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Impact of Green Steel Price Fluctuations on Investment Willingness in Sustainable Building Projects: Evidence From Vietnam's Real Estate Industry

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ABSTRACT: Vietnam's commitment to achieving net-zero greenhouse gas emissions by 2050 highlights the critical role of decarbonizing high-emission industries, particularly steel production. Green steel, which is produced via low-carbon technologies, presents a sustainable alternative but remains expensive and price-volatile, creating uncertainties for investors in sustainable building projects. This study investigates the impact of green steel price fluctuations on perceived financial feasibility and investment willingness in Vietnam's real estate sector. Drawing on the Theory of Planned Behavior and expectancy–value theory, a survey of 237 stakeholders, including investors, developers, and steel manufacturers, was analyzed using structural equation modeling. Results indicate that green steel price volatility significantly reduces perceived financial feasibility and investment willingness, with financial feasibility partially mediating this relationship. The findings offer both theoretical contributions to understanding green investment behavior under cost uncertainty and practical insights for policymakers and industry stakeholders to stabilize supply chains, design financial support mechanisms, and enhance market transparency to promote sustainable construction in emerging markets.

KEYWORDS: Green steel, investment willingness, perceived financial feasibility, price fluctuation, sustainable building

I. INTRODUCTION

Vietnam is at a critical juncture in its efforts to balance rapid economic growth with environmental sustainability. As the country pledges to achieve net-zero greenhouse gas (GHG) emissions by 2050, industries with high carbon footprints, such as the steel sector, must play a central role in emission reduction strategies (Hasanbeigi et al., 2025). Steel production as a cornerstone of Vietnam's infrastructure development and industrialization currently relies heavily on conventional, carbon-intensive blast furnace-basic oxygen furnace (BF-BOF) processes (World Steel Association, 2023). With steel production projected to nearly triple from approximately 19 million tons in 2023 to 55 million tons by 2060, the challenge of decarbonizing this sector becomes even more urgent (TransitionAsia, 2025).

The steel industry is pivotal for Vietnam's economic progress, underpinning rapid urbanization, the construction sector, shipbuilding, and export growth (Ministry of Industry and Trade, 2025). However, the dominance of traditional steelmaking technologies and ongoing expansion of BF-BOF capacity limit the country's ability to reduce carbon emissions without significant technological shifts (Hasanbeigi et al., 2025). Green steel, produced using low-carbon technologies such as electric arc furnaces powered by renewable energy or hydrogen-based direct reduction, presents a promising alternative to conventional steel (Rosner et al., 2023). Yet, the adoption of green steel faces significant economic hurdles, primarily due to higher production costs and price volatility driven by immature supply chains and fluctuating input prices, especially hydrogen (OECD, 2025; METI, 2024).

These economic uncertainties directly affect the perceived financial feasibility of sustainable building projects that rely heavily on steel as a key material (Kumah et al., 2022). In Vietnam, where the real estate sector accounts for the largest share of steel consumption (TransitionAsia, 2025), this perceived feasibility significantly influences investors' and developers' willingness to commit capital to green construction (Wang et al., 2024). Understanding how fluctuations in green steel prices impact financial perceptions and investment decisions is crucial for designing effective policies and financial mechanisms that support the transition toward low-carbon construction (Zhang et al., 2011).

Impact of Green Steel Price Fluctuations on Investment Willingness in Sustainable Building Projects: Evidence From Vietnam's Real Estate Industry

This study aims to investigate the influence of green steel price fluctuations on perceived financial feasibility and investment willingness in sustainable building projects in Vietnam. Drawing on theories of expectancy–value and planned behavior (Vroom, 1964; Ajzen, 1991), the research develops hypotheses to explore the direct and mediated relationships between price volatility, financial perceptions, and investment intentions. By shedding light on these dynamics, the study provides insights for stakeholders, policymakers, and industry players seeking to accelerate the adoption of green steel and sustainable building practices in emerging markets. The construct of the study is divided into 5 main parts including (1) introduction; (2) literature review and research model; (3) methodology; (4) findings and discussion; and (5) implications and conclusion.

II. LITERATURE REVIEW AND RESEARCH MODEL

Green Steel and Fluctuations in Prices

Green steel refers to steel produced through processes that substantially reduce carbon emissions compared to conventional blast furnace–basic oxygen furnace (BF-BOF) technology. However, the term remains imprecisely defined across global markets. Carvalho & Muslemani (2025) emphasize that there is no universally accepted standard for what qualifies as green steel, because definitions differ based on production pathways, emissions thresholds, and lifecycle boundaries. Technologies commonly associated with green steel include hydrogen-based direct reduction of iron (H_2-DRI), electric arc furnace (EAF) production powered by renewable electricity, and increased scrap recycling. These innovations are essential because the steel sector accounts for an estimated 7 to 9% of global CO_2 emissions, making decarbonization a critical component of global climate strategies (Zhang et al., 2021).

Advances in low-carbon steelmaking have demonstrated significant potential for emissions reduction, but they also introduce new cost structures. Fischer (2024) notes that green steel produced using renewable electricity and high scrap input can reduce emissions by up to 83% relative to global averages. Nevertheless, these technologies remain more capital and energy intensive than conventional production. Rosner et al. (2023), for example, show that hydrogen-based DRI systems require high hydrogen purity and price stability to reach cost parity with natural gas-based alternatives. The dependence on renewable electricity, green hydrogen, and high-quality scrap introduces cost uncertainties that amplify the volatility of green steel prices. This instability is particularly evident in emerging markets where green-steel supply chains are still developing.

Price fluctuations in green steel arise from both supply-side and demand-side forces. On the supply side, volatility in renewable energy prices, hydrogen availability, iron-ore quality, and scrap-metal supply directly affects green-steel production costs. The OECD Steel Outlook report (2025) highlights that even the broader steel market has experienced significant volatility, with prices for flat and long products falling 12% and 17% year-on-year in early 2025 following a period of elevated peaks. These broader commodity market dynamics further magnify cost variability for green steel, whose production remains sensitive to energy and input cost swings. On the demand side, fluctuations are driven by the willingness of buyers to pay a green premium. Recent evidence from European markets suggests that industries are willing to pay an additional €100 to €300 per tonne for green steel, largely due to regulatory pressures and sustainability commitments (Investing.com, 2024). However, Johansson & Kriström (2022) question the long-term viability of such premiums, suggesting that they may diminish as markets mature and cost transparency increases.

These combined forces result in substantial unpredictability in the price of green steel, which has significant implications for industries that depend on sustainable materials, including real estate and construction. Price volatility can lead to uncertainty in budgeting, difficulties in cost estimation, and increased financial risk, particularly for long-term projects with fixed budgets. In emerging economies such as Vietnam, where the green steel market is nascent, and supply chains are not yet stabilized, these challenges may be more acute. Consequently, understanding the dynamics of green steel price fluctuations is essential for assessing financial feasibility and investment willingness in sustainable building projects.

The Context of Green Steel Industry in Vietnam

Vietnam has pledged to reach net-zero greenhouse gas (GHG) emissions by 2050. To meet these climate goals, emissions from its steel industry must peak and then fall. The sector remains heavily carbon-intensive, relying predominantly on BF-BOF processes. Ongoing expansions in BF-BOF capacity will make decarbonizing steel production particularly difficult. Though Vietnam contributes a modest portion of global steel output compared to top producers, it stands out as one of Southeast Asia's most rapidly expanding steel nations. In 2023, it manufactured roughly 19 million tons (Mt) of crude steel, ranking 12th worldwide. Production is forecast to climb to as much as 55 Mt annually by 2060. The steel sector forms a vital foundation for Vietnam's economic progress, driving swift infrastructure growth, strengthening essential industries like construction and shipbuilding, and boosting export earnings and industrial jobs. The Net-Zero Roadmap for Vietnam's Steel Industry assesses the

present state of the country's steel sector and presents four potential development pathways through 2060 including Business-as-Usual, Moderate, Advanced, and Net-Zero. Despite Vietnam's pledge to achieve net-zero emissions by 2050, the challenge is compounded by the nation's relatively new fleet of BF-BOF facilities. Hasanbeigi et al. (2025) although Vietnam faces a higher green steel premium per ton due to its nascent hydrogen infrastructure, the added cost per final product is modest about $285 per passenger car and $790 per 50 m² residential unit, which suggests that adopting green steel would have little effect on end-user affordability.

The real estate sector is Vietnam's largest steel consumer, with construction steel making up most domestic demand. Civil construction steel alone accounts for 66% of construction steel use. After a sharp slowdown in 2022, the Vietnamese real estate market began recovering in late 2023, led by the commercial residential segment. Buyer interest has been strong, with over 65% of new residential units absorbed and about 30% of total listings sold. The upward trend is expected to continue, driven by growing investment in residential, commercial, and industrial projects. Rapid urbanisation in Ha Noi and Ho Chi Minh City has intensified housing demand, prompting developers to accelerate new projects and thereby increasing steel consumption, especially in major and emerging urban areas. A reccent report of TransitionAsia (2025) also highlights the importance of assessing the economic viability of low-carbon steel production. A techno-economic comparison is provided between green steel routes as green scrap-EAF, green H_2-HBI-EAF, and green H_2-DRI-EAF and the conventional BF-BOF process to evaluate their financial implications.

Figure 1. Green Steel Base Price Change - Hot-Rolled Coil in 2025
Source: fastmarkets.com, 2025

In 2025, green steel prices (hot-rolled coil) fluctuated widely in Vietnam, constantly moving from deep declines to short-term recoveries and then declines again. The chart shows that the market experienced significant falls in the beginning of the year, mid-year and early September, while the recoveries in April-May and August were only temporary. Despite the large fluctuations, prices gradually stabilized by the end of the year and remained around -6%, reflecting a market that was still volatile but showing signs of easing in the final months.

Vietnam's steel industry continues to struggle with capacity constraints, outdated equipment, high energy consumption, and environmental risks, leaving domestically produced steel, particularly fabricated steel, no more competitive in quality than imported products and keeping export volumes relatively modest as firms mainly compete within the domestic market.

According to the Ministry of Industry and Trade (MoIT), finished steel production this year is projected to reach 30 million tonnes, a 7% increase, with nearly 17 million tonnes produced in the first seven months, up 9.4% year-on-year. Coated and colour-coated steel recorded the strongest growth at 29.2%, followed by construction steel at 14.6% and hot-rolled coil at 2.9%. Finished steel consumption rose 14.3% to 16.75 million tonnes, while exports reached almost 4.9 million tonnes, up 6.8%, led by a 40.6% surge in cold-rolled coils and additional gains in coated, colour-coated, and construction steel, although exports of steel pipes and HRC fell slightly by 1.2% and 0.8%, respectively.

Perceived Financial Feasibility

Perceived financial feasibility refers to an investor's subjective evaluation of whether a project is financially viable, given its expected costs, risks, and long-term economic benefits. Rooted in feasibility theory and the expectancy–value framework, the concept suggests that individuals are more likely to undertake an action when they believe the anticipated benefits outweigh the associated costs and uncertainties (Vroom, 1964). In the context of sustainable construction, perceived financial feasibility becomes a critical determinant of whether developers and investors are willing to adopt environmentally friendly materials and technologies that often require substantial upfront capital. Financial feasibility has consistently been highlighted as a central driver of green construction decision-making. According to Hwang & Ng (2013), financial concerns particularly initial investment costs and long-term financial returns remain the most significant factors influencing the adoption of green materials and technologies in construction. When investors perceive that sustainable building solutions can deliver measurable economic advantages, such as energy savings, enhanced property value, or stronger rental performance, their likelihood of supporting green projects increases (Darko & Chan, 2016). Conversely, when perceived financial risks are high, investors tend to favor conventional materials over green alternatives.

An important element shaping perceived financial feasibility is the cost stability of green materials. As green steel remains an emerging product with relatively immature production ecosystems, its price is more susceptible to volatility. Mohandes et al. (2025) conducted a global empirical study and identified key risk factors in green building construction, including cost overruns, funding uncertainty, and the unpredictability of green material supply. This issue is especially prominent in emerging markets, where green supply chains are still developing and cost predictability is lower. Empirical studies in Asia indicate that investors are generally cautious about adopting new materials when their prices are unstable or when market information is insufficient (Alattyih et al., 2020). Financial support mechanisms also play a pivotal role in shaping perceived financial feasibility. Policies such as tax incentives, green financing programs, and government subsidies can significantly mitigate perceived risks. Research by Zhang et al. (2011) demonstrates that government interventions can reduce financial barriers and encourage firms to adopt sustainable construction practices. In the Vietnamese market, where green credit frameworks and ESG requirements are becoming more influential, supportive financial mechanisms may help offset the negative impact of green material price fluctuations on perceived feasibility.

Investment Willingness

Investment willingness in sustainable building projects refers to the inclination of investors, developers, or stakeholders to allocate financial resources toward green construction initiatives. This concept captures the intention to invest in projects that incorporate environmentally friendly materials, energy-efficient technologies, and low-carbon designs, reflecting both economic considerations and normative motivations (Ajzen, 1991). In the context of sustainable real estate, investment willingness is influenced by perceptions of financial feasibility, expected returns, regulatory incentives, and the potential reputational benefits associated with sustainability. From a theoretical perspective, the Theory of Planned Behavior (TPB) provides a useful framework for understanding investment willingness. According to Ajzen (1991), behavioral intention is determined by three components: attitude toward the behavior, subjective norms, and perceived behavioral control. In sustainable building investment, attitude reflects positive beliefs about long-term benefits, such as energy savings, enhanced property value, and corporate image enhancement. Perceived behavioral control is closely related to investors' assessment of their ability to manage financial and operational risks, while subjective norms encompass pressures from stakeholders, tenants, and government policies that promote green building adoption.

Empirical studies indicate that financial considerations play a central role in shaping investment willingness. Deng & Wu (2013) found that developers in Singapore were motivated to invest in Green Mark-certified residential buildings due to potential economic returns, including higher resale values and rental premiums, despite higher initial costs. Similarly, Kumah et al. (2022) reported that built-environment professionals in Ghana considered long-term benefits such as energy savings, occupant comfort, and reduced life-cycle costs when evaluating willingness to pay for green buildings. These findings highlight the importance of both upfront costs and anticipated financial gains in influencing investment decisions. Beyond financial

incentives, non-monetary benefits also affect investment willingness. For example, Wang et al. (2024) investigated user-level willingness to pay for green real estate projects in Asia and found that perceived usefulness and perceived behavioral control significantly affected investment intent. Their study demonstrates that confidence in one's ability to make sustainable choices, as well as the recognition of environmental benefits, are key determinants of willingness. In emerging markets, such as Vietnam, the willingness to invest in green building projects is further shaped by policy frameworks, market demand, and financing availability. Government incentives, such as tax breaks or preferential loans, can encourage investment, whereas the absence of robust green finance mechanisms may constrain willingness (IFC, 2023). Market demand from environmentally conscious tenants, particularly multinational corporations, also increases developers' motivation to incorporate green features into new constructions.

Hypothesis Development

Green steel, as a low-carbon alternative to conventional steel, is a critical input in sustainable building projects. However, its price is generally higher and more volatile due to factors such as limited supply, production costs, and fluctuating demand in the global market (World Steel Association, 2023). For developers and investors, price volatility can directly affect the perceived financial feasibility of sustainable projects, defined as the assessment of whether the project's costs, risks, and expected returns are acceptable for investment (Kumah et al., 2022). High fluctuations in green steel prices increase uncertainty regarding project budgets and return on investment. Developers may perceive greater financial risk, potentially reducing their confidence in the economic viability of sustainable buildings. Conversely, stable or predictable prices reduce uncertainty and enhance perceived feasibility, facilitating investment planning (Deng & Wu, 2013). Additionally, Johnson et al. (2025) note that emerging green steel markets continue to face challenges related to energy costs and infrastructure, contributing to ongoing cost variability and unpredictability. Based on these findings, the authors proposed the following hypothesis:

H1: Green steel price fluctuation significantly affects perceived financial feasibility towards sustainable building projects in Vietnam.

Perceived financial feasibility plays a decisive role in shaping investment intentions in sustainable building projects. When investors or developers perceive a project as financially viable, which means its expected returns, cost structure, and risk profile appear acceptable and they are more likely to commit capital to sustainable construction. Prior studies consistently show that financial feasibility perceptions strongly influence investment decisions across green real estate markets. For instance, Deng & Wu (2013) found that the financial performance of green-certified buildings, including higher resale values and rental premiums, enhances developers' willingness to invest by strengthening their confidence in project viability. Similarly, Kumah et al. (2022) demonstrated that built-environment professionals' willingness to pay for green buildings is significantly driven by beliefs about long-term financial benefits such as energy savings and reductions in life-cycle costs. More recently, Wang et al. (2024) showed that perceived behavioral control, largely shaped by perceived financial capacity and feasibility, substantially increases users' willingness to pay for green real estate in Asian markets. These findings suggest that when sustainable building projects are viewed as financially feasible, investors exhibit greater confidence, lower risk perception, and stronger investment motivation. Based on these findings, the authors proposed the following hypothesis:

H2: Perceived financial feasibility significantly affects investment willingness towards sustainable building projects in Vietnam.

Fluctuations in the price of green steel can have a direct impact on investors' willingness to invest in sustainable building projects. Because structural steel is a major cost component in mid- and high-rise construction, volatility in green steel pricing raises uncertainty about total project budgets, profit margins, and cash-flow projections. Research consistently shows that high cost variability in green materials, particularly materials with immature supply chains, tends to discourage investment due to perceived financial risks. When hydrogen costs exceed that threshold, production costs of green steel rise sharply, undermining project economics (Rosner et al., 2023). TransitionAsia (2025) reports that the cost of green steel remains significantly higher and more volatile than conventional steel because of unstable hydrogen prices and fluctuating carbon costs, making long-term cost planning difficult for developers. Moreover, Johnson et al. (2025) highlight that green steel markets, especially in emerging economies, face continuing instability due to uncertainties in clean energy infrastructure and input supply, which further reduces investor confidence. Collectively, these findings suggest that as green steel prices become more volatile, investors perceive higher financial risk and exhibit lower willingness to commit capital to sustainable building projects. Based on these findings, the authors proposed the following hypothesis:

H3: Green steel price fluctuation significantly affects investment willingness towards sustainable building projects in Vietnam.

Fluctuations in green steel prices can influence investment willingness primarily through their impact on perceived financial feasibility. Because green steel production relies heavily on cost-sensitive inputs, notably green hydrogen, any instability in these

input markets translates into uncertainty about project profitability and long-term cost control. OECD's assessment of hydrogen economics in emerging economies demonstrates that hydrogen prices remain highly volatile due to financing risks, market immaturity, and elevated capital costs, thereby making cost projections less predictable for downstream users such as steel producers (Lee & Saygin, 2023). This instability is financially consequential as Rosner et al. (2023) show that hydrogen-based direct reduction of iron only becomes cost-competitive if hydrogen prices fall near US$1.63–1.70 per kilogram; deviations above this threshold sharply reduce financial viability. Broader techno-economic analyses also reveal wide cost ranges for green hydrogen-based steel production depending on electricity, hydrogen, and capital cost trajectories, underscoring how cost volatility undermines investor confidence (METI, 2024). Collectively, these findings suggest that when green steel prices fluctuate, investors perceive higher financial risk and lower feasibility, which subsequently reduces their willingness to invest in sustainable building projects.

H4: Perceived financial feasibility mediates the relationship between green steel price fluctuation and investment willingness towards sustainable building projects in Vietnam.

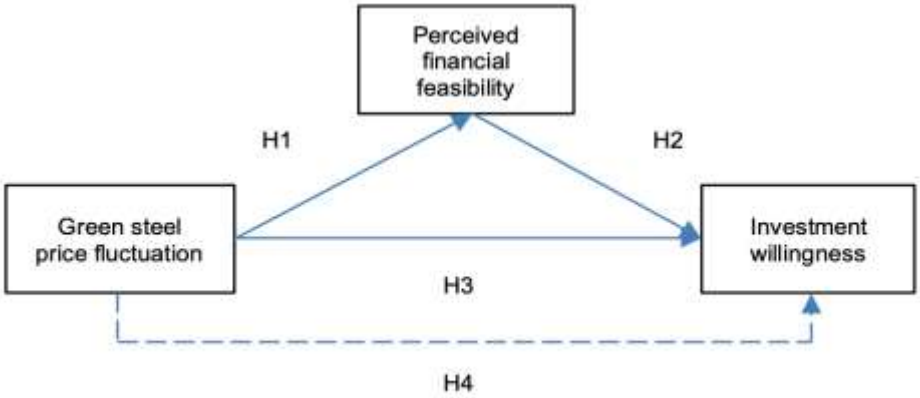

Figure 2. Research Model

III. METHODOLOGY

Research Approach and Measures

This study adopts a quantitative research approach to empirically examine the relationships between green steel price fluctuations, perceived financial feasibility, and investment willingness in sustainable building projects in Vietnam. A structured survey questionnaire was designed based on established theoretical frameworks including the Expectancy–value theory (Vroom, 1964) and the Theory of Planned Behavior (Ajzen, 1991), which underpin the conceptual model developed in this research.

Key constructs were operationalized using validated measurement scales adapted from prior studies in green building and sustainable construction literature. The Green Steel Price Fluctuation (GSPF) construct was measured by 6 items capturing investors' perceptions of market, logistics, and economic and regulatory associated with construction material price (Gunduz et al., 2025). The Perceived Financial Feasibility (PFF) scale with 4 items will inherit and adjust from the important financial indicators identified by Ramezani et al. (2025) to reflect investment costs, operating costs, payback ability, and financial risks in green construction projects. The Investment Willingness (INW) construct with 6 items measured the willingness to invest on the environmentally sustainable startups from the perspective of private investors (Voß et al., 2025).

All items utilized a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Prior to full deployment, the questionnaire underwent expert review and a pilot test to ensure clarity, relevance, and reliability of the measures. The research model and hypotheses were tested using structural equation modeling (SEM) to analyze both direct and mediated relationships among constructs.

Sample and Data Collection

The target population for this study included three key stakeholder groups in the Vietnamese sustainable construction and steel industry: (1) private investors with experience in green building or sustainable construction projects, (2) representatives from real estate and construction companies responsible for investment and procurement decisions, and (3) managers or decision-makers from steel manufacturing firms involved in supplying green steel. These groups were chosen because they are directly involved in investment decisions, material sourcing, and financial evaluation in the context of sustainable building projects, making them particularly relevant for assessing perceptions of green steel price fluctuations, financial feasibility, and investment willingness.

A structured direct survey was employed to collect data. Respondents were recruited using a combination of purposive and snowball sampling techniques to ensure that participants had sufficient knowledge and experience related to green construction and steel markets. Invitations were sent via professional networks, industry associations, corporate contacts, and social media platforms targeting construction and steel professionals.

IV. FINDINGS AND DISCUSSION

Descriptive Statistic Results

Table 1 presents the demographic characteristics of the 237 respondents involved in this study. Overall, the sample reflects a diverse and relevant cross-section of stakeholders in Vietnam's real estate, construction, and steel industries, those who are most directly involved in decisions related to sustainable building investment and the adoption of green steel. In terms of gender distribution, male respondents constitute 64.1% of the sample, which is consistent with the male-dominated nature of the construction and steel sectors in Vietnam. Regarding age, the majority of participants (45.6%) fall within the 31–40 age group, representing mid-career professionals who typically hold managerial or decision-making responsibilities. Respondents aged 41–50 years account for 26.6%, further strengthening the representation of experienced practitioners in investment and procurement roles. Educational attainment is relatively high, with 54.0% holding a bachelor's degree and 38.0% possessing a master's degree. This indicates that most respondents are well-educated and likely capable of evaluating financial, technical, and sustainability aspects of construction projects. Similarly, professional experience is well distributed such as 35.4% have 5–10 years of experience, and 30.8% have 11–15 years. More than half of the sample therefore consists of individuals with substantial industry exposure, which enhances the reliability of their assessments regarding green steel price fluctuations and financial feasibility. In terms of organizational affiliation, real estate developers represent the largest group (38.8%), followed by construction firms (25.7%). Steel manufacturers and suppliers account for 17.3%, while private investors contribute 13.5% of the sample. This diversity helps ensure that multiple perspectives across the green building value chain are captured. Job positions are also varied: managers and senior managers make up 43.0% of the respondents, while 17.3% are directors or executives. These groups typically participate directly in procurement, budgeting, and investment decisions

Table 1. Demographics of Respondents

Demographics		**Frequency**	**Percentage (%)**
Gender	Male	152	64.1
	Female	85	35.9
Age group	22–30 years old	46	19.4
	31–40 years old	108	45.6
	41–50 years old	63	26.6
	Above 50 years old	20	8.4
Education level	Bachelor's degree	128	54.0
	Master's degree	90	38.0
	Doctorate	19	8.0
Years of professional experience	Less than 5 years	28	11.8
	5–10 years	84	35.4
	11–15 years	73	30.8
	Above 15 years	52	21.9
Type of organization	Real estate development company	92	38.8
	Construction/contractor firm	61	25.7
	Steel manufacturing / steel supplier	41	17.3
	Private investor / investment firm	32	13.5
	Government/industry association	11	4.6
Job position	Manager / Senior manager	102	43.0
	Director / Executive	41	17.3

Demographics		**Frequency**	**Percentage (%)**
Gender	Male	152	64.1
	Technical/Engineering specialist	54	22.8
	Procurement / Investment officer	40	16.9
Total		**237**	**100**

Reliability and Validity Assessment

Table 2 presents the reliability and convergent validity results for the three constructs used in the study. Overall, the measurement model demonstrates strong internal consistency and satisfactory convergent validity, meeting the accepted thresholds in SEM literature. The Cronbach's Alpha values for GSPF (0.966) and INW (0.955) indicate excellent internal reliability, well above the recommended minimum of 0.70. The PFF construct also shows acceptable reliability with a Cronbach's Alpha of 0.795, suggesting consistent responses among items. The rho_A values, which offer a more accurate reliability estimation in PLS-SEM, align closely with the alpha values and reinforce the robustness of the measurement scales. Besides, Composite Reliability (CR) values further support the reliability of the constructs. All three constructs exhibit CR scores above 0.86, surpassing the commonly accepted threshold of 0.70. Specifically, GSPF (0.973) and INW (0.964) demonstrate very high reliability, indicating that the items consistently reflect their underlying latent variables. The CR value for PFF (0.864) is also strong, confirming adequate construct reliability.

Table 2. Reliability and Convergent Validity of Constructs

	Cronbach's Alpha	**rho_A**	**Composite Reliability**	**Average Variance Extracted (AVE)**
GSPF	0.966	0.967	0.973	0.856
INW	0.955	0.956	0.964	0.816
PFF	0.795	0.818	0.864	0.616

The convergent validity is verified through the Average Variance Extracted (AVE). The AVE values for GSPF (0.856) and INW (0.816) are substantially higher than the required minimum of 0.50, reflecting excellent convergent validity and suggesting that each construct explains a large proportion of variance in its indicators. The AVE for PFF (0.616) also exceeds the threshold, indicating that the items collectively capture the construct effectively.

The results presented in Table 3 provide strong evidence that discriminant validity is upheld within the measurement model. Two complementary techniques—the Fornell–Larcker Criterion and the Heterotrait–Monotrait Ratio (HTMT)—were applied to evaluate whether the constructs in the study are empirically distinct from one another (Fornell & Larcker, 1981; Henseler et al., 2015). The Fornell–Larcker Criterion confirms discriminant validity by comparing the square root of the Average Variance Extracted (AVE) for each construct with its correlations with other constructs (Fornell & Larcker, 1981). The diagonal values in the table represent the square roots of AVE, which must be greater than the inter-construct correlations to ensure adequate discriminant validity. The results show that the square root of AVE for GSPF (0.925), INW (0.904), and PFF (0.785) all exceed their respective correlations with other constructs. For instance, the correlation between GSPF and PFF is 0.652, which is notably lower than GSPF's √AVE of 0.925. Similarly, INW shows a lower correlation with PFF (0.450) compared to its √AVE of 0.904. These comparisons indicate that each construct shares more variance with its own indicators than with any other construct, thereby confirming good discriminant validity.

Table 3. Fornell-Larcker Criterion and Heterotrait-Monotrait Ratio (HTMT)

		GSPF	**INW**	**PFF**
Fornell-Larcker Criterion	GSPF	0.925		
	INW	0.425	0.904	

	PFF	0.652	0.450	0.785
Heterotrait-Monotrait Ratio (HTMT)	GSPF			
	INW	0.443		
	PFF	0.703	0.532	

Besides, the HTMT ratios provide an even more stringent assessment of discriminant validity by measuring the degree of overlap between constructs (Henseler et al., 2015). Values below 0.85 are generally recommended to indicate acceptable discriminant validity, with values below 0.90 considered adequate in more tolerant research contexts. All HTMT values in the table fall comfortably within the acceptable range, with GSPF–INW at 0.443, GSPF–PFF at 0.703, and INW–PFF at 0.532. These values suggest that the constructs are sufficiently distinct from one another and that there is no multicollinearity or conceptual redundancy among them (Hair et al., 2022). Both the Fornell–Larcker Criterion and HTMT results consistently support the conclusion that discriminant validity has been firmly established in the measurement model.

Structural Measurement Assessment and PLS-SEM Result

The structural equation modeling results presented in Table 4 provide empirical support for the hypothesized relationships among green steel price fluctuation (GSPF), perceived financial feasibility (PFF), and investment willingness (INW) in sustainable building projects in Vietnam. The model was evaluated using path coefficients, t-statistics, p-values, and adjusted R^2 values, providing insight into both the direct and mediated effects.

The path coefficient from GSPF to PFF is 0.652, with a t-value of 15.755 and a p-value of 0.000, indicating a strong and statistically significant positive effect. This finding supports H1, suggesting that fluctuations in green steel prices substantially influence investors' perceptions of financial feasibility. High volatility increases uncertainty regarding project costs and expected returns, reinforcing prior research that cost instability in green materials can heighten perceived financial risk (Mohandes et al., 2025; Rosner et al., 2023).

The relationship between PFF and INW shows a coefficient of 0.301, with a t-value of 3.168 and a p-value of 0.002, confirming H2. This indicates that when investors perceive sustainable building projects as financially feasible, their willingness to invest increases. This aligns with the Theory of Planned Behavior, where perceived control and expected outcomes significantly shape behavioral intentions (Ajzen, 1991).

The direct effect of GSPF on INW is also significant ($\beta = 0.230$, $t = 2.184$, $p = 0.029$), supporting H3. This suggests that green steel price volatility not only affects investment willingness indirectly through perceived financial feasibility but also has a direct influence on investors' decision-making, likely due to immediate concerns over budget planning and risk exposure.

Table 4: Structural Equation Modelling Results

Path	**Original Sample (O)**	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics (|O/ STDEV|)**	**P Values**	**Hypothesis conclusion**
GSPF -> PFF	0.652	0.660	0.041	15.755	0.000	Accepted
PFF -> INW	0.301	0.319	0.095	3.168	0.002	Accepted
GSPF -> INW	0.230	0.209	0.105	2.184	0.029	Accepted
GSPF -> PFF -> INW	0.196	0.212	0.069	2.838	0.005	Accepted
Adjusted R^2: PFF = 0.423; INW = 0.226						

The mediated effect of GSPF on INW through PFF is 0.196, with a t-value of 2.838 and p-value of 0.005, confirming H4. This finding indicates a partial mediation, showing that perceived financial feasibility plays an important intermediary role in how

green steel price fluctuations shape investment willingness. The result highlights that financial perception is a key mechanism linking market volatility to investment decisions, consistent with prior literature emphasizing the centrality of perceived financial risk in green construction adoption (Deng & Wu, 2013; Kumah et al., 2022).

The adjusted R^2 values indicate that 42.3% of the variance in PFF is explained by GSPF, while 22.6% of the variance in INW is explained by both GSPF and PFF. These values suggest a moderate explanatory power, implying that while green steel price fluctuations and perceived financial feasibility are important determinants, other factors such as regulatory incentives, market demand, and investor experience may also influence investment willingness

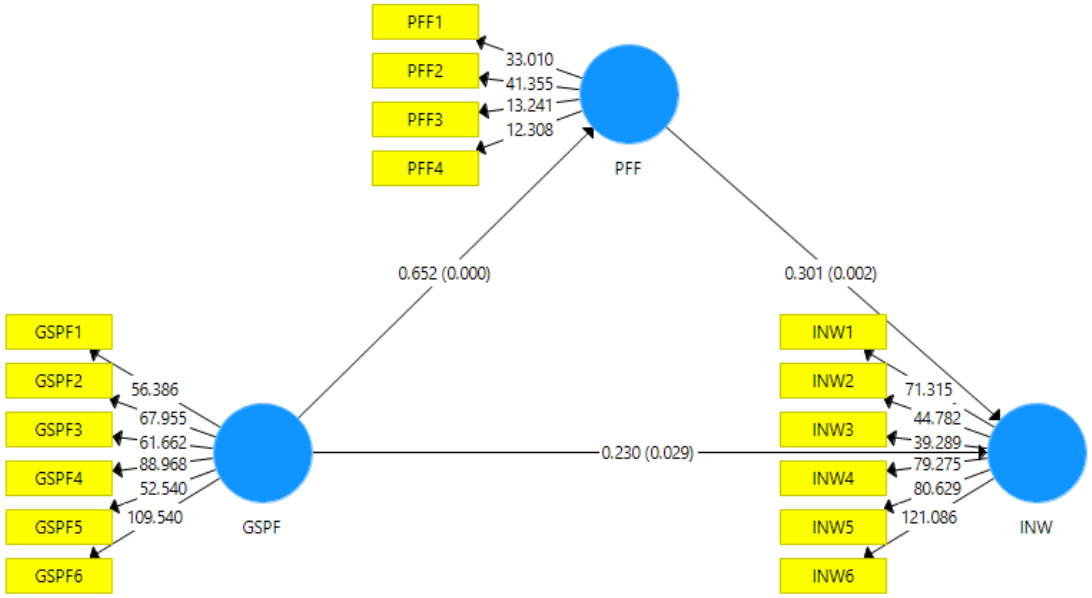

Figure 3. PLS Bootstrapping Model

V. IMPLICATIONS AND CONCLUSION

Theoretical Contribution

This study advances the literature on sustainable construction and green materials investment in three key ways. It empirically demonstrates how green steel price volatility affects perceived financial feasibility and investment willingness in emerging markets, particularly Vietnam, addressing a gap on how short-term market fluctuations influence investor behavior (Johansson & Kriström, 2022; Kumah et al., 2022). Besides, the study contextualizes the Theory of Planned Behavior (Ajzen, 1991) and expectancy–value theory (Vroom, 1964) by showing that perceived financial feasibility mediates the relationship between price volatility and investment intentions, integrating economic risk evaluation into behavioral models of green investment. Finally, the study provides insights from an emerging market perspective, highlighting that while financial considerations are universal, the effects of cost fluctuations are more pronounced in markets with nascent green steel supply chains and evolving policy frameworks.

Practical Implications

The findings of this study offer several practical implications for policymakers, investors, developers, and industry stakeholders in Vietnam and similar emerging economies. Firstly, the significant impact of green steel price fluctuations on perceived financial feasibility underscores the need for stabilizing mechanisms in the supply chain. Strategic interventions such as long-term supply contracts, price hedging, and stockpiling could reduce short-term volatility, providing investors and developers with more predictable project costs. These measures are especially critical in emerging markets where green steel production and supply chains are still maturing.

Secondly, the mediating role of perceived financial feasibility suggests that targeted financial instruments can effectively enhance investment willingness. Policymakers and financial institutions could introduce green loans, low-interest financing, and guarantees for cost overruns to mitigate perceived financial risks. By reducing uncertainty about project profitability, such instruments can encourage developers to adopt sustainable building practices despite the higher and volatile costs of green steel.

Thirdly, policy and regulatory frameworks play a vital role in promoting green building investments. Clear and consistent policies linking environmental compliance, carbon reduction incentives, and tax benefits to the use of low-carbon materials can reduce uncertainty and reinforce investor confidence. Transparent regulatory guidance can help developers and investors make informed long-term decisions, aligning financial objectives with sustainability goals.

Fourthly, enhancing market transparency and information availability is crucial. Providing real-time data on green steel prices, lifecycle cost analyses, and comparative financial modeling can help investors better assess the risks and benefits of sustainable projects. Market education and advisory services can also improve stakeholders' confidence in the financial feasibility of green construction, mitigating hesitation due to volatile material costs.

Finally, developers and firms should incorporate scenario-based planning into project evaluations, considering both cost fluctuations and potential long-term benefits such as energy savings, higher resale values, and reputational gains. Integrating financial, operational, and environmental factors into investment decisions can strengthen commitment to sustainable construction, ensuring that green initiatives remain viable even under uncertain market conditions. Collectively, these implications highlight that effective coordination among policymakers, industry, and financial institutions is essential to translate sustainability ambitions into tangible investment actions.

Limitation and Future Research Directions

This study has several limitations that should be acknowledged. It relies on cross-sectional survey data, capturing perceptions and intentions at a single point in time, which limits the ability to establish causal relationships; future research could adopt longitudinal designs to examine how green steel price fluctuations influence investment decisions over time. Besides, the sample is restricted to Vietnam, which may limit the generalizability of findings to other emerging markets with different regulatory frameworks, market maturities, or cultural contexts; comparative cross-country studies could provide broader insights. Finally, while this study focuses on perceived financial feasibility as a mediator, other factors such as organizational sustainability policies, environmental values, and risk tolerance may also shape investment willingness, offering avenues for future research to explore additional psychological, institutional, or market determinants of green building investment behavior.

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