2: Confirmatory Factor Analysis (CFA) Model

The results presented in Table 4 indicate that the Cronbach's α values for all five dimensions exceed 0.80, demonstrating good internal consistency reliability of the scale items. The AVE values for all constructs exceed 0.50, indicating that the latent constructs account for more than half of the variance in their respective indicators, confirming satisfactory convergent validity. Furthermore, the CR values exceed 0.70, indicating good composite reliability. Given the relatively homogeneous standardised loadings and high internal consistency, composite reliability (CR) and Cronbach's alpha are very close (and coincide after rounding for some constructs), which is commonly observed.

Table 4: Measurement of validity and reliability

Factor	Cronbach's Alpha	Std. Estimate	Ave	CR
EEK	0.895	0.667	0.550	0.895
EEA	0.887	0.727	0.566	0.887
EEP	0.897	0.712	0.521	0.897
PEB	0.898	0.724	0.558	0.898
EEPE	0.889	0.773	0.572	0.889

This study employed the criterion proposed by Fornell and Larcker (1981) to assess the discriminant validity of the measurement model. As shown in Table 5, the square roots of the average variance extracted (AVE) for each latent construct are greater than their correlations with other latent constructs, indicating good discriminant validity among the constructs.

Table 5: Discriminant Validity

Variables	EEPE	PEB	EEP	EEA	EEK
EEPE	0.756				
PEB	0.582	0.747			
EEP	0.280	0.215	0.722		
EEA	0.493	0.500	0.301	0.752	
EEK	0.541	0.574	0.244	0.555	0.742

4.3 Structural Model Assessment

The fit of the structural model was evaluated comprehensively using multiple fit indices, including the chi-square to degrees of freedom ratio (CMIN/DF), the goodness-of-fit index (GFI), and the root mean square error of approximation (RMSEA). These indices reflect the degree of correspondence between the model and the sample data from different perspectives.

An overall model fit analysis was conducted for the structural model. As shown in Figure 2, the structural model demonstrates good overall fit, indicating that it adequately captures the underlying relationships among the study variables.

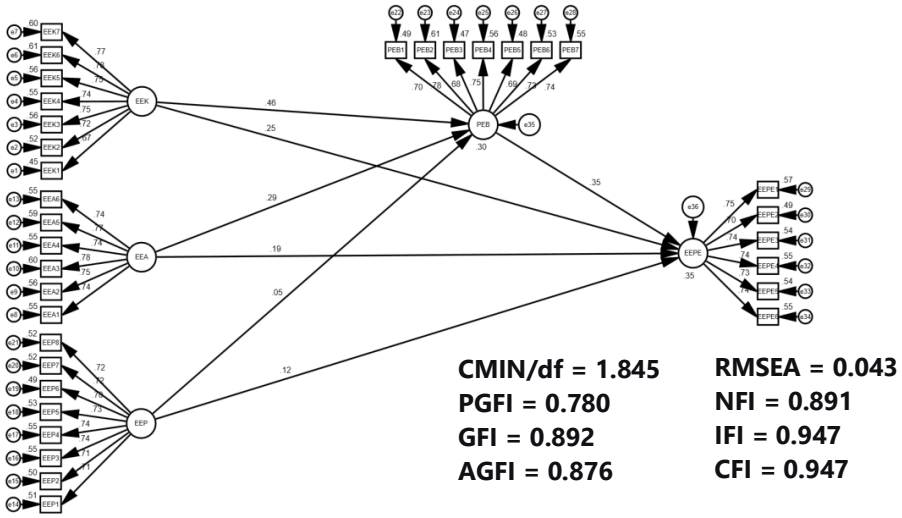

Fig.3: The Structural Model of the Study with Standardised Regression Weights.

Table 6 presents the path analysis results of the structural model. The findings indicate that EEK, EEA, EEP, and PEB all have significant positive effects on EEPE. In addition, EEK and EEA have significant positive effects on PEB, whereas EEP does not.

Table 6: Hypotheses Results of Direct Relationship Structural equation path test results

Hypothesis	Path	Std. Estimate	S.E.	C.R.	P	Result
H1	EEK→EEPE	0.247	0.057	4.516	***	Supported
H2	EEA→EEPE	0.185	0.049	3.771	***	Supported
H3	EEP→EEPE	0.116	0.043	2.582	0.01	Supported
H4	EEK→PEB	0.458	0.054	8.194	***	Supported
H5	EEA→PEB	0.289	0.045	5.854	***	Supported
H6	EEP→PEB	0.051	0.041	1.124	0.261	Rejected
H7	PEB→EEPE	0.351	0.064	5.883	***	Supported

Based on the path analysis above, it shows that:

H1: EEK ($\beta = 0.247$, CR = 4.516, $p = 0.00$) has a significant impact on EEPE.

H2: EEA (β = 0.185, CR = 3.771, p = 0.00) has a significant impact on EEPE.

H3: EEP (β = 0.116, CR = 2.582, p = 0.01) has a significant impact on EEPE.

H4: EEK (β = 0.458, CR = 8.194, p = 0.00) has a significant impact on PEB.

H5: EEA (β = 0.289, CR = 5.854, p = 0.00) has a significant impact on PEB.

H7: PEB (β = 0.351, CR = 5.883, p = 0.00) has a significant impact on EEPE.

As a result, Hypothesis H1, H2, H3, H4, H5, and H7 are supported.

On the other hand, the path analysis also shows that:

H6: EEP (β = 0.051, CR = 1.124, p = 0.261) does not have a significant impact on PEB.

As a result, Hypothesis H6 is not supported.

For the mediation effect analysis, this study employed the Bootstrap method to estimate the indirect effects. Table 7 presents the results of the mediation path analysis. PEB partially mediated the relationships between EEK and EEPE, and between EEA and EEPE. However, PEB did not mediate the relationship between EEP and EEPE.

Table 7: The result of the mediation path analysis

Parameter	Effect	Estimate	Lower	Upper	P	Conclusion
EEK→PEB→ EEPE	Direct effect	0.247	0.108	0.384	0	Partial Mediation
	Indirect effect	0.161	0.093	0.233	0	
	Total effect	0.408	0.285	0.523	0	
EEA→PEB→ EEPE	Direct effect	0.185	0.051	0.321	0.01	Partial Mediation
	Indirect effect	0.101	0.052	0.159	0	
	Total effect	0.287	0.159	0.415	0	
EEP→PEB→ EEPE	Direct effect	0.116	0.031	0.211	0.006	No Mediation
	Indirect effect	0.018	-0.015	0.059	0.293	
	Total effect	0.134	0.041	0.242	0.005	

Based on the path analysis above, it shows that:

H8a: PEB (β = 0.161, 95% CI = [0.093, 0.233], p < 0.001) mediates the relationship between EEK and EEPE.

H8b: PEB (β = 0.101, 95% CI = [0.052, 0.159], p < 0.001) mediates the relationship between EEA and EEPE.

As a result, Hypotheses H8a and H8b are supported.

On the other hand, the path analysis also shows that:

H8c: PEB (β = 0.018, 95% CI = [−0.015, 0.059], p = 0.293) does not mediate the relationship between EEP and EEPE.

As a result, Hypothesis H8c is not supported.

Based on the results of direct effect and mediation tests, the summary of hypothesis testing in this research is presented in the table.

Table 8: Summary Hypotheses Testing

Hypothesis	Path	Result
H1	EEK→EEPE	Supported
H2	EEA→EEPE	Supported
H3	EEP→EEPE	Supported
H4	EEK→PEB	Supported
H5	EEA→PEB	Supported
H6	EEP→PEB	Rejected
H7	PEB→EEPE	Supported
H8a	EEK→PEB→EEPE	Supported
H8b	EEA→PEB→EEPE	Supported
H8c	EEP→PEB→EEPE	Rejected

5. Discussion

This study examined how environmental knowledge, environmental attitude, and environmental practice influence employee environmental performance in logistics companies, and whether pro-environmental behaviour serves as a mediating mechanism in these relationships. The findings provide several important insights into how employee-level environmental performance is generated in logistics service operations.

First, the results indicate that environmental knowledge, environmental attitude, and environmental practice all significantly and positively influence employee environmental performance. Among these factors, environmental knowledge exerts the strongest effect. This finding highlights the critical role of employees' understanding of environmental issues in shaping environmentally responsible operational decisions. In the logistics industry, which is characterised by high delivery volumes, strict time pressure, and carbon-intensive logistics activities, employees with stronger environmental knowledge are better able to identify opportunities for emission reduction and adopt environmentally responsible practices during daily operations.

Environmental attitude also plays an important role in improving employee environmental performance. Employees who hold stronger environmental values are more likely to maintain environmentally responsible behaviours even when operational demands are high. This finding is consistent with prior studies suggesting that employees' internal environmental motivation and values are important drivers of voluntary pro-environmental behaviour (Afsar & Umrani, 2020). Although environmental practice also shows a positive influence on environmental performance, its effect is relatively smaller compared with knowledge and attitude. This suggests that formal environmental procedures alone may not be sufficient to maximise environmental performance unless they are supported by employees' environmental awareness and internal motivation.

Second, the findings reveal that pro-environmental behaviour plays a selective mediating role in the proposed relationships. Specifically, pro-environmental behaviour partially mediates the relationships between environmental knowledge and environmental performance, as well as between environmental attitude and environmental performance. This suggests that employees with greater environmental knowledge and stronger environmental attitudes are more likely to engage in voluntary environmentally responsible behaviours, which subsequently enhance their environmental performance.

However, pro-environmental behaviour does not mediate the relationship between environmental practice and environmental performance. This result indicates that environmental practice mainly operates through a direct operational mechanism rather than through voluntary behavioural engagement. In logistics companies, many environmental practices are embedded within organisational routines, such as route optimisation, packaging reduction, and energy-efficient driving practices. Because these practices are typically compliance-based and role-prescribed, they may improve environmental performance directly without necessarily encouraging additional voluntary pro-environmental behaviours.

Finally, the non-significant relationship between environmental practice and pro-environmental behaviour provides further insight into employee environmental actions in structured operational environments. In highly standardised operational environments, environmental practice often reflects compliance-based routines rather than intrinsically motivated environmental engagement. Traditional KAP reasoning often assumes a sequential process linking knowledge, attitude, and practice. However, the present findings suggest that in highly standardised service operations, these elements may operate more as parallel influences rather than forming a strict behavioural sequence. Environmental knowledge and attitudes stimulate voluntary pro-environmental behaviour, whereas environmental practice primarily reflects formal organisational procedures.

Overall, the results demonstrate that employee environmental performance in the logistics industry is shaped by both cognitive–motivational factors and behavioural mechanisms. While

organisational environmental practices remain important, voluntary pro-environmental behaviour plays a crucial role in translating employees' environmental knowledge and environmental attitudes into tangible environmental performance outcomes.

6. Conclusion

This study investigated the determinants of employee environmental performance in the logistics industry by examining the roles of environmental knowledge, environmental attitude, environmental practice, and pro-environmental behaviour. The results demonstrate that environmental knowledge, environmental attitude, and environmental practice all significantly improve employee environmental performance, with environmental knowledge exerting the strongest influence. In addition, pro-environmental behaviour directly enhances environmental performance and partially mediates the effects of environmental knowledge and environmental attitude.

These findings highlight the importance of both cognitive and behavioural mechanisms in shaping employee environmental performance within logistics service operations. By clarifying the relationships among environmental knowledge, environmental attitude, environmental practice, and pro-environmental behaviour, this study provides a more comprehensive understanding of how organisations can enhance employee environmental performance and support sustainable practices in the logistics industry.

6.1 Theoretical Contributions

This study contributes to the literature on employee environmental behaviour and sustainable logistics management in several ways.

First, the study extends existing research by examining the determinants of employee environmental performance within the logistics industry, a sector that has received relatively limited attention despite its growing environmental impact. By focusing on employee-level behavioural mechanisms within logistics service operations, this research broadens the contextual application of environmental behaviour theories to carbon-intensive service industries.

Second, the findings refine the understanding of behavioural mechanisms underlying employee environmental performance. The results demonstrate that environmental knowledge and environmental attitude influence environmental performance both directly and indirectly through pro-environmental behaviour. This highlights the important role of cognitive and motivational factors in shaping environmentally responsible behaviour in organisational contexts.

Third, the study distinguishes between compliance-based environmental practices and voluntary pro-environmental behaviour. While environmental practice improves environmental performance primarily through formal operational mechanisms, pro-environmental behaviour reflects employees' discretionary environmental actions. This distinction provides a more nuanced conceptualisation of employee environmental behaviour and advances theoretical explanations of how environmental performance is generated at the employee level in structured organisational environments.

6.2 Managerial Implications

The findings of this study provide several practical implications for logistics companies seeking to improve environmental performance.

Enhancing employees' environmental knowledge plays a fundamental role in improving environmental performance. Environmental training programmes can strengthen employees' understanding of environmental issues. Previous studies have shown that green HRM systems, including environmental training and employee participation mechanisms, can significantly strengthen employees' environmental engagement (Yusliza et al., 2017). Continuous learning mechanisms support the development of employees' awareness of green operational practices. Higher levels of environmental knowledge enable employees to recognise environmentally responsible operational decisions. Opportunities for emission reduction in daily logistics activities become easier

to identify.

Positive environmental attitudes also contribute to stronger environmental performance. The promotion of environmental values helps strengthen employees' sense of environmental responsibility. The development of a supportive green organisational culture creates a favourable environment for environmentally responsible behaviour. Environmental responsibility gradually becomes integrated into employees' work values. Environmentally responsible actions are more likely to be maintained even under operational pressure.

Voluntary pro-environmental behaviour among employees plays an important role in improving environmental performance. Formal environmental practices provide the basic operational framework. Employees' voluntary engagement further reinforces environmental actions. Incentive mechanisms can strengthen employees' willingness to participate. Recognition programmes support behavioural identification. A green organisational culture can sustain continuous environmental engagement.

Alignment between organisational environmental management practices and employee behavioural initiatives is essential. Formal environmental management systems provide institutional support. Employee participation generates behavioural momentum. The interaction of these mechanisms contributes to more stable environmental performance in logistics operations. Organisational sustainability can be strengthened over the long term.

6.3 Limitations and Future Research

Despite its contributions, this study has several limitations that provide directions for future research.

First, the data were collected from logistics company employees within a specific geographical and industrial context, which may limit the generalisability of the findings. Future studies could examine similar relationships in different countries or logistics sectors to improve external validity.

Second, this study adopted a cross-sectional research design, which restricts the ability to establish causal relationships among the variables. Future research may employ longitudinal approaches to better capture the dynamic relationships between environmental knowledge, attitudes, behaviours, and environmental performance over time.

Third, this study focused primarily on individual-level determinants of environmental performance. Future research could incorporate organisational-level variables, such as green leadership, environmental management systems, or organisational culture, to provide a more comprehensive understanding of how organisational and individual factors jointly influence employee environmental performance.

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Author Contributions

XH.W. was responsible for conceptualisation and led the methodological design; ZBMT contributed to data analysis and other research-related tasks; SK assisted with software implementation, formal analysis, and survey administration. All authors have read and approved the final version of the manuscript for publication.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Management and Science University, Malaysia.

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