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EXAMINING DEMOGRAPHIC MODERATION IN B2B LOGISTICS: INSIGHTS FROM BOXPLOT VISUALIZATION AND MGA OF BRAND RELATIONSHIP DRIVERS

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ABSTRACT

This study investigates the impact of demographic factors on brand loyalty in the B2B logistics sector, addressing a key gap in existing research by integrating both visual and statistical tools. Specifically, it examines how demographic characteristics, such as business age, size, logistics expenditure, annual revenue, and the number of trusted logistics providers, moderate the relationships between brand image, brand love, brand engagement, and brand loyalty. To achieve this, the study employs a dual-method approach: Boxplots in RStudio are used to visualize differences in brand loyalty across demographic groups, while Multi-Group Analysis (MGA) within PLS-SEM statistically tests moderation effects. Data were collected from 145 logistics clients in Ho Chi Minh City. Findings reveal that mid-sized businesses and those allocating 21-30% of their budgets to logistics report the highest brand loyalty. Smaller firms prioritize reliability, while larger firms favor technology-driven services. Notably, clients with 2-5 trusted logistics providers demonstrate stronger loyalty, highlighting the importance of reliability and flexibility for logistics service providers (LSPs) aiming to become preferred partners. This research provides actionable insights for LSPs to tailor brand strategies to specific client segments, enhancing loyalty and sustaining long-term B2B relationships.

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1. Introduction

In the highly competitive and dynamic field of B2B logistics, understanding the drivers of brand loyalty is crucial for building and maintaining long-term client relationships (Tokman et al., 2012; Juntunen et al., 2011). Beyond functional benefits such as service quality, efficiency, and reliability, brand perception in this context increasingly hinges on emotional connections, which are pivotal in fostering trust and loyalty (Taiminen & Ranaweera, 2019; Loureiro et al., 2012). While the tangible dimensions of B2B branding have traditionally been prioritized (Cassia et al., 2017; Leek & Christodoulides, 2012), recent studies emphasize the importance of emotional factors, such as brand love and engagement, in enhancing client retention (Mostafa & Kasamani, 2020; Junaid et al., 2020; Batra et al., 2012).

Despite the growing recognition of emotional dimensions in brand loyalty, research often neglects advanced visual methods to explore demographic influences in logistics (Mostafa & Kasamani, 2020; Tokman et al., 2012). Boxplots in RStudio, an underutilized tool, effectively visualize data variability, outliers, and group differences, offering actionable insights beyond traditional SPSS or PLS-SEM approaches solely for advancing both theory and practice (Hofmann et al., 2017).

Boxplots are well-regarded for their ability to depict data distributions and highlight demographic disparities. The method's robustness is rooted in its capacity to identify skewness, outliers, and clustering trends, which are pivotal for demographic analyses (Wickham et al., 2017). For instance, boxplots applied to datasets of salaries and academic performance have demonstrated their utility in comparing socioeconomic and educational inequalities across populations (Majaw & Ahmed, 2023). Beyond their traditional applications, innovations like notched box plots and interactive tools like BoxPlotR have enhanced accessibility and interpretive depth, supporting researchers in diverse fields, from public health to psychometrics (Streiner, 2017; Spitzer et al., 2014).

Their effectiveness has been demonstrated in various domains. For instance, Huuki et al. (2024) employed boxplots to analyze energy usage variability across socio-demographic groups in Finland, linking electricity consumption patterns with household characteristics. Similarly, Tadese et al. (2024) utilized boxplots to explore immunization rate disparities among East African children, enabling targeted interventions by identifying at-risk populations. In consumer behavior studies, Dakić et al. (2024) used boxplots to investigate regional purchasing patterns in Colombia's fashion industry, providing insights into tailored marketing strategies. When applied to brand perception, boxplots can effectively visualize differences in how businesses perceive logistics providers based on demographic attributes such as company size, annual revenue, and logistics spending. For instance, Dakić et al. (2024) highlighted the use of boxplots in analyzing generational differences in work values, revealing variations in intrinsic and extrinsic motivational drivers segmented by age cohorts.

Existing research, such as that by Solakivi et al. (2018), Lampe and Hofmann (2014), explores firm-specific variables like size, financial structure, and service offerings but identifies a lack of theoretical depth in addressing demographic impacts on logistics. Similarly, Mothilal et al. (2012) acknowledge the absence of robust frameworks for understanding how demographic and operational variables influence LSPs' performance and costs. These gaps limit the ability of logistics providers to develop tailored strategies that align with client-specific needs and priorities.

This study examines the influence of key demographic factors, business age, firm size, logistics expenditure, annual revenue, and the number of trusted logistics providers on brand loyalty in the B2B logistics sector. It explores how brand image shapes loyalty, mediated by emotional constructs such as brand love and brand engagement. Demographic variation significantly shapes client expectations and relationship preferences, reinforcing the need for logistics providers to tailor branding strategies accordingly (Rahman et al., 2024; Marquardt et al., 2011; Davis et al., 2008). Grounded in Service-Dominant Logic (Vargo & Lusch, 2017), this study argues that firm-level characteristics—such as size, maturity, and financial capacity—determine the extent of value co-creation in logistics partnerships. Larger and more established firms tend to display greater engagement and loyalty, reflecting strategic alignment and deeper relational investment (Taiminen & Ranaweera, 2019). Conversely, smaller or newer firms may prioritize adaptability and cost-efficiency, which can limit emotional commitment. Signaling Theory (Spence, 1973) further explains how brand image functions as a trust-building mechanism in high-risk B2B environments. Firms with limited experience or constrained resources often rely on brand signals to reduce uncertainty and assess provider reliability (Ahmed et al., 2023; Balmer et al., 2020). Together, these theoretical perspectives justify the moderating role of demographic factors in shaping how brand perceptions translate into emotional attachment, collaborative engagement, and enduring loyalty.

By integrating boxplots in RStudio into this analysis, the study provides a comprehensive framework for visualizing demographic variances in brand loyalty. This approach complements traditional statistical methods, such as PLS-SEM, by offering intuitive, data-driven insights into the relationships between demographic factors and brand loyalty. Ultimately, this research aims to enhance the methodological rigor of B2B logistics studies, providing actionable insights for logistics providers to optimize branding strategies and strengthen client partnerships across diverse demographic segments.

2. Literature review and hypotheses development

2.1. Overview of brand loyalty in B2B logistics

Brand loyalty is integral to success in the B2B logistics sector, where the scale and complexity of operations necessitate trust and long-term partnerships (Kittur & Chatterjee, 2020; Juntunen et al., 2011; Davis et al., 2008). Unlike B2C contexts, which rely heavily on individual customer preferences and emotional connections, B2B loyalty is a multifaceted construct that balances functional reliability, service quality, and emotional engagement (Taiminen & Ranaweera, 2019; Leek & Christodoulides, 2012). This combination underscores the unique dynamics of B2B markets, where loyalty extends beyond repeat business to reflect confidence in a logistics provider's ability to deliver consistent, high-quality outcomes, even under unpredictable circumstances (Prastyorini et al., 2023; Huma et al., 2020).

Despite this, traditional B2B branding has primarily emphasized functional benefits such as operational efficiency, cost-effectiveness, and reliability (Cassia et al., 2017; Lynch & de Chernatony, 2004). The emerging focus on emotional drivers such as brand love and engagement represents a paradigm shift, highlighting the need for more holistic strategies that incorporate the intangible dimensions of branding.

2.2. Functional and emotional dimensions of brand image

Brand image consists of two main dimensions: functional and emotional attributes, which are essential for client loyalty (Ab Hamid et al., 2023; Da Silva & Alwi, 2006). In competitive markets, relying solely on functional attributes can limit differentiation, as these benefits are increasingly viewed as standard rather than advantageous (Cassia et al., 2017; Lynch & de Chernatony, 2004). This shift emphasizes emotional attributes, fostering deeper client connections. Functional attributes, such as on-time delivery and cost optimization, are still crucial in logistics, helping evaluate reliability and efficiency (Davis et al., 2008; Cretu & Brodie, 2007). A strong functional brand image builds trust, positioning logistics providers as reliable partners in achieving operational objectives (Balmer et al., 2020). Key aspects evaluated in this context include service performance expectations, reliability in fulfilling commitments, operational efficiency, and overall service quality (Davis et al., 2009).

2.3. Brand love and brand engagement

The focus on emotional aspects like brand love and engagement is transitioning B2B branding from transactional to relational marketing, emphasizing emotional connections for loyalty beyond operational metrics. Bagozzi et al. (2017) built on this foundation by developing a practical, validated scale for measuring brand love. Their work provided a concise tool for assessing brand love's impact on consumer behaviors such as loyalty, word-of-mouth, and resistance to negative information, broadening its application beyond consumer goods to include services and potentially B2B settings. In the logistics sector, it enhances resilience and promotes customer loyalty during challenges like delays (Junaid et al., 2020; Nikhashemi et al., 2019). Brand engagement strengthens this bond by encouraging client participation and feedback, transforming the provider into a collaborative partner (Hollebeek et al., 2014). Research indicates that greater engagement correlates with increased loyalty and stronger client-brand relationships (Sombultawee & Wattanatorn, 2022).

2.4. The role of demographics in brand loyalty

Business age

The age of a company significantly influences its logistics strategies and perceptions of LSPs. Older firms prioritize stability and long-term partnerships, leveraging their experience for operational efficiency and consistency. They cultivate trust and loyalty through established relationships and contracts (Rakyta et al., 2022; Vlachos, 2021; Huma et al., 2020; Davis, 2014).

In contrast, younger firms focus on flexibility and adaptability to thrive in volatile markets. They pursue innovative logistics solutions to enhance brand awareness and market share, relying on agility for growth (Hirvonen et al., 2016; Tokman et al., 2012; Juntunen et al., 2011). While both older and younger firms benefit from long-term relationships, older firms tend to exhibit higher trust levels, whereas younger firms prefer shorter-term, experimental partnerships. This study explores how business age affects brand loyalty in B2B logistics, proposing:

Hypothesis H1: Business age positively influences brand loyalty in B2B logistics.

Business size

The size of a business significantly impacts its logistics priorities and loyalty to service providers. Smaller firms often prioritize cost-effectiveness and agility due to limited resources, while larger enterprises leverage economies of scale for broader resource allocation. According to Bardolet et al. (2017), smaller companies focus on specific investments, whereas larger ones emphasize scalability, innovation, and

consistency in logistics partnerships (Marquardt et al., 2015).

Company size also affects demand for logistics services. Larger firms need advanced, scalable solutions and often partner with providers skilled in managing complex networks (Masson, 2024; Navata, 2024). Smaller firms typically seek flexible solutions tailored to their immediate needs, but move towards more sophisticated strategies as they grow.

The global logistics market, valued at USD 3,794.4 billion in 2023, is expected to grow at a CAGR of 7.2% (2024–2030), driven by large enterprises' needs for scalable logistics (Grand View Research, 2024). Larger companies pursue long-term partnerships to optimize supply chain performance (Huma et al., 2020; Wallenburg, 2009), while smaller firms gradually adopt advanced systems and partnerships to stay competitive. This leads to the proposition:

Hypothesis H2: The size of a business positively influences its loyalty to LSPs.

Logistics spending

Shi et al. (2020) emphasize the significance of sustainable partnerships in Japanese logistics outsourcing, highlighting strategies and systems to enhance supply chain efficiency. Companies investing heavily in logistics prioritize high-quality providers, which improves flexibility and resilience (American Global Logistics, 2023). This approach strengthens competitive advantages in dynamic markets (Navrozova, 2022; Maersk, 2021).

Le et al. (2023) differentiate between relational and operational logistics service quality, showing that both improve customer satisfaction and loyalty. Their research underscores the need for excellent logistics services and lasting partnerships to boost organizational efficiency.

Larger firms often opt for premium logistics solutions tailored to their industry, while smaller firms focus on cost minimization, viewing logistics as a non-core function (Arabelen & Kaya, 2021). We hypothesize:

Hypothesis H3: Logistics spending positively influences brand loyalty to LSPs.

Business annual revenue

A company's annual revenue significantly shapes its logistics strategies. Smaller businesses, constrained by limited budgets, prioritize cost-efficiency through streamlined inventory management and lean warehousing, avoiding capital-intensive logistics systems (Widyanata & Soekarno, 2023; Navrozova, 2022). In contrast, high-revenue companies enjoy financial flexibility, enabling investments in advanced logistics systems that align with their strategic and branding goals. These firms often allocate resources to premium services, enhancing brand consistency and addressing complex operational demands (Gaudenzi et al., 2021).

Revenue levels influence how firms balance cost reduction, operational complexity, and strategic alignment. Smaller firms focus on efficiency, while larger firms prioritize scalability and brand integration (Davis et al., 2008). We hypothesize:

Hypothesis H4: A business's annual revenue positively influences its brand loyalty to LSPs.

The number of reliable logistics providers

The number of logistics providers a business relies on reflects its supply chain diversification strategy. Working with multiple providers enhances flexibility and cost management but may reduce loyalty to a single provider (Santibanez-Gonzalez & Diabat, 2016; Hartmann & de Grahl, 2011). Diversification mitigates risks and improves responsiveness but sacrifices the trust and synergies of long-term partnerships.

Selection criteria for third-party 3PLs emphasize adaptability. Factors like price,

service reliability, and flexibility dominate decision-making, often prioritizing short-term efficiency over long-term loyalty (Świtała et al., 2018). Companies seeking to optimize performance collaborate with multiple providers to achieve cost-efficiency and scalability, though at the expense of deep, singular partnerships. Diversification fosters agility, but limits relationship depth, while concentrated engagement with fewer providers strengthens trust and reliability. Therefore, we hypothesize:

Hypothesis H5: The number of reliable logistics providers a business utilizes positively influences its brand loyalty to LSPs.

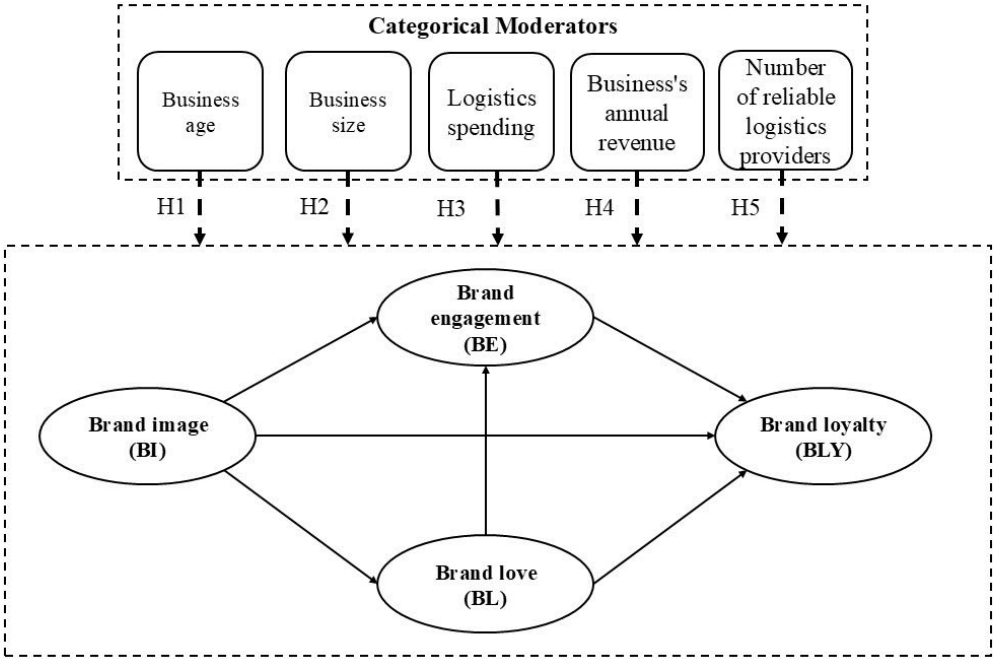


Figure 1. Conceptual framework with the moderating role of demographic factors

3. Methodology

3.1. Research design and approach

This study utilizes a quantitative research design to examine brand perception differences among B2B clients of logistics services across various demographics. Data were collected and analyzed using statistical methods, with boxplot visualizations in RStudio providing a comparative overview of demographic differences. SmartPLS software facilitated the testing of causal relationships impacting brand loyalty. The use of PLS-SEM is appropriate for exploring complex relationships among latent variables, particularly where traditional regression may overlook indirect effects (Hair et al., 2017). Boxplot visuals complement the statistical analysis, offering intuitive insights into brand engagement, brand love, and overall loyalty (Nicodemo & Satorra, 2020; Wickham et al., 2017).

3.2. Data collection and sample characteristics

Data collection

Demographic variables in this study are not modeled as direct predictors of brand loyalty. Rather, they are conceptualized as moderators, shaping how brand image, brand love, and brand engagement influence loyalty (*see Figure 1*). This distinction is operationalized through

MGA, allowing the examination of path differences across demographic subgroups. The sample included 145 companies, clients, or partners of LSPs, selected via purposive sampling to ensure relevance to the research. Participants represented diverse business sizes, industries, and operational durations, with inclusion criteria requiring at least three years of operational experience. Respondents were logistics managers, supply chain coordinators, and procurement officers, ensuring data was collected from decision-makers directly involved in logistics.

Data collection occurred between March and June 2024 using a multi-channel strategy to reach logistics professionals in Vietnam. Personalized email invitations, reminders, and partnerships with the Vietnam Logistics Business Association (VLA) facilitated participation. The survey was also distributed through Zalo, a popular messaging app.

Surveys were conducted using Google Forms for efficient data collection. The survey had two sections: Section A gathered demographic information such as employee count, years in business, logistics expenses, number of trusted logistics providers, and annual revenue. Section B assessed brand engagement, brand image, brand love, and brand loyalty, utilizing validated scales. Brand image (BI) was adapted from Davis et al. (2009) and focused on attributes like consistency and reliability. Brand love (BL), based on Bagozzi et al. (2017), measured emotional bonds in B2B relationships. Brand engagement (BE) was derived from Hollebeek et al. (2014) and emphasized collaboration, while Brand loyalty (BLY), adapted from Juntunen et al. (2011), evaluated repeat business intentions and long-term commitment *(see Appendix A)*. Data were gathered through an online survey using a Likert scale from 1 ("Strongly Disagree") to 5 ("Strongly Agree").

Data processing and encoding

Following data collection, the dataset was cleaned to remove missing or outlier records, and demographic variables such as number of employees, years of operation, logistics expenses, number of trusted logistics providers, and annual revenue were encoded as categorical variables to enable group-based analyses in RStudio (Wickham et al., 2017). Boxplots were employed to illustrate differences across demographic groups, with visualizations highlighting the median (average value), interquartile range (IQR; data variability between the 25th and 75th percentiles), whiskers (data spread up to 1.5 times the IQR), and outliers (extreme values beyond the whiskers). These visuals effectively revealed patterns in brand loyalty perceptions between enterprises of varying scales and demographics. Additionally, descriptive analysis summarized the sample characteristics, calculating frequency and percentage distributions of demographic groups, as well as the mean and standard deviation of brand loyalty measures, providing an overview of brand perception trends (Saunders et al., 2023).

MGA in SmartPLS

A key analytical method used in this study is MGA with SmartPLS, which examines differences in the effects of variables on B2B brand loyalty across demographic groups such as enterprise size, years of operation, and annual revenue (Hair et al., 2022). As part of Structural Equation Modeling (SEM), MGA identifies whether structural relationships within the theoretical model differ significantly across groups. This approach is particularly valuable in B2B research, where organizational characteristics can influence brand loyalty perceptions. By revealing whether variable relationships are consistent across groups, MGA provides critical insights to inform strategic decision-making (Cepeda-Carrión et al., 2022).

4. Results and discussion

4.1. Sample information

Fig. 1 shows that most companies in the study have been operational for 5 to 20 years, representing 71% of the sample (103 companies), which suggests that this extensive experience likely enhances brand engagement, image, and loyalty due to increased stability and credibility. This aligns with findings by Rakyta et al. (2022), Davis (2014), which emphasize the significance of long-term operational experience in fostering brand trust and engagement. Additionally, the majority of companies have fewer than 100 employees, accounting for 64.8% of the sample (94 companies); this smaller size may enable more personalized brand-building efforts, fostering greater brand love and loyalty. Furthermore, those with logistics expenses between 11 to 30% of total costs form the largest group, with 72 companies (49.7%), indicating a significant investment in logistics efficiency that can positively impact brand image. Most businesses also trust 2 to 5 logistics providers (81 companies, or 55.9%), reflecting a moderate level of trust that positively influences brand loyalty in logistics services. Finally, companies generating annual revenue between 35 to 1,050 billion VND represent the largest segment, totaling 73 companies (50.4%), suggesting that higher revenues likely lead to increased investments in branding, affecting all brand-related variables in the study.

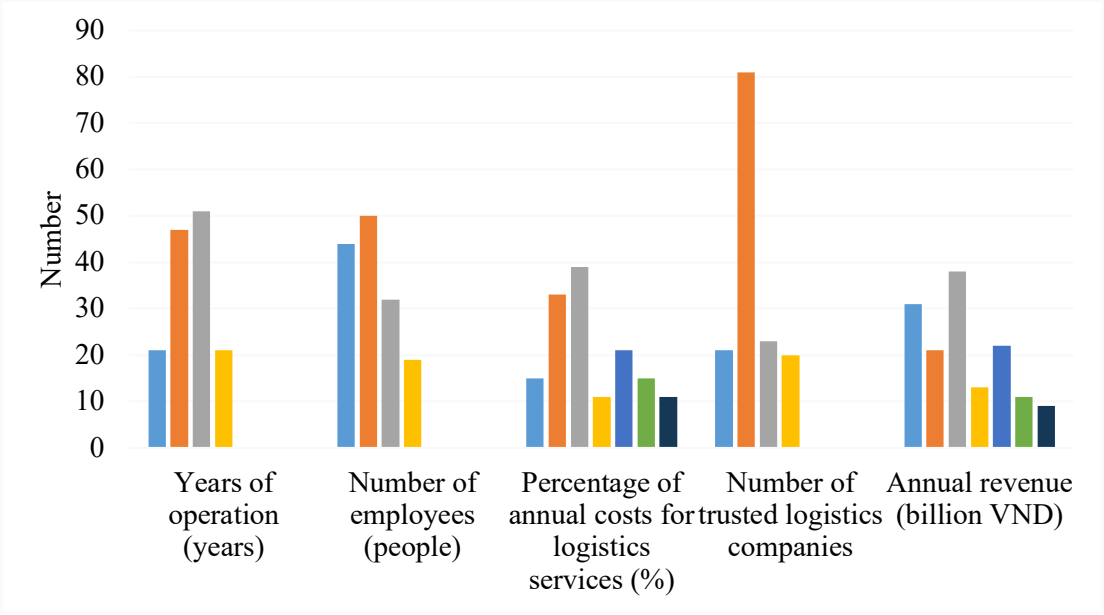


Figure 2. Description of demographics

4.2. Testing for demographic differences

To investigate differences among demographic groups, the study employed MGA using PLS-SEM with SmartPLS 3.2.9, visualizing results with Boxplot diagrams in RStudio at a significance threshold of p-value = 0.1. This approach identified key demographic factors influencing brand perception, such as years of operation, employee size, logistics expense proportion, number of trusted providers, and annual revenue, which impact brand engagement, image, affection, and loyalty. Boxplot visualizations effectively showcased the distribution of brand metrics across demographic groups, illustrating medians,

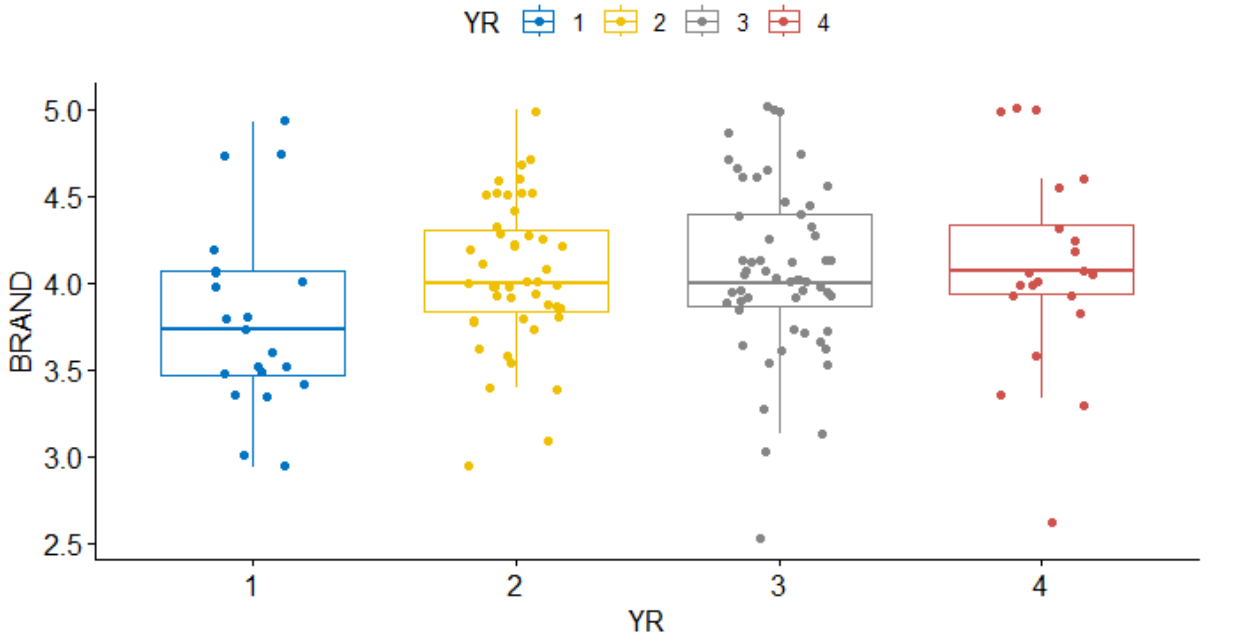
interquartile ranges, and potential outliers, thus enhancing the clarity and interpretability of the findings.

Testing differences by business age

The analysis explored differences in brand-related perceptions among businesses categorized by years of operation (<5 years, 5-10 years, 11-20 years, and >20 years). Results from MGA using SmartPLS and Boxplot visualizations generated in RStudio provide comprehensive insights into how these differences manifest across various operational stages.

Table 1. Testing differences by business age using SmartPLS

Relationship	<5 vs. 5-10	<5 vs. 11-20	<5 vs. >20	5-10 vs. 11-20	5-10 vs. > 20	11-20 vs. >20	p-value <5	p-value 5-10	p-value 11-20	p-value > 20
BE -> BLY	0.88	0.81	0.14	0.73	0.17	0.12	0.78	0.68	0.97	0.10
BI -> BE	0.63	0.59	0.51	1.00	0.76	0.71	0.08	0.12	0.02	0.47
BI -> BL	0.25	0.05	0.84	0.24	0.26	0.05	0	0	0	0
BI -> BLY	0.03	0.02	0.26	0.86	0.57	0.47	0	0.19	0.28	0.19
BL -> BE	0.49	0.63	0.47	0.77	0.17	0.22	0.10	0.21	0.07	0.01
BL -> BLY	0.12	0.23	0.23	0.61	0.56	0.44	-	-	-	-



Note: *YR = Years of operation (years) - Business age, YR1 = Less than 5 years, YR2 = 5 - 10 years, YR3 = 11 - 20 years, YR4= Over 20 years.*

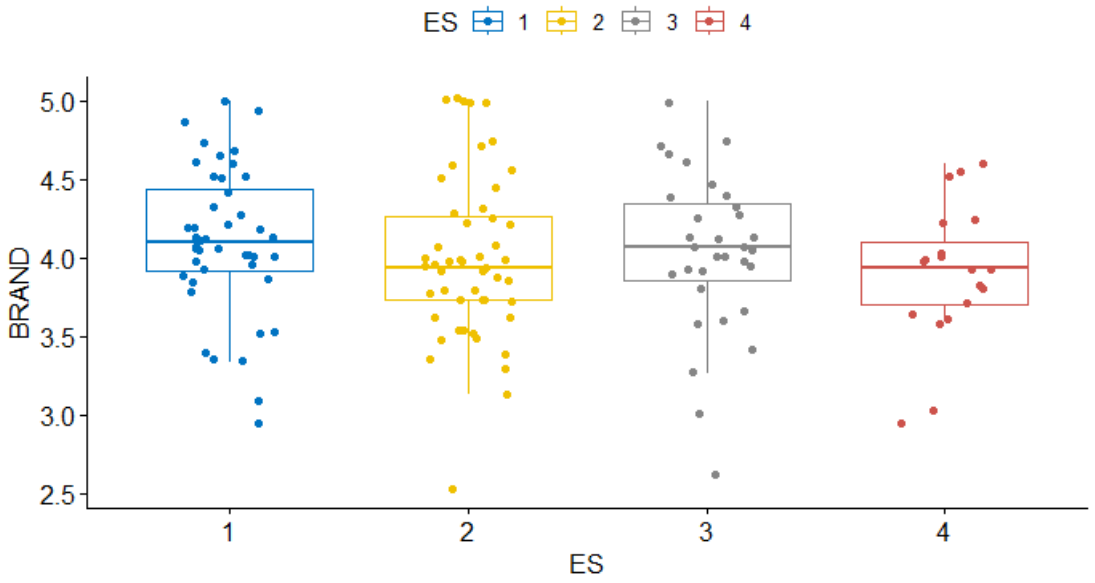
Figure 2. Differences by business age using Boxplot

Figure 2 illustrates the distribution of brand loyalty across four groups based on years of operation. Businesses operating for YR2 exhibit the highest and most consistent brand loyalty, reflecting their focus on building and maintaining strong brand relationships during this phase. In contrast, businesses operating for YR1 show the widest dispersion in brand loyalty, indicating challenges in achieving stability and clarity in brand perception typical of early-stage enterprises. The YR3 demonstrates relatively stable brand loyalty levels, though not as prominent as YR2. For businesses operating >20 years, while some achieve high levels of brand loyalty, the distribution is less consistent, suggesting that long-established firms do not always capitalize effectively on their brand potential. Both the boxplot and PLS-SEM results align in showing that 5-10 year businesses have the most balanced distribution and stable relationships between constructs, such as Brand Engagement (BE) and Brand Loyalty (BLY). Conversely, early-stage businesses (YR1) display instability, with the boxplot highlighting wide dispersion and PLS-SEM identifying weaker and less consistent relationships across constructs. Long-established businesses (YR4) exhibit variability, with the boxplot revealing uneven distributions and PLS-SEM showing inconsistent inter-group and within-group relationships, such as Brand Love (BL) → BE ($p = 0.014$). These findings resonate with those of Juntunen et al. (2011), who emphasized that businesses in their mid-growth stage prioritize relationship-building. Conversely, businesses operational for less than 5 years display inconsistent brand loyalty, echoing Tokman et al. (2012), who identified challenges in brand perception during early operational phases.

Testing differences by business size

Table 2. Testing differences by business size between groups using SmartPLS

Relationship	<20 vs. 20–99	<20 vs. 100–500	<20 vs. >500	20–99 vs. 100–500	20–99 vs. >500	100–500 vs. >500	p-value <20	p-value 20–99	p-value 100–500	p-value > 500
BE → BLY	0.01	0.80	0.17	0.01	0.57	0.16	0.51	0.01	0.44	0.21
BI → BE	0.37	0.16	0.5	0.61	0.91	0.58	0.01	0.15	0.67	0.31
BI → BL	0.14	0.39	0.11	0.73	0.51	0.39	0.01	0.00	0.00	0.00
BI → BLY	0.13	0.84	0.71	0.23	0.33	0.66	0.07	0.00	0.09	0.94
BL → BE	0.20	0.47	0.12	0.76	0.56	0.45	0.26	0.00	0.11	0.01
BL → BLY	0.76	0.84	0.55	0.68	0.52	0.57	0.01	0.09	0.06	0.29



Note: *ES = Employee Size - Business size, ES1 = Less than 20, ES2= 20–99, ES3 = 100 – 500, ES4 = More than 500.*

Figure 3. Differences by business size between groups using Boxplot

The analysis utilizes Boxplot visualizations and MGA results from SmartPLS to evaluate the impact of employee size on brand constructs across four categories: "<20," "20-99," "100-500," and ">500." Figure 3 shows that mid-sized firms (ES2) maintain the highest average brand loyalty and the least variability, indicating stable brand perceptions. In contrast, small businesses (ES1) exhibit significant variability, while large firms (ES4) demonstrate moderate stability but lower consistency than their mid-sized counterparts.

The MGA results reveal that ES2 has a strong relationship between brand engagement (BE) and brand loyalty (BLY) (p=0.005), highlighting the importance of engagement in driving loyalty. Smaller firms rely on brand image for engagement (BI → BE, p=0.008), while larger firms see brand loyalty translate into engagement (BL → BE, p=0.01). These findings illustrate the key role of mid-sized firms in achieving stable brand performance, while smaller and larger firms face unique challenges.

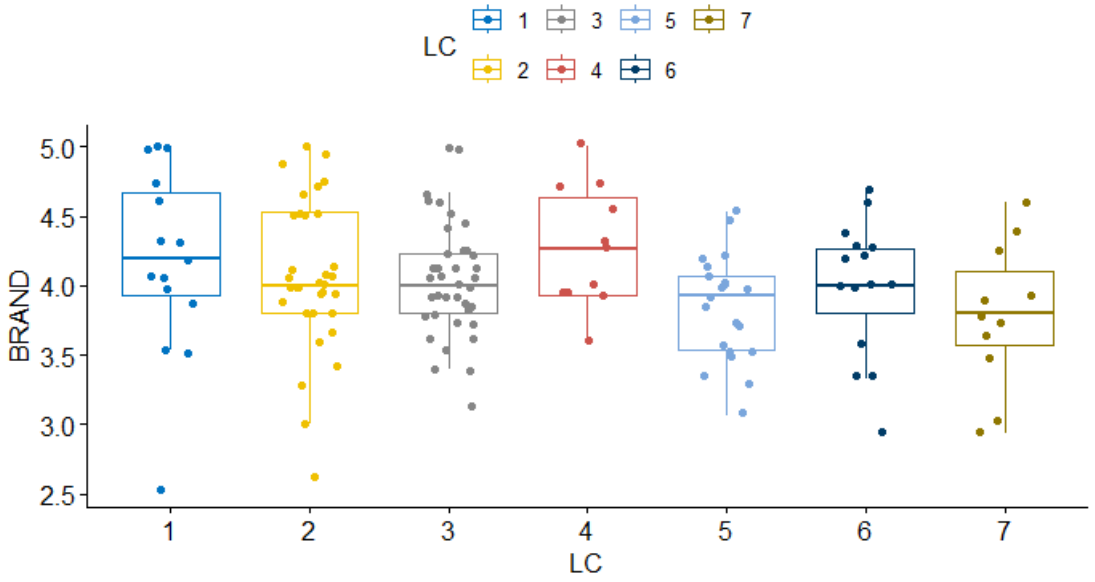
Mid-sized firms (ES2) demonstrate robust brand loyalty, consistent with Bardolet et al. (2017), while small businesses (ES1) struggle with brand perception variability due to resource constraints, as noted by Marquardt et al. (2015). Larger firms (ES4) exhibit moderate stability, echoing Wallenburg's (2009) insights on scalability challenges affecting brand consistency.

Testing differences by logistics spending

Table 3. Testing Differences by logistics spending using SmartPLS

Relationship	BE→BLY	BI→BE	BI→BL	BI→BLY	BL→BE	BL→BLY
LC1 vs. LC2 (mean)	0.664	0.49	0.10	0.37	0.97	0.42
LC1 vs. LC3 (mean)	0.149	0.85	0.05	0.46	0.52	0.64
LC1 vs. LC4 (mean)	0.179	0.41	0.75	0.42	0.40	0.87

Relationship	BE→BLY	BI→BE	BI→BL	BI→BLY	BL→BE	BL→BLY
LC1 vs. LC5 (mean)	0.204	0.32	0.25	0.82	0.65	0.93
LC1 vs. LC6 (mean)	0.991	0.18	0.56	0.27	0.28	0.33
LC1 vs. LC7 (mean)	0.397	0.94	0.26	0.71	0.60	0.71
LC2 vs. LC3 (mean)	0.037	0.40	0.62	0.76	0.56	0.47
LC2 vs. LC4 (mean)	0.159	0.49	0.30	0.60	0.37	0.43
LC2 vs. LC5 (mean)	0.218	0.56	0.93	0.35	0.60	0.52
LC2 vs. LC6 (mean)	0.671	0.25	0.64	0.39	0.21	0.46
LC2 vs. LC7 (mean)	0.383	0.66	0.79	0.24	0.63	0.26
Group p-value LC1	0.648	0.07	0.00	0.81	0.43	0.38
Group p-value LC2	0.373	0.01	0.00	0.00	0.37	0.50
Group p-value LC3	0.045	0.00	0.00	0.03	0.76	0.16
Group p-value LC4	0.849	0.94	0.04	0.75	0.29	0.92
Group p-value LC5	0.239	0.48	0.00	0.53	0.25	0.42
Group p-value LC6	0.568	0.85	0.09	0.07	0.06	0.76
Group p-value LC7	0.736	0.37	0.07	0.84	0.80	0.23



Note: *LC = Logistics cost ratio - Logistics spending (%), LC1 = 0 – 10, LC2 = 11 – 20, LC3 = 21 – 30, LC4 = 31 – 40, LC5 = 41 – 50, LC6 = 51 – 60, LC7 = 61 - 100.*

Figure 4. Differences by logistics spending using Boxplot

This study explored the effects of annual logistics cost ratios on brand constructs in the B2B environment, employing Boxplot visualizations (Figure 4) and MGA (Tables 3). The Boxplot indicates that businesses allocating 0-10% and 11-20% of their costs to logistics maintain stable and strong brand loyalty (brand). Notably, the 21-30% cost range achieves the highest average brand value, suggesting it is optimal for brand performance.

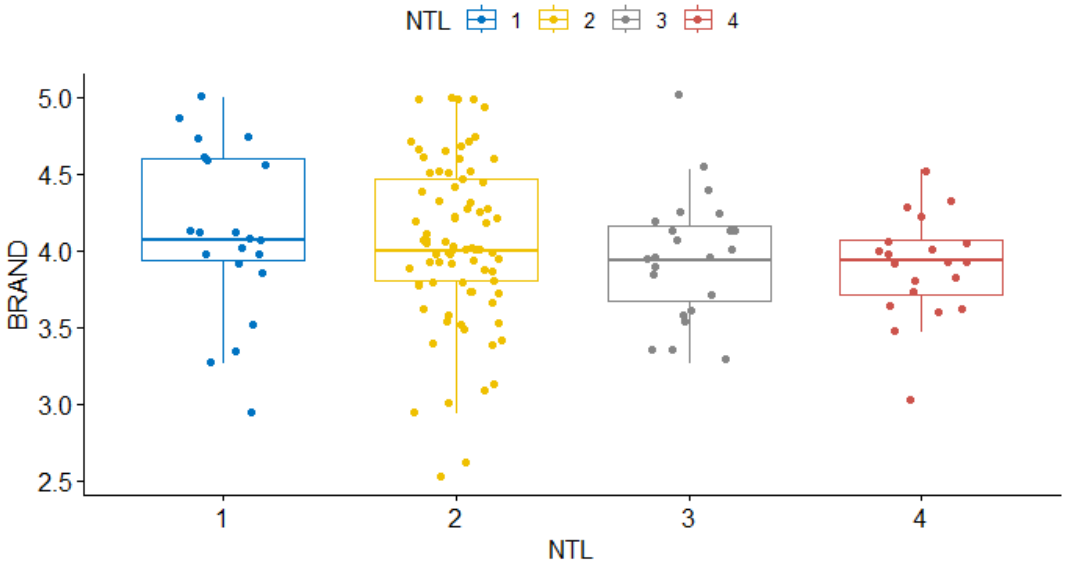
Conversely, exceeding 30% in logistics costs results in declining brand scores, highlighting diminishing returns.

MGA results further corroborate these findings. In the 21-30% cost group, brand image significantly affects brand love (BI → BL, p=0.000), while brand engagement enhances brand loyalty (BE → BLY, p=0.045). Lower-cost groups show stable but weaker relationships, whereas high-cost groups (31-100%) experience fewer significant relationships, reflecting obstacles to sustaining brand loyalty. Ultimately, the 21-30% logistics cost ratio offers the best balance of operational investment and brand impact, aligning with Shi et al. (2020) and Le et al. (2023) regarding the need for a strategic approach to logistics investment.

Testing differences by the number of trusted logistics companies

Table 4. Testing differences by number of trusted logistics companies using SmartPLS

Relationship	BE→BLY	BI→BE	BI→BL	BI→BLY	BL→BE	BL→BLY
NTL1 vs. NTL2 (mean)	0.288	0.9	0.11	0.41	0.67	0.59
NTL1 vs. NTL3 (mean)	0.11	0.4	0.03	0.63	0.65	0.79
NTL1 vs. NTL4 (mean)	0.14	0.63	0.53	0.43	0.31	0.28
NTL2 vs. NTL3 (mean)	0.226	0.17	0.19	0.92	0.77	0.87
NTL2 vs. NTL4 (mean)	0.233	0.39	0.48	0.75	0.21	0.34
NTL3 vs. NTL4 (mean)	0.57	0.59	0.24	0.71	0.43	0.35
Group p-value NTL1	0.358	0.36	0	0.81	0.78	0.04
Group p-value NTL2	0.638	0	0	0	0	0
Group p-value NTL3	0.188	0.88	0.63	0.38	0.28	0.14
Group p-value NTL4	0.223	0.5	0.14	0.24	0.03	0.75



Note: *NTL = number of trusted logistics companies, NTL1 = 1, NTL2 = 2 – 5, NTL3 = 6 – 10, NTL4 = over 10 companies.*

Figure 5. Differences by number of trusted logistics companies using Boxplot

This study examined brand trust levels (Brand) across four groups based on the number of trusted logistics companies (NTL 1-4): 1 company, 2-5 companies, 6-10 companies, and over 10 companies. As shown in Figure 5, median brand trust declines with an increasing number of logistics providers. Firms trusting a single provider (NTL1) exhibit the highest and most stable brand trust, while the 2-5 company group (NTL2) shows significant variability in trust dynamics. Groups with 6-10 companies (NTL3) and over 10 companies (NTL4) reflect lower median trust levels and narrower distributions.

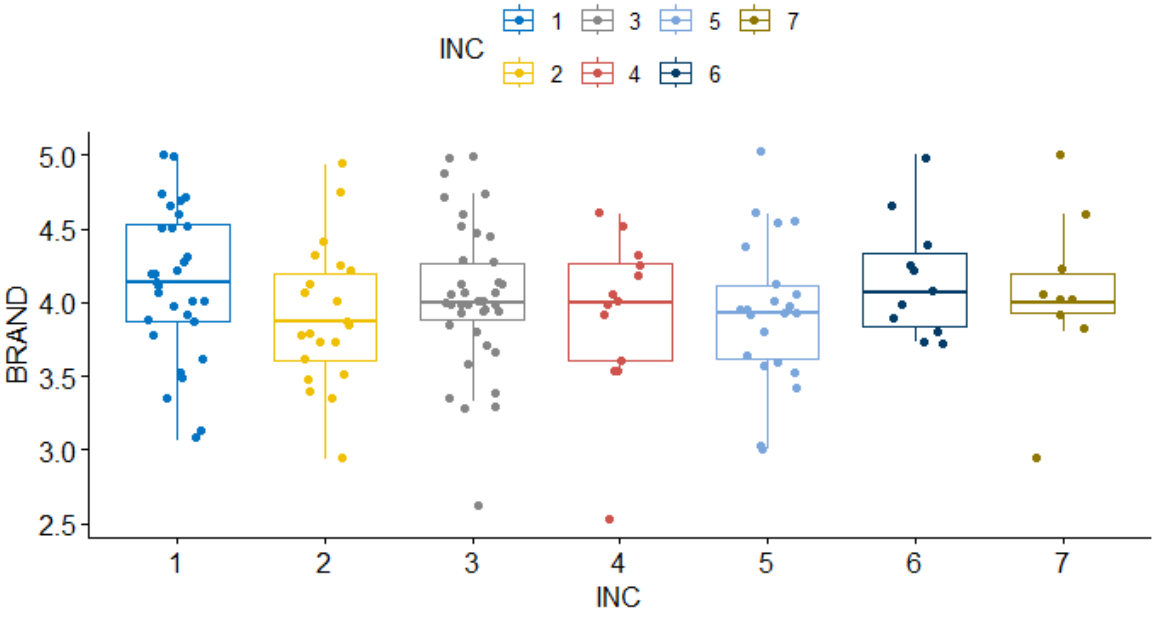
MGA results (Table 4) reveal a significant difference in the relationship between brand image and brand love (BI → BL) between the NTL1 and NTL3 groups (P = 0.032). In the **NTL2** group, brand image is a strong driver of engagement and love (P = 0 for BI → BE and BI → BL), while brand love significantly enhances engagement in both the 2-5 (P = 0.002) and 10+ company groups (P = 0.026).

Overall, firms trusting fewer logistics partners maintain higher and more stable brand trust, whereas expanding partnerships correlate with reduced trust. Those working with 2-5 reliable logistics providers report the highest brand trust and loyalty, supporting Hartmann & de Grahl's (2011) findings on the advantages of moderated provider diversity. In contrast, firms with more than 10 providers face challenges in maintaining cohesive partnerships, leading to reduced loyalty, as noted by Świtała et al. (2018).

Testing for differences in annual revenue

Table 5. Testing differences by business annual revenue using SmartPLS

Relationship	BE→BLY	BI→BE	BI→BL	BI→BLY	BL→BE	BL→BLY
INC1 vs. INC2 (mean)	0.558	0.12	0.76	0.45	0.26	0.11
INC1 vs. INC3 (mean)	0.087	0.84	0.6	0.69	0.8	0.13
INC1 vs. INC4 (mean)	0.93	0.3	0.36	0.63	0.74	0.66
INC1 vs. INC5 (mean)	0.593	0.5	0.87	0.67	0.27	0.48
INC1 vs. INC6 (mean)	0.566	0.72	0.46	0.92	0.57	0.51
INC2 vs. INC3 (mean)	0.273	0.11	0.88	0.68	0.13	0.93
INC2 vs. INC4 (mean)	0.707	0.95	0.35	0.42	0.52	0.24
INC2 vs. INC5 (mean)	0.454	0.06	0.94	0.88	0.1	0.12
INC2 vs. INC6 (mean)	0.893	0.43	0.6	0.69	0.94	0.91
INC3 vs. INC4 (mean)	0.413	0.31	0.3	0.5	0.56	0.25
INC3 vs. INC5 (mean)	0.23	0.35	0.84	0.9	0.3	0.13
INC3 vs. INC6 (mean)	0.41	0.77	0.65	0.89	0.51	0.89
Group p-value INC1	0.744	0.25	0	0.05	0.16	0.71
Group p-value INC2	0.651	0	0	0.37	0.81	0
Group p-value INC3	0.039	0.06	0	0.08	0.02	0
Group p-value INC4	0.911	0.09	0.13	0.46	0.64	0.87
Group p-value INC5	0.52	0.95	0.08	0.54	0.03	0.51
Group p-value INC6	0.8	0.47	0.5	0.49	0.9	0.47



Note: *INC = Company income - Annual revenue (Billion VND), INC1= Less than 18, INC2 = 18 – Less than 35, INC3 = 35 – Less than 175, INC4 = 175 – Less than 350, INC5 = 350 – Less than 1050, INC6 = 1050 – Less than 1750, INC7 = 1750 and above.*

Fig 6. Differences by business annual revenue using Boxplot

The Boxplot analysis (Figure 6) and MGA conducted using SmartPLS (Tables 5) reveal distinct patterns in brand perception across different firm sizes. Smaller firms, categorized as having annual revenues of less than 18 billion VND, exhibit the highest median BRAND scores, reflecting their reliance on strong relationships with logistics providers. In contrast, mid-sized firms, with revenues ranging from 350 to 1,750 billion VND, display lower median scores and greater variability. This suggests that their complex service requirements and diverse partnerships may dilute their brand perceptions. Meanwhile, larger firms, defined as those with revenues of 1,750 billion VND or more, show more consistent brand scores, likely due to well-established standards and experienced partnerships.

The results from the MGA provide additional insights into these trends. The relationship from brand image (BI) to brand love (BL) is statistically significant between smaller firms and mid-sized firms (35-175 billion VND, P = 0), emphasizing the importance of brand image in fostering brand love within the smaller firm segment. Furthermore, the link from brand love (BL) to brand loyalty (BLY) is significant for mid-sized firms ("18-35 billion VND," P = 0.001; "35-175 billion VND," P = 0.003), underscoring the crucial role of brand love in driving loyalty in this sector. Although differences in the relationship from brand loyalty (BLY) to brand engagement (BE) are limited, they approach significance between smaller and mid-sized firms ("<18 billion VND" vs. "35-175 billion VND," P = 0.087). For larger firms (≥350 billion VND), the relationship from brand love to brand engagement is significant (P = 0.032), highlighting the importance of engagement in maintaining loyalty given their diverse logistics partnerships.

These findings illuminate the varying impacts of brand constructs across revenue segments, emphasizing the need for tailored strategies to enhance brand performance. Notably, smaller

firms with annual revenues below 18 billion VND demonstrate higher median brand loyalty, attributed to their emphasis on consistent and personalized service, in alignment with Davis et al. (2008). Mid-sized firms (350-1,750 billion VND) show variability due to their complex demands, while large firms (over 1,750 billion VND) maintain more consistent brand loyalty, supported by established networks, corroborating observations made by Gaudenzi et al. (2021).

The results of the MGA and Boxplot visualizations demonstrate that the five demographic variables—firm size, business age, logistics expenditure, annual revenue, and the number of trusted logistics providers—meaningfully moderate key relationships within the branding model. Specifically:

Firm size significantly influenced the strength of the BE → BLY path, with medium-sized firms (20-99 employees) exhibiting stronger loyalty through engagement. Business age moderated multiple paths, with firms in the 5-10 year range showing the most stable brand relationships across BI → BE and BL → BLY. Logistics expenditure between 21-30% was associated with the most robust BI → BL link, suggesting an optimal investment threshold for relationship strength. Number of trusted logistics providers affected engagement and loyalty consistency, with companies using 2-5 partners demonstrating the strongest relational commitment. Annual revenue played a nuanced role: smaller firms showed emotional loyalty, while large enterprises exhibited more structured engagement mechanisms.

These findings affirm that demographic characteristics do not act as direct predictors, but rather as moderators of brand relationship dynamics. This insight addresses the reviewer's concern by clarifying the role of demographic factors and aligning the results with the study's research objectives and revised hypotheses.

5. Conclusions and practical implications for logistics service providers

5.1. Conclusion

This study explored how firm-level demographics, business age, size, logistics spending, annual revenue, and number of trusted logistics providers moderate the relationships among brand image, brand love, brand engagement, and brand loyalty in the B2B logistics sector. Grounded in Signaling Theory and S-D Logic, the findings show that these demographic factors influence how emotional and behavioral constructs convert brand image into long-term loyalty. MGA revealed key moderating effects:

Firm size and annual revenue amplify the impact of brand engagement on brand loyalty, suggesting that larger or more financially stable firms are more capable of translating engagement into lasting commitment.

Business age and logistics spending moderate the relationship between brand image and brand love, indicating that younger firms or those making strategic logistics investments respond more strongly to brand signals on an emotional level.

These patterns align with Signaling Theory, which posits that brand image functions as a trust signal, particularly valuable to firms with fewer resources or limited operating history. In parallel, S-D Logic supports the view that value emerges through co-created emotional and behavioral engagement, both shaped by the firm's context.

The roles of brand love and brand engagement as mediators are reinforced, showing how emotional attachment and active participation convert brand perception into loyalty. Notably, mid-sized firms (20-99 employees), those in the growth stage (5-10 years), and those allocating 21-30% of total costs to logistics reported the highest loyalty outcomes. These firms appear to

strike a more effective balance between strategic focus, resource deployment, and emotional alignment

5.2. Practical implications for logistics service providers

Mid-sized firms, those with 20 to 99 employees, exhibit the most stable brand loyalty. This stems from their ability to balance efficient resource use with a need for personalized service. To capture this segment, logistics service providers (LSPs) should invest in scalable, cost-effective offerings while building targeted relationships that foster long-term engagement (Bardolet et al., 2017; Marquardt et al., 2011).

Logistics investment levels also shape loyalty outcomes. Firms allocating 21 to 30 percent of operational costs to logistics report the highest loyalty scores. This suggests an optimal investment window, where performance and value align most effectively. LSPs can guide clients toward this range by highlighting how focused spending enhances reliability, efficiency, and relationship continuity (Le et al., 2023; Shi et al., 2020).

Business age further influences service expectations and brand behavior. Younger firms, operating for fewer than five years, often face uncertainty and value trust-building relationships that offer flexibility and quick returns (Tokman et al., 2012). Firms in the five to ten-year range show the strongest loyalty, indicating a prime opportunity for LSPs to deepen emotional engagement and reinforce co-creation strategies (Juntunen et al., 2011). In contrast, firms with more than twenty years of operation typically seek stability and strategic alignment. For these clients, tech-driven solutions and operational reliability are key to reinforcing long-term partnerships (Rakyta et al., 2022).

Revenue levels demand further differentiation. Smaller firms, earning under 18 billion VND annually, tend to prioritize affordability and service personalization to build trust and loyalty (Davis et al., 2008). In contrast, firms generating over 1,750 billion VND expect sophisticated, integrated logistics systems that can support complex and large-scale operations (Gaudenzi et al., 2021).

Finally, the number of logistics partners also matters. Firms working with two to five trusted LSPs show the highest levels of brand trust and loyalty. This range appears to strike a balance between diversification and depth of relationship. To become a preferred provider within this range, LSPs should emphasize flexibility, reliability, and co-leadership in service delivery, ensuring they are seen as strategic partners, not interchangeable vendors (Świtała et al., 2018; Hartmann & de Grahl, 2011).

5.3. Limitations

This research offers useful insights, but it has some limitations. The study looked at businesses in Ho Chi Minh City, Vietnam. While this provides local insights, the findings may not apply to companies in different cultural, economic, or regulatory settings. The sample included 145 companies, which is enough for analysis, but it may not represent a wide range of industries and organization types in logistics. The study relied on self-reported survey data, which can lead to biases, like people overestimating their loyalty levels. Additionally, while boxplots and PLS-SEM provide strong analytical insights, including more qualitative data could make the findings even better.

Future studies could address these limitations by expanding the geographic scope to include multiple regions or countries, increasing sample diversity, and adopting longitudinal designs to capture temporal dynamics. Additionally, incorporating qualitative methods, such as interviews or case studies, would provide deeper insights into the emotional and functional drivers of brand loyalty.

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